SCIENTIFIC CREATIVITY AS CORRELATE OF SENIOR SECONDARY SCHOOL THREE (SSS III) STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS IN BIU METROPOLIS, NIGERIA

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Abstract

This study examined the senior secondary school students' scientific creativity in relation to their academic achievement in physics. The study adopted the correlational research design. The population for the study consisted of all the SS III Physics students in six public co-educational secondary schools in Biu metropolis. A total of 120 SS III Physics students were involved from the six co-educational public schools in Biu metropolis, using intact classes. The instruments used for collection of data were Physics Scientific Creativity Test (PSCT) and Physics Achievement Test (PAT). The reliability coefficient of PAT using Kuder-Richardson 20 formula was 0.81, while that of PSCT using Cronbach Alpha stood at 0.78. Two research questions and two hypotheses, which were tested at 0.05 level of significance, guided the study. Data obtained from the study were analyzed using mean, standard deviation and Pearson Product Correlation Coefficients. The results from the study showed that there was a positive and significant correlation between the academic achievement of the students and their scientific creativity in Physics. The results also showed no significant difference between male and female creativity and academic achievement. In view of this, it was therefore, recommended that educational institutions should strive to improve students' academic achievement through scientific creativity.

Key Words: Academic Achievement, Physics, Scientific Creativity.

Introduction

In today's fast changing world, the study of physics has become a basic necessity. It is one of the fundamental scientific disciplines studying by students in secondary schools. Physics as a discipline serves as a frontier to other fields such as medicine, engineering, pharmacy, geology among others. It is a discipline of questioning, experimenting, inquiring and thinking, which engage students in innovation and creativity within the science circle. Physics, being the pivot of science and technological breakthrough of a nation is considered a difficult subject by

secondary school students. Among the sciences, Physics is considered a fundamental subject. It equips learners with systematic thinking and provides the theories necessary for understanding the mechanics of how the things mankind relies on work. Physics provides students with analytical, problem solving and quantitative skills which are relevant for other sciences. Discoveries in Physics led to the invention of the satellite. (Imo & Kefas, 2016; Mkapanag, 2016).

The study of physics helps an individual to gain knowledge about life and the world in which he or she lives. However, as Physics is being perceived to be conceptual, difficult, abstract and uninteresting, involving different representations such as experiment, formulae and calculations, graphs, among others; one may not be able to access the fullness of information and resources available to gain full knowledge about the subject without relating creativity to intellectual activity and knowledge (Olatoye et al., 2010). The question therefore, arises as to whether students' creativity towards innovation would influence their achievement in Physics. Hence the purpose of this study.

The subject of creativity as a divine, mystical, or spiritual phenomenon has fascinated human beings throughout history. Although creativity is generally regarded as an innate, natural ability, or talent, it withstands universally acceptable definition. It can be conceptualized as the ability to generate ideas, digging deeper into ideas, openness, and courage to explore ideas and listening to one's inner voice. This implies that creativity is an open exploration or search for ideas in which one generates many ideas (Kamonjo, et al., 2015). In the study of Mkpanang (2016), creativity is considered as a process that connotes interplay among several interactive cognitive, affective and psychomotor domains, which would help students generate new ideas that will contribute substantially to their intellectual domains. According to Olatoye et al. (2010), creativity is seen as an act of creating something new through imaginative skills. Nwankwo and Okafor (2017) define creativity as ability to generate multiple and unique solutions to a problem. According to them, it is bringing into existence something which did not exist before either as a product, a process or a thought.

Creativity has been perceived as an essential criterion in education and as such, can be taught in the classroom. Elaldi and Batdi (2016) argued that a feasible objective for Physics education is to enhance the creative thinking and problem solving of students. They stressed further that in order to develop creative skills, one must be provided with practice, motivation, involvement, interaction with teachers and other students and structure. In support of this, Nwankwo and Okafor (2017) posit that it is important to ascertain the creative ability of students in Physics which would translate to their readiness in achieving national consciousness and development through creativity.

Scientific creativity depends not only on well-structured imaginations coupled with habits of hard work but, more importantly on the ability to integrate in functional ways, a wider range of ideas, concepts and skills. Freeman (1971) states that creative development can be enhanced through the use of discovery methods.

Torrance (1981) argues that perhaps the most promising areas if we are interested in what can be done to encourage creative talent to unfold, is that of experimentation with teaching procedures, which will stimulate students to think independently, to test their ideas and communicate them to others. Therefore, the teacher is to guide and facilitate learning rather than to tell. According to Olatoye et al. (2010), creative thinking has two aspects, namely, divergent thinking and convergent thinking. Convergent thinking deals with intellectual ability to think of many original, diverse and elaborate thought, while divergent thinking is the intellectual ability to logically evaluate, critique and choose the best ideas from selection of ideas.

In furtherance to this, the researchers reviewed a number of studies carried out by scholars whereby achievements of students were correlated with their scientific creativity. Olatoye et al. (2010) who examined the relationship between creativity and academic achievement of students in business administration found a very negative insignificant relationship between creativity and academic achievement. Nami, Marsooli and Ashouri (2014) studied the relationship between creativity and academic achievement using a sample size of 72 students in science subjects. Findings showed a positive significant relationship. Mkpanang (2016) examined the influence of creative style and gender on students' achievement in Physics and found a positive significant influence on students' achievement in Physics. In another study on creativity, Naderi et al. (2008) who examined creativity, gender and achievement found a weak relationship between achievement and creativity. Elaldi and Batdi (2016) studied effects of different applications on creativity and academic achievement of students in physics and found that different applications had positive effects on their academic achievement.

However, the findings of these studies may have been influenced by a number of confounding factors such as the kind of test used, the nature of the sample, the study location, the procedures adopted by the researchers, the design adopted and even the attitudes of the researchers towards the investigation, among others. Specifically, two of the reviewed studies were premised on research questions only, as no hypotheses were tested. Based on these, therefore, there is need for further investigation. Furthermore, some of the reviewed literature revealed positive correlation between creativity and achievement of students in physics. Creativity is a mental process that involves the production of new ideas or concept. It is therefore, seen as key to students' proper understanding of physics. This was the motivational factor for this study. The main focus of this study was to establish the extent to which students' scientific creativity in Physics is related to their academic achievement in the subject. In addition to that, the difference between the scientific creativity and academic achievement of male and female students was also examined. Gender was used as a moderating variable to examine whether creativity and achievement discriminate between male and female students or gender sensitive. Specifically, the study was designed to examine the relationship between the scientific creativity and academic achievement of SSIII students in Physics. Therefore, the study was guided by the following research questions and hypotheses.

Theoretical Framework

The psychoanalytical theory propounded by Freud (1959) was found appropriate for this study. The theory proposed that the greater part of one's personality lies in unconscious. This implies that a creative person cannot be studied by observing his overt behaviour because most of the impressed desires, thoughts, and feelings remain in unconscious and continuously influence the person's behaviour. The theory is relevant to this present study because creativity originates from a conflict with the unconscious mind, which aims at developing students creative thinking independently.

Research Questions:

1. What is the relationship between scientific creativity and academic achievement mean scores of SSIII students in Physics in Biu metropolis?

2. Will there be any significant difference between the scientific creativity and academic achievement mean scores of male and female students in Physics in Biu metropolis?

Hypotheses:

1. There is no significant positive correlation between the scientific creativity and academic achievement mean scores of SS III students in Physics in Biu metropolis.
2. There is no significant difference between the scientific creativity and academic achievement mean scores of male and female SS III students in Physics in Biu metropolis.

Methodology

In an attempt to correlate the scientific creativity and academic achievement of Senior Secondary three (SSIII) students in Biu metropolis, the researchers adopted correlational research design for the study. The researchers considered the design appropriate for the study because the study aims at establishing the relationships between two variables using correlation coefficients. All the SSS III students who offered Physics the six public co-educational schools in Biu metropolis made up the population. All the six co-educational government secondary schools were involved in the study. The choice of using co-educational government schools was based on the fact that the students had similar learning environment. The sample for the study consisted of 120 SSIII Physics students, from the six schools using intact classes. The choice of SSIII Physics students was based on the fact that they were mentally, emotionally and physically fit to respond to the creativity test. In addition to that, they were the immediate students preparing to sit for WAEC or NECO in 2019/2020 academic session.

The instruments used for collection of data were Physics Achievement Test (PAT) and Physics Scientific Creativity Test (PSCT). The instruments were developed by the researchers and validated by experts in the fields of Physics Education and

Psychology. The instruments were trial tested by carrying out a pilot study on 40 students from a school that was not part of the selected schools. The data obtained from the pilot study was used to establish the reliability coefficients of the instruments. The internal consistency of PAT using Kuder-Richardson 20 formula (KR20) was 0.81, while that of PSCT using Cronbach Alpha stood at 0.78. The choice of using KR20 for internal consistency of PAT was based on the fact that the items were scored dichotomously (right or wrong). Likewise, the choice of using Cronbach Alpha for internal consistency of PSCT was based on the fact that it provides a reliability estimate for instrument composed of items having more than one-point value.

The PAT consisted of 25 multiple-choice questions drawn from the concepts of electricity and magnetism. The 25 items have four options A to D with one correct option in line with Senior School Certificate Examination standard. The test scores were categorized into three levels of achievements as follows: those with scores 0-49% were regarded as low achievers, those with scores 50-59% as average achievers, while those with scores 60% and above as high achievers. For PAT, each correct option attracted 5 marks, while incorrect option attracted 0 mark. So, the maximum mark obtainable was 100%, while the minimum mark obtainable was 0%.

The PSCT also consisted of 25 structured statements (related to electricity and magnetism) based on aspects of creativity such as sensitivity to problems, criticizing experimental procedure, recognition of relationships, selecting a correct hypothesis from given alternatives, generating hypothesis from a particular topic, flexibility in reasoning, among others. Then one question was developed for each structured statement. Each correct answer attracted 4 marks, while wrong answer attracted 0 mark. So the maximum mark was 100%, while the minimum mark was 0%.

The study was conducted during the first term of 2019/2020 academic calendar, and lasted for six weeks. The researchers visited the six schools and sought for permission from the principals and staff of the schools and made their intention known to the physics teachers and students of the schools. All the topics covered were made known to the researchers for the purpose of knowing the type of achievement test items to be drawn. This took place just before the schools' resumption for 2019/2020 academic session. In the first week of resumption, the researchers visited the schools and sensitized the students on the concepts that would serve as the reference point for the achievement test and creativity items. For Physics scientific creativity questionnaire, the researchers also sensitized the students on how to respond to them. The Physics teacher of each sampled school was given each copy of lesson plan for PAT and PSCT. The teaching exercise began in the second week by the physics teachers of each sampled school and lasted for four weeks using the school normal time table for physics lesson. A copy of PAT and PSCT was then given to the physics teachers for further scrutiny before they were administered on the students. The administration of the instruments was done in the sixth week. The researchers were physically present with them at the time of administration of the instruments.

Two research questions and two hypotheses were formulated to guide the study. Creativity in Physics was measured by the Physics Scientific Creativity Test (PSCT), while the Physics Achievement Test (PAT) was used to measure achievement in Physics. The students' scores in the PSCT and PAT were expressed in means and standard deviations. The mean scores of PSCT and PAT were then correlated. The data obtained from the study were analyzed using descriptive and inferential statistics. The research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance. The Statistical Package for Social Sciences (SPSS) was used to compute the Pearson Product Correlation coefficients.

Results

Research Question One: What is the relationship between scientific creativity and academic achievement mean scores of the SS III students in Physics in Biu metropolis?

To answer the research question one, the level of creativity and academic achievement mean scores of the students is presented in Table 1. From the table, the mean scores of 57.68 and 58.33 with standard deviations of 6.01 and 5.53 were recorded for scientific creativity and academic achievement respectively. The mean difference stood at 0.65. From the results, it implied that since the levels of creativity and academic achievement of students are high, scientific creativity may likely enhance their performance in Physics.

Table 1: Creativity and Academic Achievement Mean Scores of SS III Students

Variable	N	Mean	Std. Dev.	Mean Diff.
Scientific Creativity	120	57.68	6.01	
				0.65
Academic Achievement	120	58.33	5.53	

Research Question Two: Will there be any significant difference between the creativity and academic achievement mean scores of male and female SS III students in Physics?

To answer research question II, the creativity and academic achievement mean scores of the male and female students were presented in Table 2. The analysis in Table 2 revealed that the scientific creativity mean scores of 52.23 and 51.96 with standard deviations of 4.52 and 4.98 were recorded for male and female students respectively. Similarly, from the table, the academic achievement mean scores of 53.66 and 52.87 with standard deviations of 3.98 and 3.79 were recorded for male and female students. The mean difference of male and female creativity mean scores was 0.27, while that of their academic achievement was 0.79. However, the mean scores were subjected to correlational statistic in Table 4 to confirm if there was a significant correlation between the two means.

Table 2: Creativity and Academic Mean Scores of Male and Female Students

Variable	Gender	N	Mean	Std. Dev.	Mean Diff.
Scientific Creativity	Male	72	52.23	4.52	0.27
	Female	48	51.96	4.95	
Academic Achievement	Male	72	53.66	3.98	
	Female	48	52.87	3.79	0.79

Hypothesis One: There is no significant positive correlation between the scientific creativity and academic achievement mean scores of SS III students in Physics in Biu metropolis.

The comparison between the scientific creativity and academic achievement of the SS III students was presented in Table 3. From Table 3, the results showed that the P-value of 0.00 is less than the significant level set at 0.05 at degree of freedom, df = 118 ($r = 0.71$, $P < 0.05$). Since the P-value is in the critical region of rejection, then the null hypothesis was rejected. Therefore, there was a significant positive correlation between scientific creativity and academic achievement of the students. The implication of the results is that a high level of creativity would lead to a good mastery of Physics concepts.

Table 3: Comparison between Scientific Creativity and Academic Achievement Mean Scores of SS III Students in Physics

Variable	N	Mean	Std Dev.	df	r	P
Scientific Creativity	**120**	**57.68**	**6.01**			
				118	**0.71**	**0.000**
Academic Achievement	**120**	**58.33**	**5.53**			

P < 0.05; Significant

Hypothesis Two: There is no significant difference between the scientific creativity and academic achievement mean scores of male and female SS III students in Physics in Biu metropolis.

The analysis of the hypothesis two was presented in Table 4. The analysis revealed that the P-value of 0.318 for male and female scientific creativity is greater than the significant level set at 0.05 ($r = 0.413$, $P > 0.05$, df = 118). Similarly, the table showed that the P-value of 0.452 for male and female academic achievement is greater than the significant level set at 0.05 ($r = 0.214$, $P > 0.05$, df = 118). Since the P-value is at the critical region of acceptance, then the null hypothesis was upheld. This implies that there was no significant difference between the scientific creativity and achievement mean scores of male and female SS III students in Physics. The implication of this is that the male and female students have the same level of

creativity and academic achievement. The results also showed that scientific creativity and academic achievement were not gender sensitive.

Table 4: Comparison Between Scientific Creativity and Academic Achievement Mean Scores of Male and Female SS III Students in Physics

Variable	Gender	N	Mean	Std Dev.	df	r	P
Scientific Creativity	Male	72	52.23	4.52			
					118	0.413	0.318
	Female	48	51.96	4.95			
Academic Achievement	Male	72	53.66	3.98			
					118	0.214	0.452
	Female		52.87	3.79			

P > 0.05: Not Significant

Discussion of Findings

The present study examined the relationship between scientific creativity and academic achievement of SS III students in Physics in Biu metropolis, Nigeria. The analysis in Table 1 showed the scientific creativity and academic achievement mean scores of 57.68 and 58.33 with standard deviations of 6.01 and 5.53 for the students. The mean difference stood at 0.65. However, on subjecting the results in Table 1 to inferential statistics (Pearson Moment Product Correlation) in Table 3, revealed that the P-value of 0.000 is less than the significant level set at 0.05 ($r = 0.71$, $P < 0.05$, $df = 118$). Then the null hypothesis was rejected. Therefore, there was a significant positive correlation between the scientific creativity and academic achievement mean scores of the SS III students in Physics. This implies that a high level of creativity is essential for good mastery of Physics concepts. Therefore, in educational practice, scientific creativity should be encouraged among students as a means of achieving higher in science subjects. The finding of this study is in agreement with the studies of Nami et al. (2014), Kamonjo et al. (2015) and Mkpanang (2016) who found that a positive significant relationship existed between creativity and achievement in Physics However, the finding of this present study contradicts that of Olatoye et al. (2010) who found a negative insignificant relationship between creativity and academic achievement of students in business administration.

Table 2 revealed the creativity achievement mean scores of male and female students. From the table, the creativity mean scores of 52.23 and 51.96 with standard deviations of 4.52 and 4.95 were recorded for male and female students. Similarly, the academic mean scores of 53.66 and 52.87 with standard deviations of 3.98 and 3.79 were recorded for male and female students. The creativity mean difference for male and female was 0.27, while their academic achievement mean difference stood at 0.79. On subjecting the results in Table 2 to inferential statistics (Pearson Moment

Product Correlation) in Table 4, it showed that the P-value of 0.318 for male and female creativity is greater than the significant level set at 0.05 ($r = 0.143$, $P > 0.05$, $df = 118$). Likewise, the P-value of 0.452 for male and female academic achievement is greater than the significant level set at 0.05 ($r = 0.214$, $P > 0.05$, $df = 118$). Therefore, the null hypothesis was retained.

This implies that there was no significant difference between the creativity and academic mean scores of male and female students in Physics. Educational implication of this is that scientific creativity and academic achievement were not gender sensitive. Both male and female students had high level of academic achievement and scientific creativity. The finding of this study is in consonance with the study of Olatoye et al. (2010) who found no significant difference between male and female creativity and achievement in business administration, but in contrast with the studies of Deary et al. (2007) and Naderi et al. (2008) who found that there was gender difference in creativity and academic achievement in psychology.

Conclusion

The study revealed that students' scientific creativity in Physics plays a significant role in enhancing academic achievement of students in the subject. This was seen in the findings of the study which showed a positive correlation between Physics students' scientific creativity and their academic achievement in the subject. Students with high level of scientific creativity in Physics also had high Physics achievement in the subject. The study also revealed that scientific creativity and academic achievement were not gender sensitive.

Recommendations

Based on the findings of this study, the following recommendations were provided.

1. Educational institutions should strive to improve students' scientific creativity as a strategy for enhancing their academic achievement in physics.
2. Neither male nor female student should be discriminated in the tasks that require demonstration of scientific creativity.
3. Creative gifted students in science subjects should be nurtured in the interest of nation's innovative economic development.

References

Deary, I. J., Strand, S., Smith, P. & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence, 35* (1), 13-21.

Elaldi, S. & Batdi, V. (2016). Effects of different applications on creativity regarding academic achievement: a *meta-analysis. Journal of Education and Training Studies, 4* (1), 170-179.

Federal Republic of Nigeria, (2014). *National Policy on Education (6ed).* Abuja: NERDC

Freeman, J. (1971). *Creativity, a selected review of research*. London: Society for Research into Higher Education Limited.

Freud, S. (1959). Creativity writers and day dreaming. In J. Strachey (Ed.). *The standard edition of complete psychological works of Sigmund Freud.* London: Hogarth Press.

Imo, G. C. & Kefas, H. (2016). Study habit, science anxiety and self-concept as correlates of senior secondary school two students' attitudes towards science subjects in Jos, Plateau State, Nigeria. *International Journal of Research in Science, Technology and Mathematics Education, 4* (2), 1-10.

Kamonjo, W. F., Okere, O. M. & Wachanga, W. S. (2015). A correlation study of secondary students' academic achievement in Chemistry and their scientific creativity in Chemistry..*International Journal of Scientific Research and Innovative Technology, 2* (5), 86-96.

Mkpanang, J. T. (2016). Influence of creativity style and gender on students' achievement in Physics. *Journal of Education and Practice, 7* (12), 42-46.

Naderi, H., Abdullahi, R.&Tengkuaizan, H. (2008). Male vs female intelligence among undergraduate students: Does gender matter? *Asian Journal of Scientific Research, 1* (5), 539-543.

Nami, Y., Marsooli, H. & Ashouri, M. (2014). The relationship between creativity and academic achievement. *Procedia,* 114, 36-39.

Nwankwo, C. M. & Okafor, T. U. (2017). Refocusing Physics for creativity: An imperative for sustainable development. *African Journal of Science, Technology and Mathematics Education (AJSTME), 3* (1), 126-132.

Ogomaka, P. M., Ebubechukwu, A. O. & Aminu, Y. (2018). Development and validation of creativity assessment instrument in Mathematics for value orientation among junior secondary school students in Imo State. *Journal of Education, 3* (1), 89-96.

Olatoye, R. A., Akintunde, S. O. & Ogunsanya, E. A. (2010). Relationship between creativity and academic achievement of business administration students, South Western Polytechnics, Nigeria. *An International Multi-Disciplinary Journal, Ethiopia, 4* (3), 134-149.

Torrance, E. P. (1981). Status of knowledge concerning education and creativity scientific talent. In P. E. Vernon (Ed.). *Creativity.Harmonsworth* Penguin Book Limited.