PHYSICS STUDENTS' ACQUISITION OF SCIENCE PROCESS SKILLS FOR ENTREPRENEURSHIP: HARVESTING FROM CRADLE

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Abstract
This study examines the levels of acquisition of science process skills in physics among secondary school students. This is premised on the fact that acquisition of science process skills makes students become real scientists, creative and future entrepreneurs. The study was guided by three research questions and two hypotheses. Descriptive survey design was adopted for the study. The study was carried out in Nsukka Education zone of Enugu State. The population of this study is 1,712 students which comprised 879 male and 833 female SS II Physics students from the public senior secondary school in the zone in 2017/2018 session with sample size of 150 students made up of 66 male and 84 female SS 3 physics students and 93 urban and 57 rural students. The sample size was selected using purposive sampling technique from which eight public coeducational schools were sampled out of the 30 public secondary schools. Two instruments titled Science Process Skills Physics Practical Rating Scale (SPSPPRS) and Physics Practical Questions (PPQ) were developed by the researchers for data collection. Reliability coefficient of 0.76 and 0.80 were obtained using Kendal Coefficient of Concordance. Four physics teachers were used as research assistants and raters. Mean and standard deviation (SD) were employed in answering the three research questions, while t-test statistics was used to test the two null hypotheses at 0.05 level of significance. Findings of the study revealed that students have poor basic science process skills acquisition in physics. The basic science process skills that the students have poor acquisition are observing, measuring, classifying, inferring, and predicting. The finding showed that the students only have good communication skill. Findings equally revealed that gender and school location have significant influence on students' acquisition of science process skills among physics students. Based on the findings, it was recommended among others that students should be engaged in regular practical early in life so as to enable them acquire science process skills and become future employers of labour.

Key words: Physics, Science Process Skills, Entrepreneurship

Introduction

Science process skills are the horoscope for effective career in science and entrepreneurship in life. This suggests that science process skills are the compass of direction for scientists. This also means that successful entrepreneurship in sciences

is contingent upon sound acquisition of science process skills. To this end, Ewers (2001) avers that when science process skills are not acquired, it will be an obstacle to acquisition of scientific literacy due to the fact that scientific literacy is not limited with reading and learning, instead it requires efficient use of science process skills. Also corroborating, Mutlu and Terniz (2013) opined that science process skills are the basis for scientific thinking and research. Science process skills are cognitive and psychomotor skills employed by scientists in their day to day investigations. It is both thinking and performing skills used by scientists in unravelling the mysteries of nature. These skills are divided into basic and integrated process skills (Illinois State University, 1997). The basic process skills are observing, classifying, communicating, measuring, using space/time relationships, using figures, inferring and predicting. While the integrated process skills are identifying problem, controlling variables, formulating hypothesis, interpreting data, defining operationally, reading/constructing graphs and experimenting (Illinois State University, 1997) .

Fortunately, the skills are learnable and can be acquired. It proceeds from basic to complex (integrated). Therefore, there is need for teachers to possess these skills in order to guide learners properly in learning them. In line with this view, Miles (2010) opined that teachers should acquire sufficient science process skills so as teach same to their students efficiently. Sadly, science teaching in Nigeria, has centred on regurgitation of fact and concepts, with little or no emphases on the skills, thereby short-circuiting the psychomotor dimension of education. This assertion is evident by one shot approach to science practicals currently going on in most public schools where science teachers only teach practical lessons as external examinations approach. It on this premise that a study of this nature becomes imperative to assess the level of science process skills possessed by science students (physics) and to also determine whether or not gender and school location have influence on physics students' acquisition of process skills if any. Physics could be defined as a branch of science that deals with the study of matter, energy, its conservation, forces, cause, effect, and their interactions in nature. Physics like every other science, cannot be properly learnt without sound knowledge of science process skills, in that science process skills are the tools that will enable physics students and physicists to investigate physical related problems. To this end, there is need to investigate the process skills possessed by physics students so as to predict the future of the students in becoming quality scientists and tomorrow entrepreneurs, thereby agreeing with the mantra of catch them young (harvesting from cradle).

Purpose of the Study

This work assessed the levels of acquisition of science process skills in physics among the secondary school students. Specifically, the study determined the:

1. Levels of acquisition of science process skills in physics among the secondary school students.

2. Influence of gender on student's level of acquisition of science process skills.
3. Influence of school location on student's acquisition of science process skills.

Research Questions

To guide this study, the researchers posed the following questions:

1. What is the level of acquisition of science process skills in physics among the secondary school students?
2. What is the influence of gender on the level of acquisition of the science process skills especially in physics?
3. What is the influence of school location on students' acquisition of science process skills among the secondary school students?

Hypotheses

The following hypotheses were formulated to guide the study

HO_1: gender has no significant influence on students' acquisition of science process skills

HO_2: School location has no significant influence on students' acquisition of science process skills

Research Method

Descriptive survey design was adopted for the study. According to Nworgu (2015) descriptive survey is a type of study which aims at collecting data and describing in a systematic manner, the characteristic features or facts about a given population. The study was carried out in Nsukka education zone of Enugu State. Nsukka education zone comprises of 30 public secondary schools.

The population of this study is 1,712 students which comprised 879 male and 833 female SS II Physics students of the public senior secondary school in the zone in 2017/2018 session (Source: statistic and research unit of Enugu State ministry of Education Enugu, 2017/2018 data). The sample size of the study is 150 students made up of 66 male and 84 female SS 3 physics students and 93 urban and 57 rural students. The sample size was selected using purposive sampling technique from which eight public coeducational schools were sampled out of the 30 public secondary schools considering their locations in the zone. That is, four schools were sampled from urban and four schools were also sampled from rural areas respectively, given a total of eight schools. Whereas all the SS3 physics students in each sampled school were used for the study. Purposive sampling was employed because only schools with one intact class, has well trained physics teacher(s), and have taught electricity and optics to their students were used for the study.

The researchers developed two instruments for the study. The first instrument, was titled Science Process Skills Physics Practical Rating Scale (SPSPPRS) and the second titled Physics Practical Questions (PPQ). Both SPSPPRS and PPQ have

two sections. Section A demands personal information on the school and the respondents (students). While Section B of SPSPPRS consists of 25 items. The instrument (SPSPPRS) was used to rate senior secondary school III student's acquisition of the six basic science process skills, which are observing, measuring, classifying, inferring, predicting, and communicating. The SPSPPRS was designed to assess students' science process skills acquisition in physics practical on five-point rating scale thus: Excellent (E) = 5, very Good (VG) = 4, Good (g) = 3, Fair (F) = 2 and Poor (P) = 1. Also, the section B of PPQ contains two questions one in electricity and one in optics. Students followed the instructions in PPQ while carrying out their practical.

The instruments were subjected to face validation using three experts, two Physics education experts and one Measurement and Evaluation expert, all from the Department of Science Education University of Nigeria, Nsukka. Twenty (20) copies of the instruments were trial tested on 20 SSS III students from public senior secondary schools in Udenu Education zone of Enugu State, which is outside the area of this study, but share similar characteristic with the study area. The students' reports in the graph sheet were given to four independent raters to score. Thereafter, the ratings of the raters were subjected to Kendall's W coefficient of concordance to conduct inter rater reliability among four experienced physics teachers, with 0.76 and 0.80 reliability coefficients obtained for SPSPPRS and PPQ respectively.

Four physics teachers were used as research assistants and raters. The teachers were instructed for a day on how to use the rating scale developed by the researchers for the study. Photocopies of the students' graph sheets were distributed among the four research assistants. The average ratings of the assistants were then subjected to the appropriate statistics- mean and standard deviation (SD) employed in answering the research questions. Decision on mean was based on mean benchmark of 3.0 and above for good and below for poor science process skills acquisitions. t-test statistics was used to test the two null hypotheses at 0.05 level of significance.

Results

Below are the results of the study presented in line with the research questions

Research 1: What is the level of acquisition of science process skills in physics among the secondary school students?

Table 1: mean and standard deviation ratings of level of acquisition of science process skills among the secondary school physics students

S/N	*Item statement*	*Mean*	*SD*	*Remark*

a.	***Observing Skills***			
1	*Points plotted fall within the appropriate place in the graph*	*1.60*	*0.53*	*Poor*
2	*The slope line is a line of best fit*	*1.55*	*0.67*	*Poor*
3	*Readings are trending*	*2.19*	*1.54*	*Poor*
4	*The plotted points are well distributed*	*1.85*	*0.60*	*Poor*
5	*The points are neatly marked with cross or points*	*3.40*	*0.79*	*Good*
6	*Scale values are well distributed*	*2.59*	*0.82*	*Poor*
	Cluster Mean	***2.19***	***0.80***	***poor***
b.	***Measuring skills***			
7	*Values in the table are within the error margin*	*2.87*	*0.87*	*Poor*
8	*Degree of accuracy are indicated*	*2.98*	*0.92*	*Poor*
9	*Axes are well drawn*	*4.08*	*0.70*	*Good*
10	*Readings are repeated and average taken in the table*	*2.29*	*0.99*	*Poor*
11	*Readings are placed at appropriate decimal place*	*2.15*	*0.88*	*Poor*
12	*There is consistency in placement of decimal place*	*2.12*	*0.86*	*Poor*
	Cluster Mean	***2.75***	***0.73***	***poor***
c.	***Classifying skills***			
13	*Axes are well written with appropriate variable*	*3.46*	*1.05*	*Good*
14	*Scales chosen are suitable for the axes*	*2.22*	*1.01*	*Poor*
15	*Scale covered at least two-third of the graph*	*2.17*	*0.97*	*Poor*
16	*Triangle of the slope is large*	*2.36*	*1.03*	*Poor*
	Cluster Mean	***2.55***	***1.02***	***poor***
d.	*Inferring skills*			
17	*Slope was well interpreted*	*2.35*	*1.08*	*Poor*
18	*Slope value mirror the variable it represent*	*2.42*	*1.09*	*Poor*
	Cluster Mean	***2.39***	***1.04***	***poor***
e.	***Predicting skills***			

19	*the value of the slope predicts the law the experiment was meant for*	*2.07*	*0.96*	*Poor*
f.	***Communicating skills***			
20	*Variables were represented with their units*	*3.72*	*0.89*	*Good*
21	*Precautions were tailored to the instrument used*	*3.64*	*1.03*	*Good*
22	*Precautions are personalized*	*3.81*	*0.81*	*Good*
23	*Precautions are stated in past tense*	*3.89*	*0.73*	*Good*
24	*Calculations are logically solved*	*3.83*	*0.81*	*Good*
25	*Scale chosen are written*	*2.19*	*0.87*	*Poor*
	Cluster Mean	***3.51***	***0.92***	***Good***
	Overall Cluster Mean	***2.71***	***0.71***	***Poor***

Table1 revealed that students process skill acquisition are poor in all the process skills investigated, except in communication skill. This is because their mean scores were below 3.0 mean benchmark, except in communication skill that they had mean scores above 3.0. This then suggest that the students' level of acquisition of science process skills are poor especially in observing, measuring, classifying, inferring and predicting skills except in the communication skill.

Research question 2: What is the influence of gender on the level of acquisition of the science process skills especially in physics?

Table 2: mean, standard deviation ratings and t-test of influence of gender on the level of acquisition of the science process skills especially in physics

S/N	**Item statement**	**Male (N=66)**		**Female (N=84)**				
		Mean	**SD**	**Mean**	**SD**	**t**	**p-val.**	**Rmk**
a.	**Observing Skills**							
1	Points plotted fall within the appropriate place in the graph	1.58	0.53	1.62	0.54	0.49	0.62	NS
2	The slope line is a line of best fit	1.56	0.66	1.55	0.68	-0.12	0.91	NS
3	Readings are trending	2.17	1.51	2.21	1.56	0.19	0.85	NS
4	The plotted points are well distributed	1.85	0.59	1.86	0.60	0.09	0.93	NS
5	The points are neatly marked with cross or points	3.45	0.77	3.36	0.82	-0.74	0.46	NS

6	Scale values are well distributed	2.59	0.82	2.59	0.82	0.03	0.98	NS
	Cluster Mean	**2.20**	**0.60**	**2.19**	**0.77**	**0.08**	**0.94**	**NS**
b.	**Measuring skills**							
7	Values in the table are within the error margin	3.21	0.83	2.61	0.81	-4.49	0.00	S
8	Degree of accuracy are indicated	3.42	0.81	2.63	0.85	-5.82	0.00	S
9	Axes are well drawn	4.11	0.75	4.06	0.66	-0.40	0.69	NS
10	Readings are repeated and average taken in the table	2.69	1.11	1.96	0.74	-4.85	0.00	S
11	Readings are placed at appropriate decimal place	2.44	1.01	1.93	0.69	-3.67	0.00	S
12	There is consistency in placement of decimal place	2.44	1.02	1.87	0.59	-4.27	0.00	S
	Cluster Mean	**3.05**	**0.82**	**2.51**	**0.67**	**5.33**	**0.00**	**S**
c.	**Classifying skills**							
13	Axes are well written with appropriate variable	2.73	0.95	4.04	0.70	9.68	0.00	S
14	Scales chosen are suitable for the axes	2.76	0.89	1.79	0.89	-6.55	0.00	S
15	Scale covered at least two-third of the graph	2.68	0.89	1.76	0.82	-6.56	0.00	S
16	Triangle of the slope is large	3.11	0.77	1.77	0.81	-10.22	0.00	S
	Cluster Mean	**2.82**	**0.70**	**2.34**	**0.84**	**0.94**	**0.00**	**S**
d.	**Inferring skills**							
17	Slope was well interpreted	2.95	0.92	1.87	0.95	-7.03	0.00	S
18	Slope value mirror the variable it represent	3.17	0.87	1.83	0.88	-9.28	0.00	S
	Cluster Mean	**3.06**	**0.78**	**1.85**	**0.88**	**-9.11**	**0.00**	**S**
e.	**Predicting skills**							
19	the value of the slope predicts the law the experiment was meant for	2.52	0.96	1.71	0.80	-5.56	0.00	S
f.	**Communicating skills**							
20	Variables were represented with their units	3.30	0.98	4.05	0.67	5.51	0.00	S
21	Precautions were tailored to the instrument used	3.26	1.15	3.94	0.81	4.25	0.00	S

22	Precautions are personalized	3.62	0.86	3.96	0.75	2.61	0.00	S
23	Precautions are stated in past tense	3.74	0.79	4.01	0.67	2.26	0.00	S
24	Calculations are logically solved	3.62	0.87	4.00	0.71	2.93	0.00	S
25	Scale chosen are written	2.55	0.99	1.90	0.63	-4.79	0.00	S
	Cluster Mean	**3.35**	**0.84**	**3.64**	**0.93**	**3.22**	**0.00**	**S**
	Overall Cluster Mean	**2.86**	**0.83**	**2.59**	**0.72**	**4.10**	**0.00**	**S**

Table 2 revealed that female students' process skill acquisition are poor in all the process skills investigated, except in communication skill. This is because their mean scores were below 3.0 mean benchmark, except in communication skill that they had mean scores above 3.0. Also, table 2 revealed that male students process skill acquisition are poor except in measuring, inferring and communicating. However, the overall mean scores show that both gender process skill acquisitions are poor in all.

Hypothesis 1: gender has no significant influence on students' acquisition of the science process skills in physics

Table 2 revealed that under observing skill (item 1-6), the probability values were above 0.05 level of significance, which means that hypothesis on item 1 to 6 were upheld. This indicates that responses of male and female students are the same in observing skill. However, under measuring, classifying, inferring, predicting, and communication skills, the probability values were below 0.05 level of significance. This suggests that items under the listed skills were rejected, and therefore the null hypothesis was rejected in favour of male students with higher overall cluster mean. Hence, school gender has significant influence on students' acquisition of science process skills in favour of male students.

Research question 3: What is the influence of school location on students' acquisition of science process skills among the secondary school students?

Table 3: mean, standard deviation ratings and t-test of influence of school location on students' acquisition of science process skills among the secondary school students

S/N	**Item statement**	**Urban (N=93)**		**Rural (N=57)**				
		Mean	**SD**	**Mean**	**SD**	**t-test**	**p-value**	**Rmk**
a.	**Observing Skills**							

1	Points plotted fall within the appropriate place in the graph	1.59	0.54	1.61	0.53	0.25	0.80	NS
2	The slope line is a line of best fit	1.55	0.67	1.56	0.68	0.12	0.91	NS
3	Readings are trending	2.23	1.58	2.14	1.48	-0.33	0.74	NS
4	The plotted points are well distributed	1.86	0.60	1.84	0.59	-0.18	0.86	NS
5	The points are neatly marked with cross or points	3.39	0.79	3.42	0.80	2.53	0.80	NS
6	Scale values are well distributed	2.55	0.79	2.67	0.87	0.86	0.39	NS
	Cluster Mean	**2.19**	**0.73**	**2.21**	**0.80**	**0.72**	**0.40**	**NS**
b.	**Measuring skills**							
7	Values in the table are within the error margin	3.08	0.84	2.54	0.83	-3.79	0.00	S
8	Degree of accuracy are indicated	3.23	0.85	2.58	0.89	-4.46	0.00	S
9	Axes are well drawn	4.11	0.71	4.04	0.68	-0.61	0.54	NS
10	Readings are repeated and average taken in the table	2.47	1.04	1.98	0.81	-3.04	0.00	S
11	Readings are placed at appropriate decimal place	2.29	0.93	1.93	0.75	-2.48	0.01	S
12	There is consistency in placement of decimal place	2.30	0.94	1.82	0.60	-3.42	0.00	S
	Cluster Mean	**2.91**	**0.73**	**2.48**	**0.76**	**0.95**	**0.00**	**S**
c.	**Classifying skills**							
13	Axes are well written with appropriate variable	3.13	1.08	4.00	0.73	-5.39	0.00	S
14	Scales chosen are suitable for the axes	2.55	0.95	1.68	0.87	-6.89	0.00	S
15	Scale covered at least two-third of the graph	2.54	0.93	1.56	0.68	-9.00	0.00	S
16	Triangle of the slope is large	2.84	0.89	1.58	0.73	-8.46	0.00	S
	Cluster Mean	**2.77**	**0.82**	**2.21**	**0.73**	**0.92**	**0.00**	**S**
d.	**Inferring skills**							
17	Slope was well interpreted	2.83	0.99	1.56	0.68	-9.84	0.00	S

18	Slope value mirror the variable it represent	2.96	0.95	1.54	0.66	-5.99	0.00	S
	Cluster Mean	**2.89**	**0.80**	**1.55**	**0.72**	**-8.920**	**0.00**	**S**
e.	**Predicting skills**							
19	the value of the slope predicts the law the experiment was meant for	2.39	0.97	1.53	0.66	3.28	0.00	S
f.	**Communicating skills**							
20	Variables were represented with their units	3.54	0.96	4.02	0.69	2.06	0.04	S
21	Precautions were tailored to the instrument used	3.51	1.11	3.86	0.85	0.96	0.34	NS
22	Precautions are personalized	3.76	0.84	3.89	0.77	0.96	0.34	NS
23	Precautions are stated in past tense	3.85	0.78	3.96	0.65	0.94	0.35	NS
24	Calculations are logically solved	3.76	0.85	3.95	0.72	1.36	0.18	NS
25	Scale chosen are written	2.38	0.93	1.88	0.67	-3.54	0.00	S
	Cluster mean	**3.47**	**0.92**	**3.59**	**0.84**	**0.93**	**0.31**	**NS**
	Overall Cluster Mean	**2.83**	**0.78**	**2.53**	**0.83**	**0.87**	**0.21**	**NS**

Table 3 revealed that both the urban and rural students' process skill acquisition in observing, classifying, inferring, and predicting skills are poor except in communicating skill. This is because their mean scores were below 3.0 mean benchmark. However, in the measuring, urban students had good level of science process acquisition in item 7,and 8 unlike the rural students with poor skills in the items. This means that the level of acquisition of science process skills between urban and rural students are poor especially in observing, measuring, classifying, inferring and predicting skills and even in the overall, but both possessed communication skill.

Hypothesis 2: school location has no significant influence on students' acquisition of science process skills

Table 3 indicated that under observing skill (item 1-6), the probability values were above 0.05 level of significance, which means that item 1 to 6 were upheld. This indicates that responses of urban and rural students are the same in observing skill. However, under measuring, classifying, inferring, predicting, and communication

skills, the probability values were below 0.05 level of significance. This suggests that items under the listed skills were rejected, and therefore the null hypothesis was rejected in favour of responses of urban students. This means that urban students performed better than rural students in measuring, classifying, inferring, predicting, and communication skills except in observing skill. Hence, school location has significant influence on students' acquisition of science process skills in favour of urban students as evident by their mean overall score.

Summary of the Findings

Below are the summary of the findings of the study:

1. Students' basic process skills (observing, measuring, classifying, inferring, and predicting) acquisition in physics are poor. However, students have good communication skill.
2. gender has significant influence on students' acquisition of science process skills in favour of male students.
3. school location has significant influence on students' acquisition of science process skills in favour of urban students.

Discussion of Findings

Findings of the study revealed that students have poor basic science process skills acquisition in physics. The basic science process skills that the students have poor acquisition are observing, measuring, classifying, inferring, and predicting. The finding showed that the students only have good communication skill, since the students represented variables well with their units, wrote precaution based on the instrument used, personalized their precaution, stated their precaution in past tense among others**.** This poor acquisition of basic science process skills could be attributed to physics teachers not performing regular practicals for the students. If the students are constantly drilled on practicals, at least two times a week, students will acquire the basic science process skills easily. But with the current teachers' examination practical mentality, students only carry out practical during external examinations, a situation that has robbed students the prerequisite skills needed during practical. This finding agreed with the finding of Oyelede (2012) who found that science process skill acquisition depends on formal reasoning. The finding also, agreed with the finding of Igboegwu and Egbutu (2011) who found that science process acquisition depends on method. The findings equally agreed with the finding of Miles (2010) who found that science process acquisition depends on the teacher's proficiency science process.

Findings also showed that gender and school location have significant influence on students' acquisition of science process skills in favour of male and urban students. This could be attributed to the fact that male students always like practical activities and are activity oriented always. This can also be attributed to the fact that urban students, could be performing practicals more than the rural students because,

some urban schools have practical equipment more than some rural schools. This finding agreed with the finding of Gladys (2018) who found that gender and location significantly influence students acquisition of science process skills. The findings agreed with the findings of Okeke (2007) who found that girls do not like to do works that will undermine their future marriage ambition.

Conclusion

From the findings and discussion of this study, the following conclusions were made:

1. Students acquisition of science process skills are poor
2. School location influence of students' acquisition of science process skills is still inconclusive since findings are not yet in agreement
3. Gender has significant influence on students' acquisition of science process skills

Recommendations

Based on the findings of this study, the researchers recommended that:

1. students should be engaged in regular practical so as to enable them acquire science process skills and possibly become seasoned entrepreneurs in all science related fields.
2. government and nongovernmental organizations should assist in providing laboratory apparatus so as to make them readily available for teachers.

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