IDENTIFICATION OF DIFFICULT PHYSICS PROCESS SKILLS IN PHYSICS PRACTICAL ACTIVITIES AMONG SENIOR SECONDARY SCHOOL PHYSICS STUDENTS IN AWKA EDUCATION ZONE

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Abstract

The study was aimed at the identification of difficult physics process skills in Physics Practical Activities among secondary school Physics students. The sample was made up of 162 physics students from 6 secondary Schools in Awka education zone of Anambra State. The design for the study was a descriptive survey. The Physics Process Skills investigated were: controlling of variables, observation, conduct of experiment, measurement. Communication data analysis and inference. The instrument for data collection was a Physics Process Skill Rating Scale (PPSRS) designed by the researcher and validated by physics educators in Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State and physics teachers teaching the SSS3 Physics students in Awka education zone. Test –retest method was used to establish the stability of the instrument using Pearson product moment correlation and the index of stability was 0.68 . The estimate of internal consistency using Crombach alpha was 0.70. Physics students' grades for one session were used to classify them as high and low ability. Three research questions and two hypotheses guided the study. Data collected were analyzed using means, standard deviation and z-test. The study revealed that of the seven skills investigated, physics students had difficulty in the acquisition of six of the skills. The findings also revealed that female and low ability Physics students were the most affected. Among others, it was recommended that Physics teachers should start practical activities from SSS1. In addition, Physics teachers should be retrained by exposing them to seminars, workshops and conferences on Physics Process Skills. physics teachers should also be sensitized on gender issues in physics .

Keywords: Identification, Physics Process Skills, Physics Practical

Introduction

All technology is beholden to physics due to its emphasis on addressing phenomena involving the interaction of matter and energy. This interaction is necessary for the technological needs of the changing society (Musasia, Abacha &Biyoyo ,2012). Physics continues to influence applications to medicine, medical methods including imaging techniques (X-rays, CT –Scanning , ultra-sound echo techniques, MRI techniques) and diagnostic patient screaming techniques (Freeman, 2012) are based on physics principles. The unraveling of DNA structure and the subsequent genome project required a significant input from techniques (Stanley, 2000) Continuing research into challenges posed by diseases such as cancer, Ebola and HIV/AIDS, will require the development of high precision equipment employing physics principles. The current fixation with Information Communication Technologies (ICTs) could not have occurred without the primal physics discovery of the transistor. Computers, mobile phones and their attendant spin-off technologies show the indispensability of physics. Photonics and other quantum nanostructures show promise in terms of optical fibre-based communication systems (Sharma, Rohilla, Sharma & Manjunath, 2009). Electromagnetism is vital in the generation of electricity, mobile phone communication, optical and satellite communication, portable electronics, radio and radar perception, and x-ray crystallography (Campbell, 2006).

The need to include physics education in the secondary school curriculum is mainly to enable students develop scientific knowledge, skills and positive attitude towards science and technology. Physics as a practical subject provides physics students with an opportunity to interact with science processes and skills in physics that can be used to solve problems in everyday life and contribute to national development. Science Process Skills in physics are activities which physics students carry out in scientific investigations to enable the effective acquisition of scientific knowledge and skills. The importance of teaching science process skills in physics is to allow physics students to describe objects and events, ask questions, construct explanations, test those explanations against current scientific phenomena and communicate their ideas to others (Opara , 2011).

Science process skills in physics enable physics students experience hands-on engagement with physics materials when solving problems using practical approaches. The emphasis on physics process –based activities in physics lessons cannot be doubted , as this is clearly evident in the objectives and instructional programmes in physics at the Senior secondary school level. The proponents of physics process-based approach uphold the teaching of physics process – skills and advocate for the skills to be developed through experimenting (Abungu, Okere & Wachanga, 2014) . The physics students, according to West African Secondary School Certificate Examination (WASSCE) And National Examination Council (NECO) curriculum, are evaluated on practical activities in their final examinations. Physics practical test is designed to develop and test three aspects of students' intellectual development; cognitive, affective and psychomotor skills. This practical is introduced late and the students have to acquire these practical skills in less than one year to write the ordinary level (OL) examination. According to Njoku & Atanga (2011), the late introduction of training in the psychomotor skills at the OL may be the cause of poor students` achievement in physics . Ordinary level physics students will have problems acquiring these practical skills in this short period to write the final examination This might affect the overall students` achievement in OL physics. According to Macbeth (1974) , manipulative skills for early grade child is more important than the later grade child because the skills will develop with the child. This was further stressed by Lawrence in Njoku and Atanga (2011) that there are likely some specific difficulties in future if suitable opportunities are not available between the ages of four and ten. Since science process skills in physics influence physics achievement in external examinations such as WAEC and NECO, the poor achievement in physics could be attributed to physics paper 3, where practical and psychomotor skills are intensely examined at OL .

According to Njoku and Atanga (2011), difficulties related to practical physics have been associated to the ability level of students. This is evident from Mbamalu (1990), who found out that students with high academic ability have a positive attitude to physics unlike those with low academic ability. But his findings did not confirm whether these high academic ability students possess science process practical skills or achieve better in practical physics. Nzewi (1999) , has attributed girls' movement away from physics to school teacher, classroom behaviour, social conditions, environment and home background . Also Nwachukwu in Njoku and Atanga (2011) said that gender inequalities in physics are due to differences in the spatial abilities of male and female. The low enrolment of girls at OL physics as opined by Akem (1993) could be attributed to this practical paper.

Akam (1993) observed that the frequency at which practical activities is conducted could be a factor which can effect practical skill acquisition but failed to show whether students in schools who perform practical activities frequently score higher grades than those who perform practical activities less frequently. Also Offorma (1994) opined that repletion for repletion sake does not promote memory span rather it brings boredom and hatred of activity. These problems which affect practical activities in physics will also affect achievement in physics at the OL physics examination . The activities carried out by the students under this framework will enable them to practice and utilize process skills. This set of intellectual abilities is referred to as science process skills, which scientists used (Bentlay, Ebet, & Ebert, 2007). Besides promoting the acquisition of the physics process-skills, practical work in physics facilitate the necessary learning environments such as active participation integration to life and meaningful learning, Karamustafaogw (2011).

There are quite a number of science process skills provided for in the secondary school physics syllabus. The American Association for the Advancement of science (AAAS) classified the science process skills into fifteen (Bubee, cartson –powell & Trowbridge, 2008). These are: Observing, measuring, classifying, communicating, predicting, informing, using number, using space / time relationship, questioning, controlling variables, hypothesizing, defining operationally, formulating , models, designing experiment and interpreting data. Physics practical skills are science process skills. However this paper is focused on seven selected process skills commonly practiced in the physics lesson and tested WAEC physics practical paper, namely: Controlling variables, observation, conduct of experiment , measurement, communication data analysis and inference.

Problem

Achievement in physics is related to the acquisition of science process skills and if the acquisition of these skills is low, achievement in physics will consequently be low. Most importantly the acquisition of these skills is through laboratory practical activities. Perhaps, this poor achievement could be as a result of the lack of the acquisition of science process skills in physics by physics practical activities . Therefore, the problem of this study is to identify the difficult science process skills in physics practical activities among ordinary level physics students in Awka Education zone, Anambra State.

Research Questions

The following research questions were posed to guide the study

1. What are the science process skills in physics which physics students in Senior Secondary School have difficulties in acquiring during physics practical activities.

2. Which physics process skills in physics practical activities do male and female physics students in SSSIII have difficulties in acquire during physics practical activities.

3. Which science process skills in physics do senior secondary physics students at different ability levels have difficulties in acquiring during physics practical activities.

Hypotheses

The following null hypotheses were formulated to guide the study.

1. There is no significant difference in the mean level of difficulties experienced by male and female SSSIII physics students in acquiring physics process skills in physics through physics practical activities.

2. The mean levels of difficulty in the acquisition of science process skills during physics practical activities by SSSIII physics students of different ability level do not differ significantly.

Method

The descriptive survey design was used for data collection. A four-point scale rated as follows: very difficult, difficult, easy and very easy graded 4,3,2 and 1 respectively:

The population was made up of 2338 Senior Secondary School (SSSIII) physics students in Awka education zone from 55 Senior Secondary Schools of which 24 Senior Secondary Schools were purposively sampled because of the greater number of students that offer physics in SSSIII. Six Senior Secondary Schools were randomly sampled for the study using simple random sampling technique. The sample was made up of all 162 SS3 physics students in Awka-Education Zone. The instrument used for this study which was developed by the researcher was Physics Processing Skill Rating Scale (PPSRS). It was validated by physics educators in Chukwuemeka Odumegwu Ojukwu University Uli, Anambra State and also Physics teachers teaching SSSIII Physics students in Awka education zone. Test-retest method used to establish the stability of the instrument using person product moment correlation co-efficient and the index of stability was found to be 0.68. Also the estimate of internal consistency using Crombach Alpha was 0.70.

Data Analysis Procedure

Data were analyzed using mean and standard deviation to answer research questions . A mean of 2.5 and above on a skill was considered to be difficult while a mean score of below 2.5 was considered as indicator of skills easy to acquire . The Z-test was used to verify the hypotheses .

Results

Research Question 1:

What are the physics process skills in physics which physics students experience difficulties to acquire during physics practical activities.

Table I

Mean and standard deviation of scores of physics students on level of difficulty they experience in acquiring physics process skills during practical activities.

S/N	Process skills	No. of Items	No. of Respondent	$\bar{X}$	SD	Difficulty Level
1.	Controlling Variables	6	162	2.94	0.97	difficulty
2.	Observation	2	162	2.87	1.04	difficulty
3.	Conduct of experiment	5	162	2.67	1.2	difficulty
4.	Measurement	8	162	2.40	0.95	easy
5.	Communication	6	162	2.86	0.99	difficulty
6.	Data analysis	6	162	2.59	1.01	difficulty
7.	Inference	5	162	2.86	1.05	difficulty

Table 1 shows that physics students find measurement skills easy. They find the other six skills difficult to acquire. The standard deviations for skills 2, 3, 6 and 7 relatively are high indicating wide spread respondents' score from the mean. This is the reverse with skills 1, 4 and 5 where the standard deviation is low.

Research Questions 2

Which physics process skills in physics practical activities do male and female physics students in SS III have difficulties in acquiring during practical activities?

Table 2

Mean and standard deviation of scores of male and female SSIII physics students on the level of difficulties they experience in acquiring Physics process skills during physics practical activities.

No of male respondents =109, No of female respondents= 53

$\bar{X}_m$ mean for male; $\bar{X}_f$ mean for female; SD_m standard derivation for

males, SD_f standard deviation for females.

Process skills	**No of items**	$\bar{X}_m$	$\bar{X}_f$	SD_m	SD_f
Controlling variables	6	3.00	2.80	0.87	1.06
Observation	2	2.50	3.60	0.93	0.81
Conductof experiment	5	2.73	2.73	0.92	1.03
Measurement	8	2.27	2.47	0.87	0.95
Communication	6	2.79	2.97	0.92	1.00
Data analysis	6	2.52	2.75	0.95	1.04
Inference	5	2.92	2.92	1.08	0.95

Table 2 showed that the most difficult skill is Observation. Apart from measurement skill which both male and female SSS3 physics students find easy, the other skills are difficult for both male and female physics students but female physics students find them more difficult to acquire than their physics male counterparts. The standard deviation for skill 7 for male and 1, 3, 5, and 6 for female are high indicating wide spread of the respondents' scores from the mean.

Research Question 3

Which Physics process skills do SSS3 physics students at different ability levels have difficulties in acquiring during physics practical activities?

Table 3

Mean and standard deviation of scores of physics students of different ability levels in the acquisition of physics process skills in practical activities.

No of high ability respondents −= 76. , No of low ability respondents = 86

Process skills	No of items	$\bar{X}_{ha}$	$\bar{X}_{la}$	SD_{ha}	SD_{la}
Controlling variables	6	2.79	3.07	0.94	0.93
Observation	2	2.34	3.42	1.19	0.70
Conductof experiment	5	2.50	2.85	0.99	0.90
Measurement	8	2.21	2.45	0.97	0.85
Communication	6	2.54	3.07	1.03	0.83
Data analysis	6	2.46	2.70	1.02	0.95
Inference	5	2.57	3.04	1.08	0.94

X_{ha}- mean scores for high ability; X_{la}-mean scores of low ability; SD_{ha}-standard deviation for high ability. SD_{la}- standard deviation for low ability.

High ability level of students find skills 2, 4 and 6 easy while the low ability level students find only skill 4 easy to acquire. The low ability level students find skills 1, 2, 5 and 7 very difficult while the high ability level students find skills 1,3,5 and 7 difficult to acquire. The standard deviation for skills 2, 5, 6 and 7 for high ability level physics students is high indicating wide spread of scores of respondents from the mean. On the other hand, the standard deviation for skills 1, 3 and 4 for high ability students and standard deviation for all skills for low ability students is small indicating close spread of scores from the mean. In other words, most of the low ability students find the skills difficult to acquire

Hypothesis 1

There is no significant difference in the mean level of difficulties experienced by male and female SSSIII physics students in acquiring physics process skills through physics piratical activities.

Table 4:

Z-test comparisons of the mean scores of male and female physics students on the level of difficulties in acquisition of physics practical skill

Process skills	**No of items**	$\bar{X}_m$	$\bar{X}_f$	SD_m	Z-*Cal*	SIG.
Controlling variables	6	3.00	2.80	0.87	1.19	Not Sig.
Observation	2	2.50	2.60	0.93	7.8	Sig.
Conduct of experiment	5	2.73	2.73	0.96	0.06	Not Sig.
Measurement	8	2.27	2.47	0.87	1.29	Not Sig.
Communication	6	2.79	2.97	0.92	0.74	Not Sig.
Data analysis	6	2.52	2.75	0.95	1.42	Not Sig.
Inference	5	2.77	2.92	1.08	0.90	

Degree of freedom Df =160; Z table = 1.96, Significance of Z ($P< 0.05$)

In table 4, apart from skill 2 which the mean score is significantly different at the 0.05 level, all the other mean scores for all other skills are statistically not significant. Therefore apart from skill 2 where female students experience more difficulties than male students, both male and female physics students apparently experience equal difficulties in the other six skills. Thus the null hypothesis is accepted for skills 1, 3, 4, 5, 6, and 7 while it is rejected for skill 2.

Hypothesis 2

The mean level of difficultly in the acquisition of science process skills during physics practical activities by SSIII physics students of different ability levels do not differ significantly.

Table 5

Z –test companion of the mean and score of students' different ability level in the difficulty in the acquisition of physics practical skills.

Process skills	No of items	$\bar{X}_{ha}$	$\bar{X}_{la}$	SD_{ha}	SD_{la}	Z-cal	Sig
Controlling variables	6	2.79	3.07	0.94	0.9	1.96	Sig.
Observation	2	2.34	3.42	1.19	0.7	6.93	Sig.
Conduct of experiment	5	2.50	2.84	0.99	0.90	2.34	Sig.
Measurement	8	2.21	2.43	0.97	0.85	1.66	Not Sig.
Communication	6	2.54	3.07	1.03	0.83	3.57	Sig.
Data analysis	6	2.46	2.76	1.02	0.95	9.92	Sig.
Inference	5	2.57	3.04	1.08	0.94	2.80	Sig.

Table 5 shows that except for skill 4, the mean scores of SSSIII physics students of different ability levels are statistically different in all physics process skills. Low ability level SSS III Physics students experience more difficulty than their high ability counterparts in all but one skill. Therefore, hypothesis2 is rejected for skills 1, 2,3,5,6, and 7. However hypothesis 2 is accepted for skill 4. High ability and low ability SSSIII physics students experience equal levels of difficulty in skill 4, while low ability students experience more difficulty in skills 1, 2, 3, 5, 6, and 7.

Discussion

The findings indicate that measurement is the only skill which SSSIII physics students find easy to acquire. The SSSIII Physics students find the other six skills difficult to acquire during physics practical activities. The reasons for the difficulty in acquiring Physics process skills during practical activities may be attributed to the fact that from SSSI to first term in SSSIII in most senior secondary schools, physics practical is not taught. The Physics students are usually taught practicals when West African Secondary School Certificate Examination (WASSCE) is approaching or almost at hand. This is in line with Njoku and Atanga (2011) whose findings showed that though physics practical activities are very necessary for students to understand the theoretical concepts, the physics teachers shy away from them for various reasons. They also observed that most physics teachers and other science teachers in general, carry out practical activities with their students on rare occasions. Most physics teachers also lack the skills they are expected to teach. This is in conformity with Muwanga- Zaki (2003) whose finding was that teachers avoid practical because they lack practical skills. Therefore, physics teaching is aimed at the physics students obtaining their certificates and not to acquire skills to solve their life problems. Physics students in secondary schools cannot acquire physics practical skills in less than two years to write WASSCE and are expected to be efficient. The findings of the study also showed that SSIII female physics students lack the acquisition of the physics process skills more than their male counterparts. The findings support that of Njoku and Atanga (2011) who opined that female apathy towards science and technology is a serious problem as indicated by many findings worldwide.

Recommendations

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

1. The physics teachers of Senior Secondary Schools should endeavour to teach practical physics from SSSI.
2. The government should put, as a pre-condition an equipped science laboratory for the approval of any secondary school. The utilization of the laboratories in secondary schools will promote Physics teachers practical skills as well as those of physics students.
3. Pedagogic inspectors, principals and school administrators should be strict on the maximum use of the physics laboratory and other science laboratories by physics and other science teachers during teaching.
4. Since the rating of physics students acquisition of physics process skills is rather low, there may be need to retrain physics teachers in those skills. This retraining will have positive effect on the physics students.
5. The government should open Girls Science School in each education zone of Anambra state so that they will help to promote gender equality in sciences especially, physics. Workshops, seminars and conferences should be organized by Science Teachers' Association of Anambra State, Government, Post Primary Schools Service Commission (PPSSC) and higher institutions for Physics teachers.

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