DEVELOPING SCIENCE PROCESS SKILLS AMONG ADOLESCENT STUDENTS THROUGH LEARNING OF MATHEMATICS: A STRATEGY FOR SUSTAINABLE DEVELOPMENT

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Abstract
The study investigated developing science process skills among adolescent students through learning of mathematics. This study was carried out in secondary schools in Owerri Municipal Council Area of Imo State, Nigeria. Based on the objectives of the study, one research question and two hypotheses were posed for the study. Qualitative and quantitative approaches were adopted in carry out study. A sample size of 249 secondary school students involving 143 females and 106 males was used for the study. The instrument for data collection was the science process skills test (SPST). The items internal consistency had reliability co-efficient(r) of 0.78 determined using Cronbach alpha reliability method. The data generated was analyzed using mean and standard deviation for the research question while chi-square statistical tool were used to test the hypotheses at 0.05 level of significant. The result showed that the level of acquisition of science process skills is at the moderate level. They found the skill of observation; predicting and measuring are easier than the other skills. Also significant differences were observed between gender and school locality. One useful recommendation was that mathematics teachers should use science process skills teaching strategy in the teaching of mathematics, particularly at the secondary school level because it can enhance their scientific knowledge in the subject.
Keywords: Science, process, skills, Mathematics.

Introduction

Mathematics is one of core and compulsory subjects that every child must offer in secondary level of education as stipulated by the Federal Republic of Nigeria (2013). This subject is being taught in secondary schools in order to develop the mathematical potentials and capabilities of the learners. It means that adequate attention and consideration should be given to the teaching and learning of mathematics to develop students in the three domains of educational objectives (cognitive, affective and psychomotor). Federal Republic of Nigeria (FGN, 2004) emphasized the acquisition of appropriate skills and the development of mental, physical and social abilities and competence as equipment for the individual to live in and contribute to the development of the society. It therefore implies that is one of the subjects that attains to the issue for proffer advancement and growth of the nation. Aguebe (2004) opined that mathematics is the father of science. Also Ukeje in Lawrence and Kolawole (2007) acknowledged the importance and contribution of mathematics to the modern culture of science and technology and stated that without mathematics there is no science, without science there is no modern society. Mathematics enable student develops scientific skills, knowledge and positive attitude towards science and technology. This would enable them understand the role and value of science and technology in the society. Also the teaching of mathematics education at secondary school is to address the challenges of scientific literacy, so that students are encouraged to understand the scientific enterprise and how to benefit from it (Collette and Chiaoetta, 1997). Mathematics as a practical and problem solving subjects that provides students with an opportunity to interact with science process skills can be used to solve problems in everyday life and contribute to national development.

Science process skills are activities which students carry out in scientific investigation to enable the acquisition scientific knowledge and skills. The

importance of teaching and learning of scientific skills is to allow students to describe objects and events, ask questions, construct explanations, test these explanations against current scientific knowledge and communicate their ideas to others (Opara 2011). Scientific skills enable students experience hands on engagement with science materials when solving problems using practical approaches. Science process skills are known as procedural skills, experimental and investigating science habits of mind or scientific inquiry abilities (Harlen, 1999). Science process skills are special skills that simplify learning science, activate students to develop sense of responsibility in their own learning, increase the permanency of learning as well as teach them the research methods (Carey, Evans, Honda, Jay and Unger, 1989, Korkmaz, 1999, Karamustafaoglu, 2003). Besides, they are the thinking skills that students use to get information, think on the problems and formulate their results. They are also the skills which are used to understand and develop the scientific information. These skills are appropriate for all science fields, and they reflect on the current behaviours of scientists while they are solving a problem and planning an experiment. They also constitute the essence of the thinking and research within science. It is more important for the students to learn how to apply science than learning reality, concepts, generalizations, theories and laws in science lessons. Therefore, it is necessary for them to pick up the habit of science process skills, these skills are considered to enhance student's sustainability in learning and teaching.

Science process skills are in two categories which are basic and integrated skills. Basic science process skills are (BSPS): observing, classifying, measuring and predicting. These skills provide the intellectual ground work in scientific inquiry, such as the ability to order and describe natural objects and events. The ability to use basic science process skills is attributed to the ability to perform empirical- inductive reasoning (Beaumont-Walters and Soyibo, (2001), German and Aram, 1996a; Eilam, 2002). Integrated science process skills (ISPS) is identifying and defining variables, collecting and transforming data, constructing tables of data and graphic, describing relationships between variables, interpreting data, manipulating materials, recording data, formulating hypotheses, designing investigation, drawing conclusions and generalizing. The integrated science process skills are the terminal skills for solving problems or doing science experiments. The ability to carry out integrated science process skill (ISPS) is attributed to hypothetic - deductive reasoning (Piaget's formal operational reasoning; Beaumont- Walters and Soyibo (2001), German and Aram, 1996a, Happert, Lomask and Kazaraowitz, 2002). Zimmerman (2000) classified science process skills as specific for a field, or general process skills, and also argued that learning the scientific terms of the issue must be achieved in order to solve and problems about one issue. For example, Pauen (1996) declared that students need to understand the relationship between forces, in order to explain the physical movement, by using weights and for doing this they need to know the gravity concept.

Bozkurt and Olgun (2005) also argued that science process skills are related to learning issues and so cannot be evaluated in isolation. Student's motivation and interest are very important for the evaluation of these skills and, because of these; they postulated that science process skills should be evaluated. Science process skills should be practicalized in school laboratories. During the laboratory work students are supposed to improve their science process skills. Therefore, science process skills should be measured during the laboratory phase; not just their understanding, Rudolph and Stewart, 2001, Lei, 2006).

The best way to measure the science process skills of students is through laboratory reports, oral presentations and observation (Lavinghousez, 1973). In order to determine the change of the students' science process skill (SPS), we should assess to what extend the students understand the topic and their using of science process skills in novel learning situation (Buck, Bretz and Towns, 2008 and Pyle, 2008). Harlen and Jelly (1997) developed observation criteria for each skill in order to determine the improvement of students' science process skills. Educators can perform evaluations with a gradational scaling method by finding different questions and criteria for other process skills (Bozkurt and Olgun, 2005). Zeidan and Jayosi (2005) investigated science process skills and attitudes towards science among Palestinian secondary school students. The results of the study indicated that there were significant differences in science process skills due to gender farming females, and due to residence farming village studies. However, there were no significant differences in attitudes towards science due to the variables. Karamustafaoglu (2011) identify the level of science

and technology student teachers science process skills and to determine how efficient 1diagrams are in developing these skills. The results revealed that the teachers had positive with the pre-tests, and especially with the integrated process skills. At the end of the study, it was observed that the students' teachers' skills on developing 1-diagrams are increased as well as their integrated process skills problems. Mutisya, Rotich and Rotich (2013) investigated conceptual understanding of science process skills and gender stereotyping. A critical component for inquiry teaching of science in Kenya's primary schools. The findings of the study revealed that (i) SMASE trainers had very poor conceptual understanding of basic science process skills. (ii) SMASE trainers held gender based stereotypes about boys' and girls' ability in BSPS and (iii) there was a statistically significant relationship between the gender of the SMASE trainers and their gender stereotypes. Raj and Devi (2013) investigated the science process skills and achievement in science among high school students. The major findings of the research show that there is very low positive correlation (0.230) between the science process skills and achievement in science among high school students. Abungu, Okere and Wachaya (2014) investigated science process skills teaching approach on secondary school student achievement in Chemistry in Nyando District, Kenya. The results revealed that SPSTA had a significant effect on student's achievement in chemistry. Therefore the study investigates science process skills among adolescent's students through learning of mathematics education. Al-rabaani (2014) investigated the acquisition of science process skills by Omani's pre-service social studies' teachers. Data were collected using a questionnaire which consisted of 14 items covering basic and integrated science process skills. The questionnaire was distributed to all 59 social studies students' teachers in the college of education at Sultan Qaboos University in the Sultanate of Oman. The results showed that they had moderate acquisition of science process skills and there was no difference due their gender. Bang and Baker (2013) investigated the effect of high schools' gender organization on Korean tenth-grade students' science achievements, and their attitudes towards science. Three schools, three principals, three science teachers, and 302 tenth-grade students from their respective school types responded to an initial survey, and eleven academically outstanding students were subsequently interviewed. Results indicated that the male and female students from the co-ed school had significantly higher science achievement and positive attitudes towards science. Feyzioglu, Demirdag, Akyildiz and Altun (2012) studied the validity and reliability of science process skills for secondary students. The test was applied on 222 students from a vocational high school in Turkey. The test consisted of 30 multiple-choice questions; the reliability of the test was (0.83). The test consisted of sub-dimensions such as, observing, classifying, measuring, communicating, inferring, predicting, formulating hypotheses, identifying variable, organizing data, and interpreting it, designing investigations, acquiring data. The results of the confirmatory factor analysis supported validity and reliability of the test. Ozgelen (2012) studied the students' science process skills within a cognitive domain framework. A sample of 306 sixth and seventh grade students from public, private, and bussed schools. The Turkish integrated process skills test was used to measure scientific process skills, and the findings showed generally low scores. Private schools students had higher scores compared to public and bussed school students.

Statement of the problem

Mathematics educators believe that teaching mathematics as science subject must be divided into two parts: (material and method). The first one includes the facts, concepts, laws and theories, while the second part includes scientific thinking, critical thinking and scientific processes. In general, teachers evaluate the first part and ignore the second because they feel that teaching thinking skills and science processes is a waste of time and effort. According to Blooms taxonomy, educational objectives are divided into three "domains": cognitive, affective and psychomotor. In the secondary schools, science teacher's focus on the cognitive outputs rather than the other outputs such as those related to the affective domain which includes student's attitudes toward science. It is imperative to evaluate the science process skills acquired by mathematics students and its implications for sustainable development.

Purpose of the study

The main purpose of the study is to investigate science process skills among adolescent student through learning of mathematics. Specifically the study seeks;

(1) To identify the extent students acquire science process skills through learning of mathematics

(2) To ascertain if the acquisition of these skills is different based on (i) gender and (ii) school locality.

Methods

Both qualitative and quantitative approaches will be adapted through the use of observation participant and survey design. The population of the study consists of all senior secondary two (SS2) students in Owerri Municipal Council area of Imo State with a population size of 3,462 students. The sample of the study consist 249 students from two randomly selected schools from the study area. The sample size was made up of 143 female and 106 males. The instrument used for data collection was the science process skills test (SPST), it was designed based on basic skills and integrated skills. Students are supposed to acquire during practical mathematical lessons. The test consisted of 18 items, 10 testing for basic science process skills, while 8 items tested on the integrated science process skills. The SPST was categorized into three levels i.e. low, average and high. The maximum score was (100). The classification of scores was based as follows: 0-30% low, 31-60% average, 60 and above high. The face and content validity of the instrument was determined by two experts in mathematics education and one expert in measurement and evaluation. The reliability of the instrument was determined by administering it on groups of students outside the study groups who had the same characteristics with the study. The instrument was re-administered on them after two weeks interval using test-retest method. Correlating the two scores using Pearson Product Moment, the reliability was found to be 0.78. The data were analyzed with the aid of SPSS version 20.00. Descriptive statistic of mean and standard deviation deviations were used to answer the research questions while chi-square was used to test the hypotheses at 0.05 level of significant.

Results

Research question1: what is the level of acquisition of science process skills by mathematics secondary school students?

Table 1: Means, standard deviation for each component of the science process skill

No.	Skills	Max	Mean	S.D	levels
1.	Observation	2	1.63	0.55	81.5%
2.	Measuring	2	1.40	0.68	70.0%
3.	Classifying	2	1.13	0.71	56.5%
4.	Predicting	2	1.50	0.68	75.5%
5.	Communicating	2	1.28	0.79	64.0%
6.	Controlling variables	2	0.81	0.70	40.5%
7.	Hypothesizing	2	1.25	0.79	62.5%
8.	Experimentation	2	0.96	0.69	0.48%
9.	Data interpreting	2	1.18	0.73	69.0%
	SPST	18	11.64	3.76	64.7%

As shown in table 1, the observation skill gets rank one with its mean value (1.63) and standard deviation (0.55). Also, predicting skill gets rank two with its mean value (1.50) and standard deviation (0.68). Likewise, measuring skill gets ranks three with its mean value (1.40) and standard deviation (0.68). The average of SPST was (11.64)

Hypotheses testing

H_O1: They level of acquisition of the science process skills among secondary school mathematics does not significantly dependent on gender.

Table 2: Chi-square analysis on gender

x^2_{cal}	$\propto$	Df	x^2_{tab}	Decision
22.24	0.05	2	5.99	Reject H_o

The results in table 2 indicate that x^2cal(22.24) is less than x^2-tab (5.99), df = 2,at $\propto$- 0.05 level of significant. We reject Ho and accept the alternative hypothesis that the level of acquisition of the science process skills is significantly dependent on gender.

H_O2: They level of acquisition of the science process skills among secondary school mathematics does not significantly dependent on school locality

Table 3: Chi-square analysis on school locality

x^2_{cal}	∝	Df	x^2_{tab}	Decision
26.35	0.05	2	5.99	Reject H_o

Results in Table 3 shows that the X^2cal (26.35) x^2-tab (5.99) df = 2, ∝- 0.05. We reject Ho and accept the alternative hypothesis that the level of acquisition of the science process skills is significantly dependent on school locality.

Discussion

The finding of the study shown in table (1) revealed that the average of SPST was (11.64) and the percentage was (64.7%) which is moderate. The results show that adolescents secondary school students selected the correct options for items related to the skill of observation, predicting and measuring. They found the skill of observation and predicting easier than the other skills. While fewer of students selected the correct option for items related to the skill of controlling variables and experimentation. The researchers believe that the secondary school students have less experience in controlling variables and experimentation. This finding may be due to the traditional teaching method used by the teachers. The traditional methods cannot develop the integrated science process skills. The finding of this study supports the results of some previous studies, which showed that teacher and student's teachers' did not reach the high level of acquisition of science process skills (Al-rabaani, 2014; Ozgelen, 2012).

The result in table 2 and 3 shows that there are significant differences between gender and school locality on level of acquisition of science process skills. The researchers believe that the reason for this is females are more disciplined than males because females are more serious in science learning because of the opportunities offered to complete their university studies. This is consistent with Al-rabaani (2014) who found that there was no difference in acquisition of science process skills by Omani's pre-service teachers due to their gender.

Conclusions

The result showed that the level of acquisition of science process skills is at the moderate level. They found the skill of observation, predicting and measuring are easier than the other skills. Also significant differences were observed between gender and school locality.

Recommendations

1. Mathematics teachers should use science process skills teaching strategy in the teaching of mathematics, particularly at the secondary school level because it can enhance their knowledge in the subject.
2. The Ministry of Education through federal and states institutions and other professional bodies like Science Teachers Association, NREDC should organize workshops, seminars for retraining mathematics teachers on the appropriate utilization of science process skills teaching mathematics.
3. The institutions offering Teacher Education programmes should train their products to utilize science process skills teaching approach and structure their learning environments that can increase interaction among the learners and enable active participation in the learning process
4. The mathematics teachers to enhance active participation of secondary school students by organizing frequent practical sessions, provide adequate laboratory facilities and materials for doing experiments and create opportunity for students to share ideas as these activities will engage them effectively in the lesson.
5. The mathematics teachers to structure lessons to provide hands-on activities, with a hope to stimulate students 'understanding of science as a process of discovering and acquiring scientific knowledge.

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