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Availability and Utilization of Mathematics Laboratory Facilities For Pedagogical Purposes in Secondary Schools

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Abstract

The study investigated the availability and utilization of Mathematics laboratory facilities for pedagogical purposes in secondary schools in Imo State. Based on the purpose and objectives of the study, four research questions and two hypotheses guided the study. The descriptive survey research design was adopted in carrying out the study. The population of the study was made up of all Senior Secondary two (SS2) students of Government owned secondary schools in Owerri Municipal council of Imo State. A sample of 226 Senior Secondary two (SS2) students were selected for the study using simple random sampling technique. The instrument for data collection was a researcher made rating scale titled "Availability and Utilization of Mathematics Laboratory Facilities for Pedagogical Purposes (AUMLFPP)" with reliability coefficient of 0.76 determined using Cronbach alpha formula. The instrument was administered to the respondents on face to face basis. The data generated was analyzed using mean and standard deviation to answer research questions while the hypotheses were tested using independent sample t-test at 0.05 level of significance. The result of the study revealed that Mathematics laboratory facilities were available at a low extent and their utilization for pedagogical purposes was also low. Based on the findings, it was recommended that Government should provide mathematics laboratory and facilities to enable teachers and students use them during mathematics classes.

Keywords: Availability, Utilization, Mathematics laboratory Facilities, Pedagogical purposes.

Introduction

Mathematics is the foundation of science and technology and the functional role of Mathematics to science and technology is multifaceted and multifarious that no area of science, technology and business enterprise escapes its application (Okereke in Okigbo & Osuafor; 2008). Nwoke and Nnaji (2011) stated that Mathematics is the study of quantity, structures, space and change. It developed through the use of abstraction and logical reasoning from counting, calculation, measurement, and the study of the shapes and motion of physical objects. The ingredient for the effective articulation of the abstract elements of science that gives impetus to the development of technologies of any nation is based on mathematics. The indispensability of mathematics in human day to day activities

cannot be over emphasized; therefore, considered as the bedrock of all scientific and technological breakthrough and advancement for all the activities of human development. According to Arokoyu and Charles-Ogan (2017) Mathematics is not just a core science subject but a precision tool employed by all scientists in their search for a clear understanding of the physical world as well as for the development of any science-based discipline. It is the language, as well as a tool of science and engineering. According to Udousoro in Nwoke, Ugwuegbulam, Duru, and Best-Njoku (2018) Mathematics has generally been accepted as the foundation of science and technology and it is a very important subject in the secondary school curriculum, therefore, every nation needs it for sustained scientific and technological development. Mathematics occupies a crucial and unique role in the human societies and represents a strategic key in the development of the whole mankind. The ability to compute, related to the power of technology and to the ability of social organization, and the geometrical understanding of space time, that is the physical world and its natural patterns, show the role of Mathematics in the development of a Society (Fatima, n.d).

The teaching and learning of this all-important subject have been very difficult to both teachers and students as a result of its abstract nature. Most teachers fail to be innovative in their teaching process, this has made majority of students to find it difficult to grasp the concepts and slowly develop a dislike and fear for the subject. Pound and Lee (2011) and Back (2014) noted that, though some of these students may exhibit traits of interest in mathematics; it is clearly evident that the teaching and learning process is still void of the experiences, innovations and creativities needed to jolt and motivate their young and energetic minds into exploring the vast field of mathematics. This has resulted to general poor performance of students in the subject as noted by several researchers. Adedayo as cited in Charles-Ogan, Onwioduokit, and Ogunkunle (2014) indicated that despite the perceived importance of mathematics in scientific and technological development of the nation, students' performance in Nigerian institution has not been encouraging. Elekwa (2010) remarked that students exhibit nonchalance attitude towards mathematics, even when they know that they need it to forge ahead in their academic pursuit and in life. Such students who have already conditioned their minds that mathematics is the most difficult subject are usually not serious in learning of mathematics and thus perform poorly in mathematics assessment. Esu (2006) attributed the students' poor performance in mathematics to factors such as the notion among students that mathematics is an abstract and difficult subject, inadequate qualified teachers to teach the subject as specialist, improper method of teaching mathematics, lack of mathematics laboratory, insufficient instructional aids and poor use of instructional materials. STAN, (2002) as cited in Ojimba (2012) was of the view that prominent causes of poor performance in mathematics are; acute shortage of qualified professional mathematics teachers, exhibition of poor knowledge of mathematics content by many mathematics teachers, overcrowded mathematics classrooms. Students negative attitude toward mathematics, undue emphasis on the coverage of mathematics syllabus at the expense of meaningful learning of mathematics concepts, inadequate facilities and mathematics laboratories. According to Abasi (2018) the appalling state of mathematics achievement is attributed to a number of factors ranging from teachers' competency on the subject matter, learners' attitude and perception, instructional strategies and materials as well as availability and utilization of mathematics laboratory kits.

The teaching and learning of mathematics should involve students-centered approaches that grantees understanding of the concepts. According to Fatoba and Abidakun(2019) availability and utilization of materials for practical activities improve students' skills in observation and creative thinking, successfully integrating practical activities with classroom lessons and field investigations will make the learning experience richer and more meaningful to students. Practical activities help develop students understanding of scientific concepts, aids memory and stimulate interest. The abstract nature of mathematics should be demystified through demonstration and practical methods of teaching. The mathematics laboratory offers teaching opportunity that allows the students to be involved in activities that reduces the abstract nature of mathematics.

Mathematics laboratory is a room wherein we find collection of different kinds of materials and teaching/learning aids, needed to help the students understand the concepts through relevant, meaningful and concrete activities. These activities may be carried out by the teacher or the students to explore the world of mathematics, to learn, to discover and to develop an interest in the subject (Maheshwari, 2018). Adenegan as cited in Adenegan (2011)defined the mathematics laboratory as a unique room or place, with relevant and up-to-date equipment known as instructional materials, designated for the teaching and learning of mathematics and other scientific or research work, whereby a trained and professionally qualified person (mathematics teacher) readily interact with learners (students) on specified set of instructions. Mathematics laboratory is a set out room specifically for instructional materials both improvised and original useful for the effective teaching and learning of mathematics concepts. Ihejiamaizu and Ochui (2016) posited that the involvement of learner with laboratory equipment will eliminate abstraction of the concept learned, as learner are involved in laboratory activities they manipulate the equipment, conduct experiment, record scientific observation, this way basic scientific skills and attitudes are acquired that will help them both in performance and in future application of concept in ever day life. Agwagah as cited in Okigbo and Osuafor (2008) observed that the problem of ineffective teaching can be tackled through planned and intelligent application of the mathematics laboratory. CBSE (2014) as cited in Uwaezuoke and Charles-Ogan (2016) indicated that, a mathematics laboratory contributes to learning in the following ways;

- It provides an opportunity for students to internalize basic mathematics concepts through concrete objects and situations.
- It enables the students to verify or discover several geometrical properties and facts using models or paper cutting and folding techniques.
- It helps the students to build interest and confidence in learning the subject.
- The laboratory provides opportunity to exhibit the relatedness of mathematical concepts with everyday life.
- It provides greater scope for individual participation in the process of learning and becoming autonomous learners,
- It provides scope for greater involvement of both the head and the hand which facilitates cognition.

- The laboratory allows and encourages students to think, discuss with each other and with the teacher, and assimilate concepts in a more effective manner.
- It encourages the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters etc.

The quality of teaching and learning experience in secondary school mathematics depends on the extent of the adequacy of laboratory facilities and the teacher's effectiveness in the use of laboratory facilities with the aim of facilitating and providing meaningful learning experiences in the learners. The materials or kits that can be found in the mathematics laboratory includes but not limited to, constructed (wooden/metal/plastic made) mathematical sets, charts and pictures, computer(s), computer software, audio-visual instructional materials such as projector, electronic starboard, radio, television set, tape recorder, video tape, etc, solid shapes (real or model), bulletin board, three-dimensional aids, filmstrips, tape photographs, portable board or whiteboard, abacus, cardboards, tape measure, graphics, workbooks, graphs, flannel boards, flash cards, geo-boards, etc.

According to Uyoata (2007) availability of mathematics laboratory kits provide the teacher with varieties of concrete teaching aids across different concepts in mathematics which if utilized, enhances the quality of mathematics instruction. Laboratory kits promote efficiency of education by improving the quality of teaching and learning. It offers a variety of learning experiences individually or in combination to meet different teaching and learning experiences as well as encourage learners to become skilled individual with an endless passion for learning (Abasi,2018). According to Arokoyu and Charles-Ogan(2017) the use of laboratory kit materials provides the teacher with interesting and compelling platforms for conveying information since the laboratory materials motivate learners to learn more. Hence the teacher is assisted in overcoming physical difficulties that could have hindered his effective presentation of a given topic. The use of laboratory kits for teaching does not only encourage teachers and students to work collaboratively but also results in more cooperative learning activities among the students.

To develop secondary school students' interest and creativity in mathematics, the utilization of mathematics laboratory facilities is highly necessary. Adenegan and Balogun (2010) testified to this by indicating that instructional materials, when properly used in the teaching and learning situation, can supply concrete bases for conceptual thinking, high degree of interest for students in making learning more permanent.

Statement of the Problem

The enormous importance accorded to mathematics with regards to its contributions to technological and scientific development of a nation requires that, result oriented strategies should be adopted in the teaching and learning process. Regrettably, evidences are bound to show consistent poor performance among secondary school students in the subject. Among the factors earlier indicated as causes of the poor performance includes non-availability and utilization of mathematics laboratory facilities.

Therefore, this study was carried out to determine the availability and utilization of mathematics laboratory facilities as pedagogical tools in secondary schools in Imo State.

Purpose of the Study

The main purpose of the study was to determine availability and utilization of mathematics laboratory facilities for pedagogical purpose in secondary schools. Specifically, the study will determine;

1. The availability of mathematics laboratory facilities for pedagogical purposes in secondary schools.
2. The level of utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools.
3. Whether students' opinion of availability and utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools is gender related.

Research Questions

The following research questions guided the study.

1. To what extent are mathematics laboratory facilities available for pedagogical purposes in secondary schools?
2. What is the extent of utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools?
3. What is the difference between the response mean of male and female students on the availability of mathematics laboratory facilities for pedagogical purposes in secondary schools?
4. What is the difference between the response mean of male and female students on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools?

Hypotheses

The following hypotheses were formulated to guide the study.

HO_1: There is no significant difference between the response mean of male and female students on the availability of mathematics laboratory facilities for pedagogical purposes in secondary schools.

HO_2: There is no significant difference between the response mean of male and female students on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools.

Methodology

The descriptive survey research design was adopted in carrying out the study since it required opinion of students on availability and utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools. The population of the study was made up of all Senior Secondary two (SS2) students in 10 Government owned secondary schools in Owerri Municipal Council of Imo State, Nigeria. The sample of the study consists of two hundred and twenty-six (226) students from 4 secondary schools selected using simple random sampling technique. This includes, one hundred and thirty-five (135) females and ninety-one (91) males. The instrument for data collection was a researcher made rating scale titled "Availability and Utilization of Mathematics Laboratory Facilities for Pedagogical Purposes (AUMLFPP)". It was divided into two parts, part A dealt with respondents demographic variables while part B had two clusters, Cluster 1 dealt with Availability of Mathematics Laboratory Facilities and cluster 2 dealt with utilization of Mathematics Laboratory Facilities with responses ranging from Very High Extent(VHE)=4points, High Extent(HE)=3points, Low Extent(LE)=2points, Very Low Extent(VLE)=1point. The validity of the instrument was determined by two Mathematics Education experts and one measurement and evaluation expert, their expert judgments guided the restructuring of the instrument. To determine the reliability of the instrument, 30 copies were trial tested on students outside the study sample with the same characteristics and their responses gave a reliability coefficient of 0.76 determined using Cronbach's alpha formula. To administer the instrument, the researcher visited the selected schools and sort permission from the principals who directed the mathematics teachers to aid in the distribution of the instruments to the students. The students were allowed to fill-out the instruments on face-face basis, at the completion of the exercise, the instruments were returned to the researcher. The entire process lasted for two weeks. The data generated were analyzed using mean and standard deviation to answer research questions, any response mean within and above the criterion mean of 2.50 was accepted while any below was rejected. The hypotheses were tested at 0.05 level of significance using t-test statistical tool.

Result

Research Question 1: To what extent are mathematics laboratory facilities available for pedagogical purposes in secondary schools?

Table 1: Summary of Students' Responses on Availability of Mathematics Laboratory Facilities

S/No	Mathematics laboratory facilities	Mean	SD	Remark
1	Plane Shapes	2.68	0.55	A
2	3-D Objects	2.82	0.60	A
3	Charts	3.10	0.62	A
4	Geo-boards/Rubber bands	1.80	0.45	NA
5	Mathematical Sets	2.95	0.59	A
6	Globes	2.15	0.51	NA
7	Clocks/Watches	2.56	0.53	A
8	Abacus	2.30	0.50	NA
9	Broom Sticks	3.00	0.64	A
10	Various Games	2.35	0.50	NA
11	Weighing Balance	2.36	0.51	NA
12	Graph Paper/Boards	3.01	0.61	A
13	Pins & Threads	2.40	0.52	NA
14	Cello Tapes	2.15	0.50	NA
15	Cardboard Sheets	2.71	0.56	A
16	Blades/Knife	2.58	0.53	A
17	Scissors	2.00	0.48	NA
18	Measurement Tapes	2.35	0.50	NA
19	Cuisenaire Rods	1.50	0.43	NA
20	Tangram Puzzles	1.20	0.42	NA
21	Flash Cards	2.42	0.51	NA
22	Algebra tiles	1.55	0.45	NA
23	Pythagoras Boards	1.75	0.46	NA
24	Flannel Boards	2.13	0.50	NA
25	Audio-Visual Materials	1.25	0.43	NA
26	Computers & Software	1.00	0.41	NA
27	White Boards	1.31	0.44	NA
28	Stationeries	2.52	0.51	A
29	Counting Pebbles	3.30	0.67	A
30	Wooden boards	2.19	0.51	NA

Average mean=2.25 *(A = Available; NA = Not Available)*

Table 1 shows that 11 Mathematics laboratory facilities were indicated to be available as they had response mean above the criterion mean of 2.50. Also 19 Mathematics laboratory facilities were not available as they had response mean below the criterion mean**.** The average response Mean of 2.25 implies that facilities were availability at a very low extent**.**

Research Question 2: What is the level of utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools?

Table 2: Summary of Utilization of Mathematics Laboratory Facilities for Pedagogical Purposes

S/N	Utilization of Mathematics Laboratory facilities	Mean	SD	Remarks
1	Plane Shapes	3.04	0.64	U
2	3-D Objects	3.12	O.65	U
3	Charts	3.35	0.67	U
4	Geo-boards/Rubber bands	1.52	0.42	NU
5	Mathematical Sets	3.52	0.71	U
6	Globes	1.54	0.43	NU
7	Clocks/Watches	2.54	0.58	U
8	Abacus	1.24	0.40	NU
9	Broom Sticks	2.62	0.59	U
10	Various Games	1.44	0.41	NU
11	Weighing Balance	1.23	0.39	NU
12	Graph Paper/Boards	3.12	0.64	U
13	Pins & Threads	2.03	0.52	NU
14	Cello Tapes	2.32	0.55	NU
15	Cardboard Sheets	2.68	0.59	U
16	Blades/Knife	2.52	0.56	U
17	Scissors	1.54	0.42	NU
18	Measurement Tapes	1.85	0.43	NU
19	Cuisenaire Rods	1.80	0.44	NU
20	Tangram Puzzles	1.53	0.42	NU
21	Flash Cards	1.55	0.43	NU
22	Algebra tiles	1.62	0.44	NU
23	Pythagoras Boards	1.84	0.46	NU
24	Flannel Boards	2.03	0.50	NU
25	Audio-Visual Materials	1.61	0.42	NU
26	Computers & Software	1.72	0.45	NU
27	White Boards	1.83	0.46	NU
28	Stationeries	3.21	0.66	U
29	Counting Pebbles	2.95	0.58	U
30	Wooden boards	1.56	0.41	NU

Average mean=2.15 *(U = Utilized, NU = Not Utilized)*

Table 2 shows that 11 Mathematics laboratory facilities were indicated to be utilized as they had response mean above the criterion mean of 2.50. Also 19 Mathematics laboratory facilities were not utilized as they had response mean below the criterion mean. The average response Mean of 2.15

indicates that the utilization of mathematics laboratory facilities for pedagogical purpose is at a low extent.

Research Question 3: What is the difference between the response mean of male and female students on the availability of mathematics laboratory facilities for pedagogical purposes in secondary schools?

Table 3: Summary of Gender Responses on Availability of Mathematics Laboratory Facilities

Gender	No.	Mean	SD	Mean Diff
Male	91	2.30	0.51	
Female	135	2.28	0.44	**0.02**

Table 3 shows that male students had response mean of 2.30 with standard deviation of 0.51 while their female counterparts had response mean of 2.28 with standard deviation of 0.44. The difference in the mean of male and female students was 0.02 in favour of the male students.

Research Question 4: What is the difference between the response mean of male and female students on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools?

Table 4: Summary of Gender Responses on Utilization of Mathematics Laboratory Facilities

Gender	No.	Mean	SD	Mean diff
Male	91	2.18	0.52	
Female	135	2.21	0.53	0.03

Table 4 shows that male students had response mean of 2.18 with standard deviation of 0.52 while their female counterparts had response mean of 2.21 with standard deviation of 0.53. The difference in the mean of male and female students was 0.03 in favour of the female students.

Hypothesis 1: There is no significant difference between the response mean of male and female students on the availability of mathematics laboratory facilities for pedagogical purposes in secondary schools**.**

Table 5: Summary of t-test analysis

Gender	No.	Mean	SD	Df	t_{-cal}	$t_{-0.5}$	Decision
Male	91	2.30	0.51				
Female	135	2.28	0.44	224	0.33	1.96	Ns

Table 5 shows that, the calculated t-value of 0.33 is less than the critical value of 1.96 at 0.05 level of significance and degree of freedom 224. Based on the result, the null hypothesis is upheld at 0.05 level of significance.

Hypothesis 2: There is no significant difference between the response mean of male and female students on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools.

Table 6: Summary of t-test analysis

Gender	No.	Mean	SD	df	t_{-cal}	$t_{-0.05}$	Decision
Male	91	2.18	0.52				
Female	135	2.21	0.53	224	0.43	1.96	NS

Table 6 shows that, the calculated t-value of 0.43 is less than the critical value of 1.96 at 0.05 level of significance and degree of freedom 224. Based on the result, the null hypothesis is upheld at 0.05 level of significance.

Discussion

The result of the study revealed that only few mathematics laboratory facilities were available in secondary schools as they had response mean greater than the criterion Mean. The average response mean showed that the facilities were available at a low extent. The students' gender was not a factor with regarding to their opinion on the availability of mathematics laboratory facilities for pedagogical purposes in secondary schools. This result is in similarity with the findings of Abasi (2018) which showed that students were of the opinion that there are poorly available mathematics laboratory kits for teaching and learning of mathematics. Also, Adesoji (2006) which stated that there are inadequate resources for teaching and learning of Science subjects in public secondary school in Nigeria.

The study also revealed that, few Mathematics laboratory facilities were utilized for pedagogical purposes as they had response mean greater than the criterion mean. The average response mean showed that the facilities were utilized at a low extent. Further analysis showed that students' opinion on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools was irrespective of their gender. This result is in agreement with that of Fatoba and Abidakun (2019) and Arokoyu and Charles-Ogan (2017) which indicated that utilization of laboratories in secondary schools is moderate and inadequate.

Conclusion

The study was conducted to determine the availability and utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools. The results of the study revealed that, the availability of mathematics laboratory facilities and their utilization for pedagogical purposes are at low level. This implies that secondary schools in Imo State are faced with the challenge of low availability of mathematics facilities as well as their poor utilization for pedagogical purposes.

Recommendation

Based on the result of the study, it was recommended that;

1. The Government should provide mathematics laboratories and facilities in secondary schools to enable students and teachers utilize them in mathematics teaching and learning.
2. Mathematics teachers should work in synergy with school management to improvise some mathematics laboratory facilities they will use in teaching mathematics.
3. The Government, NGOs and school managers should organize workshops, symposium and conferences to train teachers on improvisation and utilization mathematics laboratory facilities.

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