

## ***Students' Self-Exploration and Discovery through the Instrumentality of Mathematics Laboratory***

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### **Abstract**

*The conceptual understanding of Mathematics enables students to handle logical and complex information throughout their lives. So, a Mathematics Laboratory set up in any school should be a formal environment where Mathematical concepts are made fully explicit and, the environment should be such that the user can create and explore mathematics and learn on his own and make his/her own assessment. This opinion paper is about students' self-exploration and discovery through the use of mathematics laboratory; it provides an opportunity for the students to discover through doing. In many of the activities, students learn to deal with problems while doing concrete activity, which lays down a base for more abstract thinking. The activities in the mathematics laboratory should be appealing to a wide range of people, of different ages and varying mathematical proficiency. The activities help students to visualize, manipulate and reason. They provide opportunity to make conjectures and test them, and to generalize observed patterns. The paper highlighted the importance of Mathematics laboratory as a place to design new mathematical activities, and enjoy mathematics through informal exploration. And hence, takes students' knowledge beyond the curriculum.*

**Keywords:** self-exploration, students, mathematics, laboratory

### **Introduction**

Mathematics is an indispensable subject of study which plays an important role in forming the basis of all other sciences. It deals with the material substance of space and time and may be described as the fundamental science. It is that branch of science that uses numbers and symbols. Numbers and symbols are arranged using systematic mathematical rules with methodical application of matter. It is so said because the subject makes a man methodical and systematic. 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, as posited by Okigbo and Osuafor, (2008). Ukeje (1986) described mathematics as the mirror of painstaking calculation and the most basic discipline for any person who would be truly educated in any science and in many other endeavours.

Mathematics involves thinking logically and reasonably so as to understand how formulae are derived and their applications. In order to enhance learners' mastery and meaningful learning of mathematics, it is necessary to reduce the rigours of seeming difficulties in learning mathematics to the barest minimum through the use of instructional materials. Adenegan and Balogun (2010) testified to this that instructional materials, when properly used in their teaching and learning situation, can supply concrete bases for conceptual thinking, high degree of interest for learning in making learning more permanent.

According to Oyekan (2000), instructional materials (Mathematics laboratory inclusive) are those things that can facilitate effective teaching and pleasant learning, through which learner's processes may be encouraged and motivated under the classroom situation. These enhance the teacher and learning process when adequately and appropriately used. To this end, this paper focuses on students' self-exploration and discovery through the instrumentality of mathematics laboratory. Specifically, the paper aims at defining mathematics laboratory, stating its importance, listing and identifying mathematics equipment/materials that can be used in a mathematics laboratory and enumerating ways of self-exploration and discovery through the instrumentality of mathematics laboratory.

### **Perception of Mathematics and Education**

Mathematics is the study of numbers, set of points and various abstract elements together with relation between them and operations performed on them. In the beginning, mathematics curriculum was just arithmetic, since people were just able to calculate; but by the early 1950's the concept of mathematics in schools as a subject had developed and was being taught in three different sessions as arithmetic, geometry and algebra. One of the objectives of teaching mathematics in all strata of education, from primary school level upward is the attainment of an understanding of the nature of the subject within the umbrella of science education in relation to everyday activities of one's life, as asserted by Adenegan (2003). Mathematics leads people into

discovering things. However, new discovery cannot be made unless it is effectively taught through application of adequate and efficient human and physical facilities.

Education is not limited to the classroom only; it is also not limited to a particular period of life. Education is a life-long process and goes on from birth to death. Throughout life, one goes on learning to adjust oneself to the changing patterns of life. An individual learns through his experiences, which are acquired throughout his life. Education is not merely collection of some information; it is an acquisition of experiences through life in the social and natural environment. It includes all the knowledge and experiences, acquired during infancy, childhood, boyhood, adolescence, youth, manhood or old age through any agency of education - the press, the travels, the club, the nature - formally and informally.

Whatever broadens our horizon, deepens our insight, refines our reactions and stimulates thought and feeling, educates us. In other words, education is the process whereby a human being gradually adapts himself in various ways to his physical, social and spiritual environments. It is the development of all those capacities in the individual, which will enable him to control his environment and fulfill his possibilities.

Education, in the broader sense, is “transmission of life by the living, to the living, through living and for living” (Kumar & Ahmad, n.d). Education is a means for the development of balanced all-round harmonious development of personality. Personality includes not only body and mind but also spirit. Education can be defined as the process of imparting and acquisition of knowledge through teaching and learning especially at a formal setting such as school or similar institution (Alao, 1997). Thus, education can be perceived as a process whereby a person learns how to learn. It actually begins at birth and ends at death. In fact, education is an age-long concept. Mathematics, as a subject, is part of the curriculum contents taught and learnt at different educational strata. Education enriches man with information and when one is not informed, one is at the risk of being deformed.

### **Value of Mathematics**

Mathematics is a methodical application of matter. It is so said because the subject makes a man methodical or systematic. Mathematics is also important as a school subject because not only is it needed for the sciences (Norris, 2012), but it is also a requirement for some undergraduate courses in the university, including, engineering, psychology, sciences and social sciences (Norris, 2012). The main arguments for the

importance of mathematics, however, fall into three areas namely: mathematics is a core skill for all adults in life generally; a mathematically well-educated population will contribute to the country's economic prosperity; and mathematics is important for its own sake. Mathematics makes our life orderly and prevents chaos, as posited by Pawan (2017). Certain qualities that are nurtured by mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability and even effective communication skills. Mathematics is the cradle of all creations, without which the world cannot move an inch. Be it a cook or a farmer, a carpenter or a mechanic, a shop-keeper or a doctor, an engineer or a scientist, a musician or a magician, everyone needs mathematics in their day to day life.

Mathematics helps us to have analytical thinking. This is what we do when we do a mathematical problem: collect the data, break down its premises, observe the relations that keep or systematically solve their parts in a rational way. If we are able to understand mathematics and arrive at logical solutions, we will be able to prepare our minds when we have real problems. We can look for the best logic, see the possible solutions and relate the data we have to reach conclusion.

It seems to be generally agreed that in order for adults to function reasonably well in an increasingly complex world, they require a basic level of numeracy. There is little doubt that mathematical skills are increasingly needed in the workplace. Hodgen and Marks (2013) distinguish between the sophisticated mathematics used by specialists with degrees in mathematics or with substantial mathematics in specialised workplaces and the use of lower level mathematics in the workplace. Importantly, "People in the workplace need to be able to make sense of the mathematics they are using if they are to avoid making mistakes in the workplace" (Hodgen & Marks, 2013, p. 1).

A further argument is made that mathematics is important because it encourages and develops important ways of thinking. For example, the Vorderman report states that mathematics is "critical in fostering logical and rigorous thinking" (Vorderman, Porkess, Budd, Dunne & Rahman-Hart, 2011, p. 11). Mathematics helps us to have analytical thinking. We could define it as the thought directed to decompose the arguments in its premises or expressions that compose it, to see the relations that exist between them and their conclusion, in order to judge its veracity or reliability of the same.

Analytical thinking develops the ability to investigate and know the truth about the world around us. There are truths that we try to look for and that are based on the

evidence and not on emotions. It is a thought that allows us to be alert against deception, manipulation and errors both in ourselves and others. This is possible because mathematics allows us to reason clearly and logically, taking into account real data that can be verified. Mathematics develops the ability to think because to find the solutions, you have to think of a whole coherent process. It could be said that mathematics is fundamental in the education of student since mathematics teaches them to think.

People who have become more and more skeptical towards mathematics saw it as discipline that pursues needless complications, inventing unrealistic problem and prescribing solving method within the frame of elementary mathematics. To this end, Adenegan (2003) highlighted mathematics importance under four broad functions: Utilitarian, Cultural, Social and Personal functions. Utilitarian functions are useful in everyday life; that is, it serves as a functional tool in studying individual's everyday problem. Mathematical knowledge plays a crucial role in understanding the contents of other school subjects such as Economics, Physics, Navigation, Finance, Biology and even Music and Art. This service of mathematics is exceedingly important to life situations. Cultural functions: It is useful for calculation in local languages and useful for naming objects. Social functions: It is useful in voting, games and lotteries, birth and death rates and population census. Personal functions: It encourages correct or accurate thinking, allows for cooperation with others to achieve common goals, allows for character building (patience, persistence and perseverance) and remarkably, it makes one to be happy.

Despite the importance placed on mathematics, Agwagah (2001) and Obioma (2005) had observed that students lack interest in the subject and perform poorly in it. Ukeje (1986) observed that mathematics is one of the most poorly taught, widely hated and abysmally understood subject in secondary school. Okereke (2006) attributed students' poor performance to factors such as the society's view that mathematics is difficult, shortage of qualified teachers, lack of mathematics laboratory and lack of incentive.

Many students in our schools today show displeasure towards the learning of mathematics; they view mathematics as dull, boring and stereotyped. Most students think that mathematics means to 'get something right' or to 'get something wrong.' When they get it wrong, they think that they are not good enough for mathematics and lose interest in learning. On the other hand, a few students learn enough tricks to 'get something right' to pass the exam. There are not enough instances when a teacher has

tried to teach mathematics in a different way, say through activities and games. These activities and games (setting up of a mathematics laboratory) aid and make the process of learning more interesting and effective.



**Figure 1:** A cross section of students' made equipment in Mathematics Laboratory  
**Source:** (Maidugu, 2019)

### **Need and Purpose of Mathematics Laboratory**

Agwagah (1997) observed that the problem of ineffective teaching can be tackled through planned and intelligent application of the mathematics laboratory. Thus Agwagah recommended the use of laboratory approach to the study of mathematics. The method of drill and verbal recitation makes learning boring and lacks motivation for further learning. Okigbo and Osuafor refer to previous work by Srinivasa (Srinivasa, 1978, cited in Okigbo & Osuafor, 2008, p.258) on Mathematics laboratory where he had recommended the use of mathematics laboratory in teaching mathematics. According to Srinivasa, this will lead the student to form action of concepts out of experience with discrete objectives. In this case the vague theories and imaginary objectives take real shape and the students understand better and perform better. It is important therefore to consider strategies that may help to improve performance with the view of considering their effect on teaching and learning of

mathematics. Such strategies include the use of mathematics laboratory (Ogunkunle, 2000).



**Figure 2:** A cross section of students' made equipment in Mathematics Laboratory  
**Source:** Maidugu (2019)

A mathematics laboratory is a place where we find a collection of games, puzzles, teaching aids and other materials for carrying out activities. These are meant to be used, both by the students on their own and together with their teacher, to explore the world of mathematics, to discover, to learn and to develop an interest in mathematics. Although mathematics is not an experimental science in the way in which physics, chemistry and biology are, a mathematics laboratory can contribute greatly to the learning of mathematical concepts and skills. Mathematics laboratory is a place where students can learn and explore various mathematical concepts and verify different mathematical facts and theories using varieties of activities or materials (Igbokwe, 2000). The use of mathematics laboratory helps to integrate theory and practical work in mathematics teaching/learning. Ohuche (1990) advocated the need for moderately equipped mathematics laboratories. Ogunkunle (2000) itemized the advantages of using mathematics laboratory to include:

- i. It is an avenue for experimentation through practical work.
- ii. Helps to display mathematical information.
- iii. It is a pool of storage of mathematical materials for easy access.
- iv. Helps to remove abstractness and increase effective teaching/learning

Based on the advantages of mathematics laboratory, it is expected that teaching and learning mathematics with mathematics laboratory will help to reduce the abstract nature of the subject.

Homi Bhabha Centre for Science Education (2017) suggested ways that a mathematics laboratory could contribute to learning mathematics. This includes:

- ❖ A mathematics laboratory provides an opportunity for the students to discover through doing. In many of the activities, students learn to deal with problems while doing concrete activity, which lays down a base for more abstract thinking.

- ❖ It gives more scope for individual participation. It encourages students to become autonomous learners and allows a student to learn at his or her own space.

- ❖ It widens the experiential base, and prepares the ground for later learning of new areas in mathematics and of making appropriate connections.

- ❖ In various puzzles and games, the students learn the use of rules and constraints and have an opportunity to change these rules and constraints. In this process, they become aware of the role that rules and constraints play in mathematical problems.

- ❖ Because of the larger time available individually to the student and opportunity to repeat an activity several times, students can revise and rethink the problem and solution. This helps to develop metacognitive abilities.

- ❖ It builds up interest and confidence in the students in learning and doing mathematics.

- ❖ Importantly, it allows variety in school mathematics learning.

Mathematics laboratory is a place rich in manipulation materials to which students have ready access to handle them, perform mathematical experiments, play mathematical games, solve mathematical puzzles and become involved in other activities. The laboratory approach allows pupil to set up mathematical experiment for the purpose of discovering some mathematical principles, patterns or process. These activities may be carried out by the teacher or the students to explore to learns, to stimulate interest and develop favorable altitudes towards mathematics. More involvement in the laboratory work helps in satisfying the creative and constructive urges of the students.



**Figure 3:** A cross section of students' made equipment in Mathematics Laboratory  
**Source:** Maidugu (2019)

### **Conclusion**

Conceptualizing mathematical ideas stimulates the growth of analytical thought, which is critical for succeeding in the modern world. The conceptual understanding will better enable students to handle logical and complex information throughout their lives; and this is made possible through Mathematics Laboratory - a place where students can learn and explore mathematical concepts and verify mathematical facts and theorems through a variety of activities using different materials. The strategy of teaching mathematics in a mathematics laboratory would transform the position of the teacher from being active speaker to the facilitator.

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