COURSE GUIDE

EDU 740
SUBJECT METHODS (MATHEMATICS)

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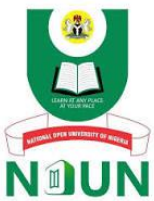

NATIONAL OPEN UNIVERSITY OF NIGERIA

2022 by NOUN Press
National Open University of Nigeria
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University Village
Plot 91, Cadastral Zone
Nnamdi Azikiwe Expressway
Jabi, Abuja

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Victoria Island, Lagos

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Reprinted 2006, 2022

ISBN: 978-978-058-758-6

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INTRODUCTION

Mathematics Method II EDU 740 is a one semester, 2 credits unit course. It will be available to all students reading for B.Sc.(Ed) in Mathematics Education.

The course consists of fourteen units, which involves brief history of mathematics, importance of mathematics in relation to other subjects, some mathematicians and their contributions, curriculum in mathematics. Mathematics syllabus, scheme of work, lesson plans, individual differences in mathematics learning, some selected methods of teaching mathematics, introducing mathematical concepts, learning aids in mathematics, their objectives and characteristics, mathematics laboratory as an approach to teaching mathematics.

The material has been developed for students of NOUN by referencing some available works such as those of National Teachers Institute, Kaduna (NTI), the internet and other relevant text materials.

COURSE AIM

This course aims at equipping the student teacher with mathematical knowledge and skills necessary and effective for improving the teaching and learning of mathematics in our primary and secondary schools. This is expected to bring about improved performance in students' achievement in mathematics by rekindling interest in mathematics and the learning and teaching of mathematics in schools. Mathematics can be made very interesting, important, useful, rewarding and fun to be loved by most of the students if well prepared and presented in rich learning environment involving integrated methods and strategies inclusive enough to take care of every learner. There is no doubt that strong foundation in mathematics especially at the primary and secondary schools will improve the learning of other school subjects.

There is no doubt that the mathematics content is a good document and this can be poorly implemented if the mathematics teacher has not been adequately prepared especially in terms of teaching methods and strategies. The contents of this course have been carefully selected so that by the end, the student teacher will be competent enough to teach mathematics effectively
at the primary and secondary schools.

COURSE OBJECTIVES

Toward effective realization of the broad aims set out above, the course sets overall objectives. In addition, each unit has specific learning

outcomes to be demonstrated in observable performance behaviours by the students. These are always included at the beginning of every unit. You should refer to them during your study of the units. It will be a good guide to check your progress. By the end of every unit, the student is advised to go back to the state learning outcomes. This type of reflective learning will make the student be in charge of his own study.

WORKING THROUGH THIS COURSE

To complete this course, you are required to read the study units, read reference books and read other materials, provided by NOUN. Each unit contains Self-Assessment Exercises (SAEs) At points in the course, you are required to submit assignments for assessment purposes.
This is a 2 credits unit course consisting of 14 study units

COURSE MATERIALS

Major components of the course are:

1. Course Guide
2. Study Units
3. Self-Assessment Exercises
4. Presentation Schedule.

ASSESSMENT

There are two aspects to the assessment in this course. We have the self –assessment exercises (SAEs) and the end of the semester written examination. You are expected to apply the information, knowledge and techniques gathered during the course.

The tutor-marked assignments in the course will be submitted to the course facilitator and this will account for 30%, while the end of semester examination will contribute the remaining 70%.

How to get the most from this Course?

In distance learning, the study units replace the teachers. This is one of the great advantages of distance learning. You can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Each of the study units has a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning outcomes that will guide you on what you should be able to do by the time you have completed the unit.

You should use these performance learning outcomes to guide your study of the course.

Working through the given SAEs will help you achieve the stated learning outcomes of the units and prepare you for the examination. There will also be some examples given in each unit. Work through these when you come to them.

The following is a practical strategy for working through the course.

1. Read the course guide thoroughly
2. Organize your personal study schedule (time table)
3. Stick to your study schedule strictly
4. Start with unit 1 and read the introduction and the stated learning outcomes for the unit
5. Assemble all study materials
6. Work through the unit
7. Do the Assignment and convince yourself that you have mastered the unit
8. Move to the next unit
9. Go on like this until you get to the last unit.

STUDY UNITS

There are fourteen study units in this course EDU 740/Mathematics Methods II as follows:

Module 1

Unit 1	Brief history of Mathematics and Contributions of early Greek Mathematicians to Development of Mathematics
Unit 2	Great Mathematicians and their Contributions
Unit 3	Importance of Mathematics in relation to other subjects and Curriculum Development in Mathematics as a subject in Nigeria
Unit 4	Selection of Goals and Objectives of Mathematics
Unit 5	Mathematical Syllabus

Module 2

Unit 1	Scheme of Work and Weekly Unit Plan and Note
Unit 2	Characteristics of a lesson plan or notes of lesson
Unit 3	Psychological basis for Mathematics Education: Contributions of Piaget, Bruner and Gagne to Learning of Mathematics

Unit 4 Individual Differences in Mathematics Classroom: Causes and Care
Unit 5 Developing Positive Attitude toward Mathematics by Students

Module 3

Unit 1 Learning Aids: Definitions and Types
Unit 2 Learning Aids: Criteria for Choosing and Uses
Unit 3 The Mathematical Laboratory
Unit 4 Discovery Approach to Teaching Mathematics.

Assignments are very important and are treated as that. It is expected that every Student should submit these when they are required by the course facilitator. It is advisable that you attempt all the questions yourself. They are meant to probe your understanding of the concepts in the units. Final grading in this course will be in two ways which consists of the SAEs of 30% for the whole course. The cumulative score for the SAEs will be computed over 30%.

The end of semester examination is the second component and constitutes 70% of the total for the end of semester examination. 75% attendance at the tutorial and counselling session must be met.

TUTORS AND TUTORIALS

The facilitator will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and also provide assistance to you during the course. You are expected to mail your assignments to the facilitator well before the due date.

You should try your best to attend discursion classes

This is a very important opportunity to interact with the course facilitator as you are free to ask him questions. You will learn a lot from participating in active discussions.

We wish you success with the course and hope you will find it interesting, useful and rewarding.

MAIN COURSE

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MODULE 1

Unit 1 Brief History of Mathematics and Contributions of Early Greek Mathematicians to Development of Mathematics
Unit 2 Great Mathematicians and their Contributions
Unit 3 1Importance of Mathematics in Relation to Other Subjects
2 Curriculum Development in Mathematics as a Subject in Nigeria
Unit 4 Selection of Goals and Objectives of Mathematics
Unit 5 Mathematics Syllabus

UNIT 1 BRIEF HISTORY OF MATHEMATICS AND CONTRIBUTIONS OF EARLY GREEK MATHEMATICIANS TO DEVELOPMENT OF MATHEMATICS

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1.0 Introduction
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- 3.2 Thales of Miletus
- 3.3 Pythagoras
- 3.4 Plato
- 3.5 Euclid
- 3.6 Apollonius of Perga
- 3.7 Archimedes

4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested solution to SAEs

1.0 INTRODUCTION

The ordinary man associates a lot of mystery with Mathematics. This should not be so, since mathematics is as old as man himself. Primitive man started counting by matching objects. He also started writing by marking on cave wall strokes to represent the number of cattle, hens or other objects he possessed. He started counting in base ten because he is endowed with ten fingers and ten toes. He could have counted in other bases such as two or five or seven. In fact, the Mayas of South America counted in base twenty (20).

We shall also show the development of Mathematics from medieval times. The contributions of some Greek Mathematicians will be highlighted.

2.0 Intended Learning Outcomes

The objective of this unit is to show the painfully, slow but orderly development of Mathematics. It did not just fall from heaven and is not the work of mad men. It is not shrewd with mystery as many people think. It was the work of sane, sensible and intelligent men who were convinced of its utilitarian value.

It is also to show how much we owe to Greek Mathematicians who have

blazed the trial of mathematical development. Also to show the importance of the development of zero, 0 or sifr and the positional value of numbers. Without these developments, our calculations would have been wordy and descriptive and not tidy but clumsy.

3.0 Main Content

3.1 History of Mathematics

Today, different types of people count and write in different ways. So it

was in early days with different civilizations. Our present system of counting and writing numbers was developed from the Hindu-Arabic System i.e. 0,1,2,3,4,5,6,7,8,9.

The earliest type of mathematics was “Earth Measurement” which developed in Egypt by the river Nile. It was the partitioning of land for farming year by year. This was the beginning of survey or rope stretching.

The first writing material was the papyrus paper. They were made of reels of papus which grew by the river Nile. They were difficult to make. Later, writing was done on parchment paper from skins of animals. Printing did not start until the 14th Century. The first discovered book was written by Amos an Egyptian in 1500 B.C. It was titled “Rules for Inquiry into Nature and knowing all that Exist”.

Simple Arithmetic’s – Addition and Subtraction did not begin until as late in the 15th Century. This was because of the clumsy way of writing numbers, the absence of symbol for zero and lack of positional value.

In-Test Question: Describe briefly the development of our ten-digit numeral.

The following is the history of six early Greek Mathematicians and their contributions to the study of the subject.

3.2 Thales of Miletus

He was born in 640 B.C. and lived in Miletus. He was a merchant politician. He visited Egypt and Babylon to buy and sell wares. So, in Babylon, he came in contact with its people and got their ideas of Astronomy and Earth Measurement from Egypt. After retiring from merchandise, he devoted his time to the study of Astronomy and

Mathematics. He started Deductive Geometry. He successfully predicted an eclipse of the sun from May 28th in 585 B.C.

3.3 Pythagoras

He was born in 580 B.C. on the Island of Samos. He later moved to Crotona in Southern Italy, where he did most of his mathematics. He studied under Thales. He founded a school in Crotona and his students

lived like a brotherhood or cult, (the Pytagoreaians). Some of their knowledge were treasured orally but later became written. Their specific contributions to Mathematics included:

1) discovery of the harmonic progression
2) invention of the terms odd and even numbers
3) Pythagoras theorem
4) they were the first to use the word parabolas, ellipse, hyperbole, Apollonius borrowed these words in conics.
5) he was the first to discover that the world was a sphere.

3.4 Plato

He lived 400 B.C in a place near Athens. He founded a school called the Academy. His philosophy was that anyone who would become a

leader of men should learn and know Mathematics. This philosophy influenced the great American leader Abraham Lincoln to learn the

thirteen (13) books of Euclid called “Elements”. He believed that Mathematics was the best discipline for the human mind. His ideals was that mathematics should be taught with amusement and pleasure and

made very interesting. He wrote at the entrance of his school "Let no man destitute of Mathematics, enter my door".

3.5 Euclid

His name was first met in the records around 300 B.C. Before him, Mathematical knowledge was in fragments and pieces. He collected all this knowledge and wrote them in 13 volumes known as "Euclid Elements" He taught Mathematics in the Royal School of Alexandria. His was the mastermind that collected all the muddled, confused pieces of mathematical jigsaw, puzzle and put them together in such a way that a clear and beautiful picture suddenly emerged. All the proofs in the Elements were based on deductive reasoning.

3.6 Apollonius of Perga

He was born some 50 years after Euclid. He also studied in Alexandria where Euclid taught. He contributed substantially to the study of conics. His treatment of conic section was the best for 18 centuries until 1637 when Descartes completely revolutionized the study.

3.7 Archimedes

He was born in Syracuse in 287 B.C. He was perhaps the world's greatest Mathematician. He too studied in the Royal School of Alexandria. His father was a Mathematician and Astronomer. He was so much a man of ability, energy and power of application that he

brought the mathematics of his time to such a height that not much furtherprogress was made until new mathematical tools were invented. He was said to have remarked, "Give me a place to stand and I will move the earth" His achievement included:

1) Calculated an approximate value of π
2) He invented a method for finding square roots
3) Discovered how to find area of an ellipse.

He wrote a number of books on spheres, cylinder and cones. With his death in 212 BC, came the end of the Golden Age of Greek Mathematicians.

4.0 Self-Assessment Exercises

(1) Three major areas of Hero's specialization in which he made contributions were……

(2) What are the three areas of Hipparchus specialization?

(3) Mention any three major contributions of Hipparchus in the

5.0 CONCLUSIONS

Since the 19th Century till now, Mathematics has witnessed a great development quantitatively and qualitatively. Mathematics has been applied to virtually all faces of human activities. It has become the greatest tool in modern technology, industries and business.

6.0 SUMMARY

We have traced the development of Mathematic, from early man through to the 1st Century. We highlighted the contributions of Greek mathematicians. Theirs was referred to as the Golden Age of Greek Mathematicians.

7.0 REFERENCES/FURTHER READINGS

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Odili, G.A. (1986) Teaching Mathematics in the Secondary School.

Port Harcourt: Anachuna Education Books.

8.0 Suggested solution to SAEs

1. three major Hero's area of specialization are; mathematics, engineering and invention.
2. Three areas of Hipparachus, astronomy, geography and mathematics.
3. Three major contributions oh Hipparachus are foundation of trigonometry, compilation of star catalogue and production of the first trigonometric table.

UNIT 2 GREAT MATHEMATICIANS AND THEIR CONTRIBUTIONS

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3.3 Blaise Pascal
4.0 Self-Assessment Exercise(s)
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested solutions to SAEs

1.0 Introduction

In unit 1, we studied early Greek mathematicians and their contributions. In this unit, however, we will discuss the contributions of these later mathematicians beginning with Napier John. There are many other Mathematicians which could also be considered but suffice us to stop at these. You can read so many others.

2.0 INTENDED LEARNING OUTCOMES

By the end of this you will be able to:

- Discuss the invention of logarithm followed.
- Explain the development of differential calculus by Fermat Pierre and
- the discovery of probability.

3.0 Main Content

3.1 Napier

He was born by middle of the 16^{th} Century and published his first work on Loganthm titled. "A Description of the Marvelous Rule of Logarithm" in 1614 A.D. Johnst Bueg of Switzerland at about the same time also worked on logarithm but the work of Napier was first published. Napier was not a professional mathematician as such but had interest in writing certain aspects of mathematics. His work was related to computation and trigonometry. Napier "roles or bones" were sticks on which items of multiplication table were carved in forms ready for

multiplication. His other works, the "Napier Analogue" and "Napier's rule of curricular parts" were devices of memory on spherical trigonometry His system of logarithm differed from our own today because his base is different from our own. Napier died in 1617.

3.2 Fermat Prierre

Fermat was a lawyer by profession but by 1629 A.D., he began to make discoveries of capital importance in Mathematics. He discovered many theorems in analytical geometry. One of which was in 1636. Whenever in a final equation two unknown qualities are found, we have a locus. The extremity of one of these describing a straight line not curved. Most of his works were however published after his death.

Fermat used not only a method of finding the tangent to curves of the form $y = mx$ but he also in 1629 came up with a theorem on the areas under these curves. He eventually discovered differential calculus by studying "rate of change".

3.3 Blaise Pascal and the Discovery of Probability

Pascal was a gifted child in Mathematics, just like his father. He abandoned mathematics for Theology. But his father encouraged him in Mathematics. At the age of sixteen 1640 young Pascal published one of the most fruitful papers in history in "Essay Comques" This in essence states, that opposite set of a hexagon inscribe in a conic intersects in three collinear points.

In 1654 his friend Chevalier de Mere gave Pascal a problem to solve thus. In eight times throw of a die, a player is to attempt to throw a one, but after three unsuccessful trials, the game is interrupted. What is the probability of winning for each player" Pascal wrote to Fermat on this problem and the resulting correspondence became the effective starting point for the modern theory of probability? Although neither Pascal or Fermat wrote up their result. But their result was published in 1657.

Pascal connected the study of probability with Arithmetic and thereby formed what is known as Pascal Triangle to determine the coefficient of Binomial Expansion.

The theory of probability attracted many mathematicians in the early

18^{th} Century. One of them is Abraham De Mourve who published more than 50 problems on probability as well as questions relating to life and annuities. Pascal discovered the theory of permutation and combination from the principles of probability. Probability theory grew into a very

useful subject having application in Engineering, games of chance, Business and Science.

4.0 Self-Assessment Exercise(s)

(1)	Who developed Napier bones?
(2)	Who discovered the rectangular coordinate system?
(3)	Mention any three major discoveries made by Fermat

5.0 CONCLUSIONS

Mathematics has been shown to be relevant to all other area of knowledge. It is the language of science and technology. It is used in commerce, business, engineering and all branches of science. It is a very dynamic subject, which continues to grow qualitatively and quantitatively. In recent times, the volume of new mathematics is staggering due to research.

6.0 SUMMARY

In this unit, you have been introduced to the following mathematicians in addition to those in unit I.

(i) John Napier is the founding father of Logarithm
(ii) Pierre Fermat did an original work on differential calculus and in his work, the modern use of rate of change grew up.
(iii) Blaise Pascal who originated the theory of probability in an attempt to solve his friend's problem of throwing a dice.

7.0 REFERENCES/FURTHER READINGS

Boyer C.B, (1968) History of Mathematics; John Wiley and Sons.

Odili, G. A. (1986) Teaching Mathematics in the Secondary School.

Port Harcourt: Anachun Educational Books.

8.0 Suggested solution to SAEs

1. Napier bones was developed by John Napier (1550-1617)
2. The coordinate system was developed by Rene Descartes.
3. Three major discoveries of Fermat
    a. Naperian logarithm (b) Napier roles or bones used sticks to develop mathematical table. (c) Napier rule of circular parts and Napier Analogies

UNIT 3 (1) IMPORTANCE OF MATHEMATICS IN RELATION TO OTHER SUBJECTS (2) CURRICULUM DEVELOPMENT IN MATHEMATICS AS A SUBJECT IN NIGERIA

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  3.4 During the Oil Boom (1970-1976)
4.0 Self-Assessment Exercise(s)
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested solutions to SAEs

1.0 INTRODUCTION

Mathematics is a very useful and dynamic subject. It has long been accepted as a veritable tool of communication, of knowledge. It is the

language of science and all areas of technology and business. It has long been referred to as the Mother and Queen of all subjects.

Its curriculum has undergone a lot of growth and development. The curriculum has been revised considerably in the last twenty-five years.

2.0 INTENDED LEARNING OUTCOMES

By the end of this units you will be able to:

(i) show the importance of Mathematics in relation to other subjects
(ii) show the development of Mathematics curriculum during the pre-independence era, then during the oil boom period (1970-1976). Also the “modern” mathematics controversy in Nigeria.
(iii) Discuss Mathematics curriculum development from end of “modern” Mathematics (1977) to the present.

3.0 Main Content

3.1 Importance of Mathematics

Mathematics has been clouded in mystery because many people do not know or understand it. It is a man-made subject. Somebody has rightly said "seek ye first the knowledge of Mathematics and it's understanding and all other subjects will be added on to it".

3.2 Mathematics is Fundamental to the Study of other Subjects

Without acknowledge of Mathematics, many other subjects cannot be developed beyond a descriptive level. This is particularly true of the sciences, physical, and social sciences. This is one of the reasons for making mathematics compulsory at the Secondary School level.

Mathematics is a complex discipline. It is a tool for architects, engineers, agriculturists, economists, geographers, sociologists, business

administrators and computer/scientists. Hence Secondary School students should understand the inter-relationship among Mathematics, Biology, Chemistry, Geography, Economics, Physics, Social Studies and other subjects. However before a Secondary School student can understand the inter-relationship, he or she must have the knowledge of the nature of mathematics.

3.3 Pre-Independence Mathematics Curriculum

During the pre-colonial period, the mathematics that was taught in Nigeria Secondary Schools was divided into Arithmetic, Algebra and Geometry. The subjects were examined that way at School Certificate level. The text books were written by foreign authors. There was the additional mathematics meant for a few talented ones who may continue studies in Mathematics, Science and Engineering in institutions of higher learning. Because of the demands for mathematics in so many areas of activities in the society, it soon became evident that the contents of the Secondary School mathematics were inadequate. The large number of students taking mathematics made the few number of mathematics teachers inadequate. Mathematics was taught poorly as the other science subjects. Efforts were not made to teach concepts, patterns and principles. There was a popular belief that mathematics was meant for a few gifted ones. This produced a kind of apathy in learning on the

part of majority of the students. Many of the teachers did not care much. They appeared satisfied with the notion of difficulty surrounding the subject.

3.4 During the Oil Boom (1970-1976)

The Universal Primary Education (U.P.E) was introduced in 1976. It made it compulsory for all children of school age to go to school. This led to an astronomical increase in student enrolment without the attendant increase in teachers and infrastructure. This negatively affected the teaching and learning of Mathematics. Before the Oil Boom 1961-1969, some major mathematics curriculum innovations were initiated. Two of them were the Entebbe Mathematics Experiment and the School Mathematics Project (SMP). The schools were allowed to choose the curriculum they preferred and the examining body WAEC examined both projects. The change made worst the already bad state of

teaching and learning of Mathematics. Each of the projects included elements of the so called "Traditional" and "Modern" Mathematics. This crisis between the two so-called Mathematics made both students and parents more confused about the subject. The crisis came to a halt in April 1977 when the then Federal Minister of Education Col. Dr. A. A. Ali abolished the controversial modern mathematics in all Nigerian Secondary Schools. The following year the National Critique Workshop set up by the Federal Government of Nigeria released a new Mathematics Curriculum for the Secondary School in April 1978 in

Benin. It covers both the Junior and Senior Secondary Schools Mathematics. That is JSS1 – 3, SSS 1-3.

The Nigerian Educational Research Council (NERC) in collaboration with the Comparative Education Studies and Adaptation Center (CESAC) played a great part in fashioning the new Primary, Secondary School and the Teachers Grade II – 5 years mathematics curricula.

The feature of Mathematic Curriculum in the Secondary mathematics is that horizontally, it shows the topics being taught followed by the objectives of teaching the topics, then the contents, activities/materials and lastly the remarks.

Vertically, the contents under the above horizontal headings are described. There are lots of things for improvement and innovation by the teacher under the different headings. A sample of this curriculum is included in Unit 5 – mathematical syllabus, particularly JSS III syllabus.
4.0 Self-Assessment Exercises
. How mathematics helps in the study of Physics.

5.0 CONCLUSION

Mathematics has been shown as a veritable tool for the development of virtually all other subjects. The progress in its development in this country has been traced from pre-independence period till 1979. The mathematics curriculum now in use dates back to 1979. This is not good enough. It ought to have undergone a lot of revision and improvement by now. Mathematics is such a dynamic subject whose content continues to expand due to research and development. It is good news to know that a revised curriculum will soon be in place, as a result of the introduction of the Universal Basic Education (U.B.E) introduced throughout the country in 1999.

6.0 SUMMARY

We have discussed the importance of Mathematics as a subject and its relationship to all other subjects. We have traced its development to modern times. The contributions of NERC/CESAC and the National Critique Workshop of 1978 have been highlighted.

7.0 REFERENCES/FURTHER READINGS

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Port Harcourt: Anachuna Educational Books.

8.0 Suggested Solutions to SAEs

How mathematics helps in the study of Physics.

1. Physics concepts, laws and principles are clearly expressed in mathematical terms and equations.
2. Most computations in physics are carried out using mathematical tools and formula.
3. Mathematical language makes physics contents simplified and more comprehensible

UNIT 4 SELECTION OF GOALS AND OBJECTIVES OF MATHEMATICS

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1.0 Introduction
2.0 Learning Outcomes
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- 3.1 National Goals or General Aims for Teaching Mathematics
- 3.2 Utilitarian Goals of Mathematics
- 3.3 Primary Mathematics
- 3.4 Importance of Specific Behaviour Objectives
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4.0 Self-Assessment Exercise (s)
5.0 Conclusion
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8.0 Suggested Self –Assessment Exercises

1.0 INTRODUCTION

In this unit, we want to be acquainted with the goals of teaching mathematics on the national level and then the objectives of teaching it at the levels of primary and secondary school.

The Objectives of Teaching Mathematics in the classroom fall under "Behavioural Objectives". Each teacher is expected to state in his lesson note for each period his behavioural objectives in measurable terms.

2.0 INTENDED LEARNING OUTCOMES

By the end of this unit, you will be able to;

state the goals and objectives of mathematics bearing in mind the needs of the Nigeria Society and those of the individual learners.

3.0 MAIN CONTENT

3.1 National Goals or General Aims for Teaching Mathematics

As stated in the 1977 National Policy of Education, the following are the goals or general aims of teaching mathematics in the primary and secondary school levels. Goals or general aims refer to long-term educational expectations while objectives are for classroom instructions.

(i) To generate interest in Mathematics and to provide a solid foundation for every day living.
(ii) To develop computational skills and foster the desire and ability to be accurate to a degree relevant to the problem at hand.
(iii) To develop precise, logical and abstract thinking.
(iv) To develop ability to recognize problems and solve them with related Mathematical knowledge
(v) To provide necessary Mathematical background for further education
(vi) To stimulate and encourage creativity.

3.2 Utilitarian Goals of Mathematics

Mathematics is a very useful tool for everyday living. It is used when counting, buying and selling. Everybody makes use of it daily. We talk of times, days of the week, month or year. In these days of modern technology, almost everyone owns a mobile phone. We dial numbers, read credits, used or remaining. The computer and calculator are tools in the hand of pupils/students. Mathematics is fundamental to the use of all these gadgets.

3.3 Primary Mathematics

The objective of the teacher education programme is to produce teachers who will promote and achieve effective and efficient teaching and

learning of Mathematics in primary schools. This is as found in the general objective of the 1978 Teacher Education Curriculum as approved by the National Critique Workshop.

An objective stated specifically during the planning for a daily lesson note in the class is referred to as a **Specific Behavioural Objective**. It states specifically what change in behaviour is expected of a student by the end of the lesson. It is assumed that the student in question was not able to perform that behaviour before the lesson. A behavioural objective is **specific** when it states the behaviour clearly to be achieved by the student.

3.4 Importance of Specific Behavioural Objectives

Classroom learning depends on both the teacher and the learner. It is the duty of the teacher to create an environment in the classroom conducive to learning. He then guides the learner to perform certain acts capable of changing the learners' behaviour to the desired behaviour.

The desired behavioural objective should be stated in measurable terms. This is done by using action verbs that require direct observation such as write, state, recite, identify, classify, differentiate, solve, compare, contrast, list e.t.c Some verbs are capable of multiple interpretations such as know, believe, enjoy, appreciate and understand. These verbs that are ambiguous should not be used to state specific behavioural objectives.

3.5 Parts of any well-stated specific behavioural Objective

Every well-stated specific Behavioural Objective has five parts.

(a) The condition under which the change in behaviour is to take place must be stated. The classroom environment, the direction to be given to the learner so as to make him change his behaviour must be stated.
(b) The person whose behaviour has to change must be stated. It is usually the learner in the class-room situation.
(c) What specific behaviour will the learner exhibit. These specific behaviors must be stated in operational (i.e. measurable) terms. This is done by using action verbs as stated above.
(d) What should be the end product or outcome of the change in behaviour? This is also called the performance product.
(e) To what level is the learner expected to perform for this performance to be considered acceptable to the teacher.

Example of such well-stated behavioral objective is as follows. By the end of the lesson, the pupils will be able to list the first ten multiples of any number from 1 to 5 inclusive.

Under what Condition	Who	What behaviour	What result	To what level
By the end of the lesson	The pupils	Will be able to list	First ten multiples of no 1-5	First ten

3.6 Types of Specific Behavioural Objectives

The most correct classification of specific behavioural objective is that of B.S. Bloom (1956) and his associates. They called this classification "The Taxonomy of Educational Objectives" This is an attempt to arrange instructional objectives in behavioural classification.. It starts from simple behaviour easy to achieve to highly complex groups of behaviour. There are three categories (domains) of instructional objectives.

(i) Cognitive Domains
(ii) Affective Domains
(iii) Psychomotor Domains

Cognitive Domain

This refers to the thinking area of the student behaviour. This includes the following:

(a) **Knowledge:** This includes simple recall of knowledge of specific facts, terminologies, generalizations, theorems, structures or algorithms.

(b) **Comprehension:** Which includes ability to translate, interpret, explain correctly, extrapolate.

(c) **Applications:** i.e. use of ideas, theories, principles or concepts learnt in other situations.

(d) **Analysis:** it involves identification of relations and organizations or order in a concept.

(e) **Synthesis:** It includes organization of ideas into reports, plans or systems

(f) **Evaluations:** Implies passing judgment on basis of internal or external evidence.

Affective Domain

Affective domain of behaviour relates to students' feelings and biases. These are:

(i) Receiving or attending
(ii) Participating or responding
(iii) Organizing values into a system
(iv) Valuing or believing in the worth of a thing
(v) Characterization by a value. This domain is difficult to measure but the Federal Government of Nigeria has mapped out a system of continuous

assessment for teachers to measure affective achievement in the classroom.

Psychomotor Domain

This domain is easy to identify and measure. It involves the ability to use our locomotor sensory organs such as:

(i) ability of a child to write a number
(ii) Draw straight lines
(iii) Make an arc or a circle or ability to use the protractor correctly to measure an angle.

4.0 Self-Assessment Exercises

1. Mention any one contributions of NERDC and CESAC in the development of Mathematics curriculum in Nigeria.

5.0 Conclusions

The teacher should be aware that he should from the onset be able to teach mathematics in such a way, the National goals or general aims and Instructional objectives can be achieved. In addition, his specific behavioural objectives must be addressed in each lesson taught.

He needs to evaluate how effectively he is achieving these by looking at and grading student assignments, work and tests.

6.0 SUMMARY

The difference between Goals or General Aims and Specific

Behavioural Objectives has been explained. The utilitarian value of Mathematics has also been explained.

The five properties or parts of a well stated behavioural objective are stated in section 2.5 of this unit. The objective must be stated in measurable terms using action verbs.

The broad three domains of behavioral objectives are given in section 3.3. They are namely:

(i) Cognitive
(ii) Affective and
(iii) Psychomotor

All three occur in the teaching and learning of Mathematics in both Primary and Secondary Schools.

7.0 REFERENCES/FURTHER READINGS

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Fakuade, R.A. (1981) Teaching Arithmetics and Mathematics in the Primacy School. University Press Ltd, Ibadan.

Johnson and Rising (1972) Guideline for Teaching Mathematics. Wadsworth Publishing Company.

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Odili, G.A. (1986) Teaching Mathematics in the Secondary School.

Port Harcourt: Anachuna Educational Books.

8.0 Suggested Solution to Self- Assessment Excercises.

Contributions of CESAC.

1. Contributed in developing new mathematics curriculum for primary, secondary and grade II for 5-year program.
2. NERC Contributions.
   Review of modern mathematics syllabus.

Development of new syllabus for secondary school. Mathematics contents was made to relevant to everyday life activities.

UNIT 5 MATHEMATICAL SYLLABUS

CONTENTS

1.0 Introduction
2.0 Intended Learning Outcomes
3.0 Main Content
    3.1 Contents of syllabus in Primary School
    3.2 Junior and Senior Secondary School Mathematics Syllabus
    3.3 Mathematics in Teacher Grade II
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solution to SAEs

1.0 INTRODUCTION

The terms Curriculum and School Syllabus have erroneously been taken to mean the same thing and the two have been used interchangeably. Curriculum has been regarded as a body of school subject (Daramola, 1995). However, today, curriculum is not equated to the school syllabus.

Curriculum is perceived to include all the various activities and learning experiences available in school situations. Mathematics syllabus is described as sequential arrangement of Mathematical topics at the Primary, Secondary and Teacher Training Schools.

It is therefore seen that curriculum subsumes syllabus and not verse versa: (Daramola, 1995)

2.0 INTENDED LEARNING OUTCOMES

The objective of this unit is to show the content of the Mathematics Curriculum which comprises the syllabus.

3.0 MAIN CONTENT

3.1 Content of Syllabus in Primary School

Before the 1960s as stated in unit 3, Mathematics was taught as arithmetic. Emphasis was on the four rules of addition, subtraction, multiplication and division. The new curriculum now emphasizes

teaching Mathematics as activities – doing, writing, talking, manipulating objects and experimenting with them. According to Johnson and Rising (1971).

(i) Sorting into classes and categories, objects, events, or ideas
(ii) Becoming aware of relationships within the classes or categories
(iii) We look for patterns which suggest structure and relationships
(iv) Establishing generalizations by deductive reasoning or proof
(v) Formulating conclusions which seem to contain the ideas and events.

Thus, we see that students make the best use of what they see, hear or do. (Fakuade, 1981). We summarize the goals of teaching mathematics in primary and even pre-primary schools as:

(a) To prepare every individual rightly for life in view of the inherent utilitarian values of mathematics.
(b) Primary education serve as a good foundation for preparing them adequately for Secondary school Mathematics and other school subjects where mathematics is needed.

The utilitarian aspects are catered for by learning counting, notation, addition, subtraction, multiplication, division, weighing, measurement, buying, selling etc. These are some of the needs to know fundamental processes of pre-primary, primary and secondary school mathematics. (Aiyedun, 1990).

3.2 Junior and Senior Secondary School Mathematics Syllabus

As sated in unit 3, the mathematics curriculum which was given to the nation in 1978 by the National Critique Workshop of that year, has been used since then with little modifications. This is not good enough as Mathematics is a very dynamic subject and has witnessed a lot of changes. With the volume of research in the last two and half decades and the influence of communication technology, such as the computer, ICT, internet and networking, mathematics teaching cannot be left behind. Infact, it should set the pace.

The features of this curriculum are as follows:

Horizontally, the curriculum states the topic followed by the objectives, contents, then activities/materials and lastly remarks.

Vertically under each of the above horizontal rows are the required items. Attached to the end of this course material is the curriculum/syllabus of the Junior Secondary School II JSS III as an Appendix.

Many textbooks are in the market covering various aspects of this syllabus. Various mathematicians, mathematics educationists and state governments have commissioned its teachers through workshops and

seminars to write books for the pupils/students. At the Senior Secondary School level, a curriculum has long been written called

"Further Mathematics" to replace the Additional Mathematics. It is intended to be used by students in Secondary Schools who have a flair or aptitude for mathematics and mathematics related-careers or

programmes such as Engineering, Economics, Geology, Computer/Information technology etc. At the tertiary levels such as University, Polytechnic or Colleges of Education, topics covered in further mathematics include:

(i) Differential and Integral Calculus
(ii) Elementary Statistics,
(iii) Probability etc.

3.3 Mathematics in Teacher Grade II

In the Grade II teacher Education only Arithmetic process was taught. Just as the name implies, Arithmetic comprising Addition, Subtraction, Multiplications and Divisions were taught. Later on Basic Mathematics was incorporated. But in 1978, the national teachers Institute (N.T.I) was mandated by Decree No. 7 to organize programmes for upgrading practicing teachers at all levels. This task NTI has done creditably well. Since then over 300,000 unqualified teachers have graduated in the TC

II Distance Learning System for upgrading unqualified teachers. A look at all the states shows that the number of unqualified teachers in the primary schools has been reduced. They have also embarked on training NCE teachers by the same Distance Learning System. This is to upgrade TC II Teacher to NCE which has been made the minimum teachers

qualification in the Nation's Primary Schools. This is as stipulated in the 1979 National Policy on Education Section 9 Subsection 61.

4.0 Self –Assessment Exercises

State the five important aspects of a good learning outcome

5.0 CONCLUSIONS

The development of the Mathematic curriculum from the pre-primary, Junior and senior secondary schools have been traced. That of the

Teacher Grade II-5 years has also been stated. That of the Teacher Grade II has been faced out and this has been left in the hands of the National Teacher Institute (NTI). The NTI is doing a good job as stated in 3.3 above.

6.0 SUMMARY

We have explained the differences between Mathematics syllabus and Mathematics curriculum. We have also given the content of the curriculum at the Primary, Junior, Senior Secondary and Grade II levels. The development of Mathematics should be a continuous process. This

is so because Mathematics is a dynamic subject. The growth of Mathematics content and the development of ICT Technology is impacting on the subject.

7.0 REFERENCES/FURTHER READINGS

Aiyedun, J. O. (1990) "The Case for Nursery Primary Education in Mathematics in the 6-3-3-4 Education Policy for Nigeria" in ABACUS. Journal of the Mathematic Association of Nigeria.

Daramola, S. O. (1995) "Curriculum Development in Schools". Lekan Printing Press, Ilorin. P. 6.

Fakuade, R. A. (1981). Teaching Arithmetic and Mathematics in the Primary School: Ibadan University Press, Ibadan. Nigeria.

Johnson and Rising (1971). Guideline for Teaching Mathematics. Wadswroth Publishing Company.

Federal Republic of Nigeria 1977: National Policy on Education; Lagos: Federal Ministry of Education.

8.0 Suggested Solutions to SAE

1.The specific condition under which change in behaviour is to occur.
2. The audience or person whose behaviour will change
3. The expected specific behaviour change.
4. level of performance of the expected behaviour change.
5. The performance product. (outcome of behaviour change)

MODULE 2

Unit 1 Scheme of Work and Weekly or Unit Plan
Unit 2 Characteristics of a Lesson Plan or Note of Lesson
Unit 3 Psychological Basis for Mathematics Education: Contributions of Piaget, Bruner and Gagne to Learning of Mathematics
Unit 4 Individual Differences in Mathematics Classroom: Causes and Care
Unit 5 Developing Positive Attitude Towards Mathematics by Students

UNIT 1 SCHEME OF WORK AND WEEKLY OR UNIT PLAN

CONTENTS

1.0 Introduction
2.0 Learning Outcomes
3.0 Main Content
  3.1 Scheme of Work
  3.2 The Role of the Teacher
  3.3 Weekly Plan or Unit Plan
  3.4 Format of Unit Plan
4.0 Self –Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

Having taught you the details of the mathematics syllabus in Unit 5, it is ecessary for you to know the breaking down of the syllabus to determine how much of it is to be taught in each of the three terms of the six years of Secondary School. It is this chunk of the topics to be taught each term that is referred to as the “Scheme of work”. The weekly breakdown of the scheme of work is called the “Unit plan” or “Weekly Plan”

2.0 INTENDED LEARNING OUTCOMES

The objective of this unit is to show how the mathematics teacher is to divide the syllabus for each year into termly scheme of work and each week unit plan. A term is normally taken to last twelve weeks. The las

two weeks of the term is meant for revision of the materials taught and the end of term examinations.

The Secondary School Mathematics teacher will further divide the scheme of work into topics to be taught each week. This is called "Unit Plan" or "Weekly Plan". In the next unit, the teacher will learn how to divide the unit plan or weekly plan into "Lesson Plan" or "note of lessons". The note of lesson is the teaching of mathematics for every thirty-five minutes of lessons in primary school and forty minutes in secondary school. Mathematics is usually taught for about eight lessons in a week.

3.0 MAIN CONTENT

3.1 Scheme of Work

The teacher is expected on receiving the curriculum for each year to break it up into each term's weekly scheme of work. This scheme of work should make allowance for interruptions such as midterm breaks and school social activities. These should be considered when sequencing themes/topics according to weeks.

According to Daramola 1995), the scheme of work booklet is intended for practising and prospective teachers. For prospective or student teachers on teaching practice, the booklet is meant to serve the following purposes:

(i) It reminds him the sequence of the scheme of work to use.
(ii) Helps him to know what progress has been made in respect of the coverage of the work intended for a given term
(iii) Helps the teaching practice supervisor to know whether or not the student-teachers have been following the scheme of work in a logical and sequential order and lastly
(iv) Serves the student-teacher as a useful document for use when he finally becomes a full time teacher.

In writing the Scheme of Work, the sequencing of the topic should go from simple to complex, and known to unknown. That is, topics taught at the beginning of the term should not be as difficult as those at the end.

The format of the scheme of work for a term of secondary school

Mathematics is given below:

(i) 1st week
(ii) 2nd week
(iii) 3rd week
(iv) 4th week
(v) 5th week
(vi) 6th week
(vii) 7th week
(viii) 8th week
(ix) 9th week
(x) 10th week
(xi) 11th week
(xii) 12th week
(xiii) 13th week

The topics should be sequentially arranged as written above.

3.2 The Role of the Teacher

The teacher is the leader in the class. Therefore, he must be a role model who must exhibit poise and confidence to the pupils. He should have a purpose and direction. He must know the knowledge at hand and must understand his pupils. This character will be brought to bear on planning his Mathematics lessons. Because of these characteristics, he will be loved, obeyed and given attention by the students. According to Gagne (1970), informing student on what to do serves as direction that can facilitate students' achievement. By planning, helps the teacher break the content of his teaching to manageable sizes so that they are just appropriate. That is, not too much and not too little. It also assists him to identify the sequence of thought, activities and content development of the topic. He will have read made questions to direct the pupils to the expected objectives.

3.3 Weekly Plan or Unit Plan

After breaking the syllabus into termly plan or scheme of work, the next thing is for the teacher to further identify learning units within that of the term. A learning unit is a broad unit of base concepts capable of being broken into more than one daily lesson content. For example from a learning unit in the primary school curriculum is "Addition of Fractions". Surely this cannot be taught effectively in one lesson.

It is good if one learning unit fits into the number of lessons for one week. In this case, the learning unit can then be said to be the **Weekly Plan**: With proper planning, it is possible to make every learning unit plan coincide with the weekly plan for supervision purposes.

3.4 Format of Unit Plan

The broad pieces of information of a Unit Plan or Weekly Plan are set out below:

(i) The topic to be planned for
(ii) The class for which the topic is being planned
(iii) General objectives. They are stated in the curriculum
(iv) Entering behaviors: It is the pre-requisite behaviour necessary or essential for the new concept.
(v) The daily lessons involved in the learning units. It is the most important aspect of this format. Breaking the learning unit into the suitable number of daily lessons enough to cover the unit is as art every teacher must develop. A good guide to doing this is teaching one **Concept** at a time. In other words, let one specific objective determine one lesson. This is not always the case. We may have two specific objectives depending on the relative intelligence of the class and the content to be taught. But in most cases let one objective be enough for a lesson of 40 minutes.
(vi) Some suggested teaching aids may be identified at the learning plan level. This makes the planning of the daily lesson plan easy. Evaluation and teaching techniques are not necessary at this planning level, but these are necessary at the daily lesson plan or note of lesson plan level.

4.0 SELF ASSESSMENT EXERCISE (SAE)

1. State any five points in the format for a unit lesson plan.
2. The Scheme of work is developed from the lesson plan. True or False

5.0 CONCLUSIONS

In conclusion, we say that the scheme of work is very important and it is the first work of every teacher on getting hold of the curriculum for each year of the primary or secondary school. After this, he will then plan the weekly plan or unit plan and then the daily lesson note.

6.0 SUMMARY

In this unit you have studied the importance and meaning of the scheme of work, how to draw it and the meaning and format of the weekly or the unit plan. With practice, these can easily be mastered.

7.0 REFERENCES/FURTHER READINGS

Fakuade, R. A. (1981) Teaching Arithemetics and Mathematics in the Primary School, Ibadan University Press, Ibadan.

Gagne, (1970) Report M. The Conditions of Learning Hold Rinihot and Winston, New York

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Port Harcourt Anachana Educational Books.

Daramola, S.O. (1995) "Curriculum Development in Schools". Lekan Printing Press, Ilorin.

8.0 Suggested Solutions SAEs

Possible answers to SAEs

1. These can include the following
   (i) topic for the week
   (ii) learning outcomes stated in broad measurable terms.
   (iii) entry behaviour relevant to the topic stated in observable performance behaviour. (iv) teaching aids can be suggested. (v) class to be taught.
2. False.The scheme of work is developed from the curriculum and the lesson plan developed from the scheme of work.

UNIT 2 CHARACTERISTICS OF A LESSON PLAN OR NOTE OF LESSON

CONTENTS

1.0 Introduction
2.0 Learning Outcomes
3.0 Main Content
    3.1 Daily Lesson Format
    3.2 What the Teacher should note
    3.3 Junior Secondary School 3 Mathematic Curriculum
    3.4 An Example of a Lesson Plan or Note.
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

The writing of a lesson note is the duty of every teacher or prospective teacher in our primary and secondary schools. It is essential for every mathematics teacher to be very good in this "art" for the effective teaching and learning of Mathematics.

2.0 INTENDED LEARNING OUTCOMES

By the end of this unit, you should be able to:

- List the features of a good lesson note and
- Write a standard lesson note or lesson plan

3.0 MAIN CONTENT

3.1 Daily Lesson Format

A note of lesson differs from a daily lesson plan in matter of details.

A daily lesson plan is a write up that spells out clearly the class being taught for a specific time or period usually 40 minutes, the specific behavioural objectives of the lesson, the entry behaviour, the activities involved, the teaching aids, the teaching strategies, the development of the content sequentially, evaluation techniques and the closure of the lesson.

The reasons for writing a lesson note by the mathematics teacher are as follows:

(i) direct his attention to realize the specific behavioral objectives
(ii) locate the needed teaching aids for teaching the lesson
(iii) locate the entry behaviours which will help to introduce the new concept.
(iv) define the sequence of thought and actions needed to develop the content and allow time to achieve the objectives.
(v) prepare for questions to be asked by both the learner and the teacher himself
(vi) Make room for student activities
(vii) End the lesson with a summary and assignments.

3.2 What the Teacher should note

In order to write a good lesson note, the teacher should be very well aware of the three words namely:

(i) the content (ii) the child and (iii) the curriculum

Each of them as stated must be borne in mind while teaching both Primary and Secondary School Mathematics. Briefly explained.

(i) Content: The teacher must know very well what he wants to teach. He must know the concept he is teaching and how it relates to other concepts. He should be able to arrange the content sequentially, step by step so as to succeed in achieving the behavioural objectives he has in mind. He should move from simple to complex, known to unknown. The entry behaviour, that is, what the child already knows will be used to teach him new concepts.

(ii) The Child: The Teacher must understand the child he is teaching. He should know his maturity level so as to know which teaching aids he will like and appreciate. The child's age will show his level of intellectual development. In the primary school, the majority of them are in the concrete operational stage and so must be taught using concrete objects such as stones, counters, matches, stick etc. After this, pictures, drawings on card

boards etc and then symbols before abstractions in the Secondary School.

Many teachers neglect consulting the curriculum. The 6-3-3-6 Mathematics curriculum should be consulted at all times. It isvery comprehensive and good. It contains a wealth of information for the teaching of any concept. The column for objectives indicates the necessary general objectives that must be achieved. The teacher can then write his own specific objectives that will lead to the general goals or aims. The content column gives other topics relating to the concept being treated and allows relational awareness on the part of the teacher. The column for the materials/activities suggests the method to be used, activities to be carried out in class, the aids to be used and experiments to carry out. The column for remarks narrates the depth to be reached for any concept. The area for emphasis and area not to be treated and special teaching strategies or aids to be used.

3.3 Junior Secondary School 3 Mathematic Curriculum

The teacher should consult the text-books. He should use the textbook that contains the most materials arranged as stated in the curriculum. Also with exercises and activities suitable in quality and quantity for the class identified.

He should be free to use other relevant books. He should not be a slave to any textbook.

3.4 An Example of a Lesson Plan or Note

Topic: A lesson on subtraction of a smaller fraction from a bigger fraction with different denominators. E.g. $\frac{4}{} - \frac{1}{}$

53 **Class: 6**

Specific Behavioral Objectives

By the end of this lesson, the students should be able to correctly subtract a smaller fraction from a bigger fraction with different denominators

Entering Behaviour

(i) The students have studied equivalent fractions and how to find them

(ii) They can add correctly two fractions with common denominators.

(iii) They can distinguish smaller fractions from bigger fractions comparing the numerators of fractions with common denominators.

(iv) They can add correctly two fractions with different denominators

(v) Pupils can change improper fractions to proper fractions.

(vi) They can also write fractions in their lowest terms.

Teaching Aids

(i) Fraction charts
(ii) Equivalent fraction boards

Content Development and Learning Activities

Step I:

Quickly find out if the pupils can add fractions with common denominators. Thus write on chalks boards:

$\frac{2}{5}+$ $\frac{3}{5}=$ ☐

Let each child write the answer. Go round and check their answers.

Step II:

Write on the chalkboard the problem
$\frac{3}{4}+\frac{2}{3}=$

and demand an answer from the pupils. Pause a little for them to think. Remind them that we have to reduce them to common denominators:

Step III:

Open up the equivalent fraction chart.

Teacher: Write out a least four equivalent fractions for each of the fractions:

Pupils:

$\frac{3}{4} = \frac{6}{8} = \frac{9}{12} = \frac{12}{16}$

$\frac{2}{3} = \frac{4}{6} = \frac{6}{9} = \frac{8}{12}$

Teacher goes round to supervise and helps those who could not do these.

Teacher: Identify the equivalent fraction with common denominator in the two.

Pupils: $\frac{8}{12}$ & $\frac{9}{12}$

Teacher: Arranges on the chalkboard

$\frac{3}{4} + \frac{2}{3} = \frac{9}{12} + \frac{8}{12} = \frac{17}{12}$

$\frac{2}{3} = \frac{4}{6} = \frac{6}{9} = \frac{8}{12}$

Pupil copy in their notes.

Step IV:

Teacher asks $\frac{}{5}$ and $\frac{}{3}$ which one is greater $\frac{}{5}$ or $\frac{}{3}$?

Teacher pauses and allows the pupils to think. A pupil may say lets arrange them to have equal denominators.

$\frac{4}{5} = \frac{8}{10} = \frac{12}{15} - \frac{16}{20}$

$\frac{1}{3} = \frac{2}{6} = \frac{3}{9} = \frac{4}{12} = \frac{5}{15}$

Teacher goes round to check pupils work
Teacher asks which ones have common denominators

Pupil:

12 and 5 $4 - 1_{} = 12 - 5 = 7$

15 15 $5 \quad 3 \quad 15 \quad 15 \quad 15$

Another example is then given:

$5 - 1$

Teacher asks students to follow the same method as above to arrive at the answer.

Assignment

Subtract the following fractions:

(i) $\underline{1} - \underline{1}$

2 3

(ii) $\underline{4} - \underline{1}$

7 2

(iii) $\underline{2} - \underline{1}$

5 3

As the pupils are working, teacher goes round to mark each individual's work.

4.0 SELF ASSESSMENT EXERCISES (SAE)

1. State any five points in the format for a unit lesson plan.
2. The Scheme of work is developed from the lesson plan. True or False

5.0 CONCLUSIONS

The necessity and importance of the note of lesson has been given and stressed. It is useful in the realization of the specific behavioural objectives of the lesson and it helps in getting each one engaged in the learning process.

6.0 SUMMARY

In this unit, we have learnt the characteristics and meaning of a Lesson Plan or Note of Lesson. The lesson note is very important to the teacher. The features and format of it have been given. It is an "art" which every teacher must cultivate and perfect and this is easily done with practice.

7.0 REFERENCES/FURTHER READINGS

Fakuade, R. A. (1981). Teaching Arithmetic and Mathematics in the Primary School, University Press, Ibadan.

Gagne (1970) "The Conditions of Learning" Hold Rinihat and Winston, New York.

Odili, G. A. (1986): Teaching Mathematics in the Secondary Schools.

Port Harcourt: Anachnna Educational Books.

8.0 Suggested Solutions to SAEs

1. These can include the following
   (i) topic for the week (ii) learning outcomes stated in broad measurable terms.
   (iii) entry behaviour relevant to the topic stated in observable performance behaviour. (iv) teaching aids can be suggested. (v)class to be taught.
2. False.The scheme of work is developed from the curriculum and the lesson plan developed from the scheme of work.

UNIT 3 PSYCHOLOGICAL BASIS FOR MATHEMATICS EDUCATION: CONTRIBUTIONS OF PIAGET BRUNER, AND GAGNE TO LEARNING OF MATHEMATICS

CONTENTS

1.0 Introduction
2.0 Learning Outcomes
3.0 Main Content
  3.1 Paiget's Theory of Intellectual Development
  3.2 Contributions of Jerome Bruner
    3.2.1. Implications of Bruner's Work to Teaching and Learning of Mathematics
  3.3 Works of Robert Gagne
    3.3.1 Implication of Gagne's work to the teaching and learning of Mathematics
4.0 Self –Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested solutions to SAEs

1.0 INTRODUCTION

In Educational Psychology, we are concerned with the study of human behaviour. In teaching mathematics, teachers must learn to cope with the problem of children learning and the conditions that enhance maximum learning. You therefore learn how educational psychology can be applied to make good teaching and learning possible in our primary and secondary schools.

2.0 INTENDED LEARNING OUTCOMES

By the end of this unit, you will:

- be able to state the four levels or stages of cognitive or intellectual development of a child as stated and analyzed by Jean Piaget.
- highlight and explain Bruner and Gagne's contribution to the teaching and learning of Mathematics by learning their psychological theories.
- watch various terms or words used in this unit and their appropriate meanings.

- Learn the implications of these theories to the teaching and learning of mathematics.

3.0 MAIN CONTENT

3.1 Piaget's Theory of intellectual Development

Jean Piaget was a French-Swiss Psychologist who was originally a trained biologist. His research along with those of other psychologists spanned more than fifty years. They were based in Geneva. Piaget researched into intellectual and cognitive development of children. He was not the only contributor to this field. Others include Bruner and

Gagne and many more. Piaget and others studied and analyzed the growth and development of children thinking.

According to Piaget, there are four stages of intellectual thinking and development. The stages are sequential.

His school was noted for the study of psychological or intellectual

problems underlying the learning of mathematics. His work has the greatest value for teachers of mathematics especially at the primary school level. Piaget saw cognitive or intellectual development in terms of well defined sequential stages in which a child's ability to succeed in terms of his biological readiness (heredity) for the stage and partly his experiences with activities and problems in earlier stages.

According to Piaget, the four stages of Intellectual development are:

1. The Sensory-motor stage: Age (0-2) years

At this stage, the child relates to his environment through its senses only. By the end of the second year of life, children have a rudimentary understanding of space and are aware that objects exist apart from their experience of it.

2. Pre-Operational stage: Age (2-7 years.)

This generally covers the cognitive development of children during pre-school years, normally referred to as a pre-nursery and nursery (kindergarten) years. At this stage, children are able to deal with reality in symbolic ways.

Their thinking at this stage are, however, limited by centring inability to consider just one characteristic of an object at a time. At this, stage most of them are not able to understand Reversibility: - the ability to think back to the causes of events. Because of these inabilities, they cannot conserve – retain important features of objects and events. They cannot therefore engage in logical thinking in any coherent sense. The child is said not to possess the concept of conservation of number, volume, quantity or space.

Piaget Demonstrated the Lack of Conservation in Two Experiments.

The implication of children not understanding conservation at the pre-operational stage is for the mathematics teacher not to waste his time and not to harm the children by telling the pupils what they cannot experience through their senses. That is through seeing, feeling as well

as hearing. Abstract mathematical ideas should therefore not be introduced at this stage. Children at this stage should be permitted to manipulate objects and symbols so as to be able to appreciate reality. Mathematically-oriented recreational activities such as mathematics games, plays, use of counters, blocks, stones and marbles etc are important materials for learning mathematics at this stage.

3. The Concrete Operational Stage (7-12 years)

This stage is very important to every primary school teacher since most

of their pupils are in this stage of development. This stage is the beginning of what is called the logico-mathematical aspect of experience. At this stage, pupils understand the conservation of objects, counting a set of objects from front to back, back to front or from the middle gives the same answer. This is also part of logico-mathematical. This logico-mathematical also underlines the physical act of grouping

and classifying in the algebra of sets. Conservation of invariant is usually illustrated by the pouring of equal amount of liquid to two equal jars of cups. One of the two cups is then emptied into a thinner cup. When asked which cup contains more liquid, he says the new cup, because the height of the liquid in the thinner cup is higher even though he saw that the liquid poured is the same as in the first case.

At this stage, there is one limitation children have, difficulty from hypothetical assumptions.

4. Formal Operational Stage (12+ years)

This is Piaget's last stage of intellectual development. At this stage, children can think abstractly if they are not affected by the limitations of the concrete operational stage. As shown by research, less than half of adults ever function at the formal operational level. At this stage, the child now reasons or hypothesizes with ideas or symbols rather than needing objects in the physical world as a basis of his thought. He can think scientifically and as a logician. He can reason hypothetically. He is no more tied by his thoughts to existing reality. He can construct new operations. The ages separating the stages are approximate and they differ slightly according to cultures.

3.2 Contributions of Jerome Bruner

He was an educational psychologist whose work has also affected the

teaching and learning of mathematics. He did not like Piaget's operational structures, especially the way Piaget seemed to have classified the experimental task and by implication other tasks of the child and rigidity to the stages. (Abimbade, 1995). He maintained that learning in general depended on four factors:

(i) the structure of the concept that is to be leant
(ii) the nature of learner's intuition
(iii) the desire or willingness of the learner to learn
(iv) the readiness (as well as biological) for learning

According to Bruner, a theory of instruction is prescriptive in the sense that it outlines rules concerning the most effective ways of attaining knowledge or skills. Also, a theory of instruction sets up criteria and states conditions for them. To him, theory of instruction is needed since psychology already contains theories of learning and developments descriptive rather than prescriptive. He opines that the theory should provide a means of leading the child to the path of reversibility. Instruction is concerned mostly with how a teacher wants to teach. How to present the learning materials so as to achieve learning? According to Bruner, his own stages or processes by which learning occurs in a child are as follows:

(i) Enactive Stage

The child thinks only in terms of action. He enjoys touching and manipulating objects as teaching proceeds. Specifically, no learning occurs at this stage. Topics can however be introduced to the child using concrete materials.

(ii) Iconic Stage

The child manipulates images. He builds up mental images of things already expressed. Learning at this stage is usually in terms of seeing and picturing in the mind any objects which transform learning using pictorial presentations.

(iii) The Symbolic Stage

Here apart from action and symbols, the child uses language. This he calls the highest stage in learning. The individual engages in reflective thinking to consider proposition and concrete examples to arrange concepts in an hierarchical manner. By this, acquired experiences are

translated into symbols form. Bruner opined that the progressive development of the three stages and further elaboration vary from one

individual to another and depend on the inter play between psychological maturation, experience and socio-cultural factors.

3.2.1 Implications of Bruner's work to teaching and learning of Mathematics

He says teacher should stimulate children's readiness to learn. Like Piaget, Bruner believes that mathematics can be learnt by discovery approach by starting early in life using concrete materials relevant to concepts which are to be learnt at a higher stage.

That learning mathematics should start from known to unknown. It should not be learnt in abstract. It should be learn first with concrete material, then pictorial, symbols and then abstract.

The home and school environment help the mathematics teacher to see them as important in mathematics education. A child exposed to a rich

environment will do well in mathematics. Teachers of mathematics must make their lessons child-centered. The use of teaching – learning

materials is emphasized. There should not be rote learning and the learning must be practicable.

3.3 Works of Robert Gagne

He was an American Educational Psychologist. As a behavioural psychologist, his model is a prescription for teachers and learning is quickly described. He believed that children have learned when they

performed acts which they could not perform before, the acts can be analyzed to sub-acts. His theory is built on learning hierarchies from a number of qualitatively different kinds of learning described as:

(i) Stimulus Response (S-R)
(ii) Multiple Discrimination Learning
(iii) Concept learning

To him, a concept is defined as "a unique feature common to a number of objects processes, phenomena or events which are grouped according to this unique properties.

(iv) Principle Learning (Process Skills). Process skills include observing, using space/time relationship, using numbers, measuring, classifying, communicating and predicting, inferring.

These skills are especially desirable for primary school children.

Five additional process skills are proposed for the intermediate grades at JSS such as:-

- Formulating hypothesis
- Controlling variable
- Interpreting Data
- Defining operational and
- Experimenting

All five processes are indispensable in Mathematics and the Sciences.

3.3.1 Implication of Gagne's work to the teaching and learning of Mathematics

Gagne emphasized the idea of prerequisite knowledge or entry behaviour in the learning of mathematics. An individual cannot master complex concepts without first mastering the fundamental concepts. He introduced the "principle of programme learning and the idea of learning set" to mathematics instruction. He emphasized "guided discovery" which is useful in the teaching of mathematics and science. He also worked on:

(i) Planning of courses, curricula or lessons
(a) needs and interests of the child
(b) the child's readiness
(ii) Conduct of Instruction

The specific behavioural objectives of instruction should be made clear to the child.

(iii) Assessment of instruction

Adequate assessment of the child should be carried out based on the specific objective(s) of the lesson and the pupils should be given a feed back so as to motivate them for progress and readiness to learn new things and new concepts.

4.0 Self-Assessment Exercises (SAEs)

1. Mention any two of the psychologists whose theories influenced the study of Mathematics.
2. Mention the stages in the Piaget's theory of learning.

5.0 CONCLUSIONS

We have studied the psychological theories of Piaget, Bruner and Gagne with their implications for the teaching and learning of mathematics at all levels of our education. Other psychologists also contributed to the psychological theories but ones from these three are the most relevant.

6.0 SUMMARY

In this unit, we have studied Piaget's theory of intellectual development. He postulated four stages beginning from childhood to adulthood. At the early stage, the pupils interact with the environment through their senses and at the pre-operational stage which covers the pre-nursery and nursery (2-7 years). Then the concrete stage (7-12 years) and lastly the formal operation state (12+ year) when adult reasoning – abstract and logical, scientific thinking start. The child can go from possibility to reality. The implications for teaching and learning of mathematics were explained.

The theories of Bruner and Gagne were also treated with the implications of their theories for the teaching and learning of Mathematics.

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8.0 Suggested Solutions to SAEs

(1) Psychologists whose theories influenced the teaching and learning of mathematics. Piaget, Jerome Bruner and Robert, M. Gagne

(2) Stages in the theory of learning by Piaget are

Sensory-motor stage(0-2years)
Pre-operational stage (2-7years)
Concrete-operational stage (7-12 years)
Formal operational stage (12+years**)**

UNIT 4 INDIVIDUAL DIFFERENCES IN MATHEMATICS CLASSROOM: CAUSES AND CARE

CONTENTS

1.0 Introduction
2.0 Learning Outcomes
3.0 Main Content
  3.1 Ability Relevant to Mathematics
  3.2 Abilities that are not measurable
  3.3 Accommodating Individual Differences
  3.4 Practical Ways for Catering for Individual Differences
  3.5 Uses of Differences in Mathematical Ability
4.0 Self –Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

No two people are exactly alike. Every individual is unique. Even identical twins differ in many ways. People differ in intelligence or academic ability, interest, sex, attitudes, attention span, maturation motivation etc. So as soon as you have a class of thirty to forty pupils to teach mathematics, the teacher must accommodate these varied and many differences.

2.0 INTENDED LEARNING OUTCOMES

At the end of this unit, you will be able to:

- Enumerate these differences
- How to accommodate them
- Teach while bearing them in mind

- Identify traits that cannot be measured and
- Suggest ways of providing for individual differences.

3.0 MAIN CONTENT

3.1 Ability Relevant to Mathematics

The following differences are especially relevant to Mathematics learning. They include:

(i) Mental Ability:- This includes ability to think or reason reflectively or ability to solve problems.

(ii) Mathematical Ability:- Ability to compute, ability to do logical reasoning.

(iii) Knowledge of Mathematical concepts, structures and processes. These three traits are measurable for example, the first one is measured by what is called Intelligence Quotient (IQ) MA – Mental Age Psychologist use M.A. to measure differences in mental ability, for example a child of five years of age may be able to perform a task no more complex than those performed by those of age four years.

His mental age is thus 4 years while his chronological age is 5 years.

His I.Q. is thus:

$$I.Q = \frac{100 \times MA}{CA} = \frac{100 \times 4}{5} = 80\%$$

CA is child chronological age or

Actual Age.

In a typical classroom, we expect I.Q. to vary from 75 to 150.

3.2 Abilities that are not Measurable

Other differences that are not measurable are:

(iv) Motivation, Interest, Attitude and Appreciations.

(v) Physical, Emotional and Social maturity of the learner.

(vi) Special Talents or Deficiencies such as creativity, inability to read properly or retention span.

(vii) Learning habits, attentions, self -discipline and organization of written work.

Mathematical Aptitude Tests (A test of quantitative thinking) teacher made achievement test. This can be administered early in the year.

Knowledge of Mathematical concepts structure and processes is related to the previous educational experiences of the learner. It determines the readiness of the learner for the content of a new course. A diagnostic test or pretest determines the area of difficulty of the learner.

Traits listed in (iv) to (vii) cannot at present be measured precisely as at now. They are usually measured by interviewing the learner. These methods of measurements are now being perfected in Europe and America. They are now being tried in the country.

The new Universal Basic Education curriculum now out this year is being trial-tested. By next year 2007, it will be implemented, Lord willing. It will include the Mathematics Curriculum for Nursery, Primary and First three years of Junior Secondary School, J.S.S. 1-3

3.3 Accommodating individual differences

Since individuals differ so much in the traits listed above, it is not wise or reasonable to teach every one in the class using the same time duration, the same strategies, assignments, method, attention span e.tc. The differences must be catered for. The traits may be inborn, inherited, acquired or learnt. The first step in addressing the differences is for the teacher to gather as much information about the pupil as possible. This is to help us to decide what help will be most appropriate for him. The teacher will be responsible for accommodating these traits by looking at the programme and the school. He has to carry along the majority of the class. He offers slightly different experiences for different learners. He varies contents, language rate of learning, materials of instructions and the goals of learning according to individual differences.

3.4 Practical ways for caring for individual differences

Special curriculum with learners assigned to classes on the basis of abilities and interests is desirable. Such programme might include:

(i) accelerated class for gifted students
(ii) remedial instruction courses
(iii) special course for slow learner's classroom activities modified according to learners needs. Such as:
    (a) vary daily learning activities according to ability or achievement levels
    (b) organize the class into small group and giving each group special instructions and assignments.
    (c) Provide supervised study time so that the work of individual can be observed and help given when needed.
    (d) involve the pupils in many of the classroom activities such as writing on the chalkboard, collecting papers etc. Each learner needs to feel he

has a place in the class and participates in some activities without frustration.

(e) Provide textbooks that are suitable to the level of the learner.

(f) provide and use teaching-aids, and models etc appropriate to the needs and interests of the students.

(g) use methods and instruments of evaluation appropriate to the course or pupils involved. For instance, do not give the same work or assignment to the group of weak students and those of the gifted ones.

3.5 Sex Difference in Mathematic Ability

Research has shown that males perform better than females in measurement of numeral and spatial ability but this is not significant at the five percent level of significance. Females perform better than males in test of language and fluency. The fact that females perform slightly less than males in mathematics calls for more patience, tolerance and use of better methods and strategies when teaching female (Aiyedun, 2000) students.

4.0 Self –Assessment Exercises

1.Mention any two methods that can be employed in managing individual differences among learners in a mathematics classroom?
2.State any two ways the mathematics teacher can use to identify individual differences among learners in his class?

5.0 Conclusions

There is individual differences in mathematics classrooms and this calls for care and awareness of the teacher in teaching the pupils. These differences need to be accommodated while teaching. Some of these differences and traits are measurable and others are not measurable. Some of them need to be catered for while others cannot be solved as

they are inborn, learnt and acquired. They call for special strategies, methods, breaking into smaller groups and using special times such as break times for remedial teaching. Efforts should be made to carry along the majority of the students in the class.

6.0 SUMMARY

Consideration of the differences between pupils is very important especially in a mathematics classroom. The basic idea

is that every child should be given the opportunity to display his abilities as fully as possible. This requirement is not specific to mathematics but is particularly important here. There are a variety of ways of organizing the mathematics programme and a variety of materials for use in meeting individual needs. The teacher is still the key since his understanding of the learner is the first step towards providing for the learners special needs.

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8.0 Suggested Solutions SAEs

1. (i) Use of special curriculum where learners can be assigned to on ability level and interest.
   (ii) encouraging social interactionvarying daily activities due to ability level variety of different class activities
   supervised class activities use of varied teaching aids
   evaluation tools and methods should be appropriate to the learner's level.
2. To identify individual differences, use any of the following; observation, interview, tests, teacher-student conference, use of open day, study of official report of the student, physical appearance etc

UNIT 5 DEVELOPING POSITIVE ATTITUDE TOWARDS MATHEMATICS BY STUDENTS

CONTENTS

1.0 Introduction
2.0 Learning Outcomes
3.0 Main Content
  3.1 Types of Learning that Encourage Development of Positive Attitude
  3.2 Developing Love for Mathematics
  3.3 Sex Difference in the Learning of Mathematics
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

As a result of the poor performance, many of the pupils have a negative attitude towards mathematics. As a result, anytime they have a mathematics class they feel unhappy and they dread the periods of learning mathematics. Consequently, they do not concentrate and make no effort to study. The teacher therefore needs to be careful not to worsen an already bad situation by encouraging them through praise, gifts and motivation.

2.0 INTENDED LEARNING OUTCOMES

At the end of this unit, you would be able to get your pupils to develop a positive attitude toward mathematics. Primary and secondary school pupils would be made to love and enjoy doing and learning mathematics.

3.0 MAIN CONTENT

3.1 Types of Learning that Encourage Development of Positive Attitude

(i) Discovery learning especially during the early years in Pre-Nursery and Nursery years should be encouraged. This means that the child's natural tendency to explore and manipulate the environment for his usefulness must be sustained and encouraged. There is no gainsaying that this

tendency is maintained and fostered in the nursery schools.

(ii) Individual differences should be recognized and controlled. Different responses should be expected in learning situations in view of children existing cognitive organizations which have grown out of past experiences. They will learn different things from the same experience so opportunity should be given for self expression just as it is done in pre-nursery and nursery schools.

(iii) Enrichment of children's experience in the various stages is advocated. It should be pointed out here that through the availability of teaching aids and other instructional materials in nursery schools, enrichment of children's experience is achieved. Many psychologists urge parents to provide instruction in an effort to speed up intelligence but Piaget recommends that children be allowed a maximum of activities on their own, directed by means of materials which permit their activities to be cognitively useful.

Piaget advocates a system whereby children could develop at their own pace with the teacher fostering cognitive development rather than forcing it.

(iv) Early childhood education should provide the foundation for later learning. Teachers should capitalize on the optimal period in children's life for certain kinds of learning to avoid difficulties in later stages. The early years being those in which children gain the experience which form the basis of future logical thought are extremely crucial to all children. The close attention given to pupils in nursery schools by their teachers is in line with this observation.

Maria Montessori and Froebel's "ideas" also contributed immensely to the successful education of the growing child. Educationists like Montessoriemphasized "prepared environment" for the child's education while Froebel's emphasized the "play method". Their theories make learning interesting to the child. Orem (1974) observed that Montessori's education is an experimentally derived system of human development through individualized learning and small teacher

pupils' ratios. All these should be fully encouraged in the primary schools. Among the factors which affect academic performance apart from the school environment and early school experiences, the home background is very essential. Researches have been and are still been done on some of these factors. For example, in Coleman (1966) cited in Adeniyi (1987) and his team's investigation of education in the United States, they found that the influence of the school in the academic performance of children compared with that of the home is less important. According to their findings, the variable with the most predictive value in connection with varying academic achievement was the home background. The team emphasized the characteristics of children as determined by their families. They contended that children come to school roughly at the age of six years when they must have acquired much of their attitudes, values and intelligence from their homes and varying situations. Also in Nigeria, Fakuade (1979) found that academic achievement of secondary school students correlated significantly with their home background.

3.2 Developing love for Mathematics

There is a need to develop a love for mathematics by most of all our pupils and students. It is this love for mathematics that gives them a positive attitude rather than a negative attitude towards mathematics. In order to do this, mathematics should be taught practically, purely and in a pleasurable manner. Students should be taught to discover mathematical truths, facts, principles and patterns. Discovery methods as done in laboratory approach is highly recommended. It is this type of learning of mathematics that leads to intrinsic motivation. This type of motivation helps to develop a love for mathematics and the development of positive attitude towards mathematics. I recommend the setting up of a "mathematics club" for all secondary school students. It should be made voluntary for all students from Junior Secondary one to six. It's aims should be as follows:

(i) To develop a love for mathematics
(ii) To help them develop positive attitude toward the subject
(iii) To learn the "History of Mathematics" by showing its slow and progressive development from ancient times till today
(iv) To show it's relevance to every day living thereby emphasizing its utilitarian value.
(v) To show its basis for technological development
(vi) Career guidance in mathematics and in mathematics-related professions such as engineering, survey, physics, computer, statistics etc.
(vii) To introduce the learner to computer technology.

Activities and programmes in the Mathematics Club would include

(a) Debates on Mathematics-related topics
(b) Excursions to places of mathematical interests such as Mathematical Centre, Abuja etc.
(c) Talks by invited Mathematicians, Mathematics – Educationists and other experts in Mathematics-related disciplines on specific topics of interests to the students.
(d) Competitions between members of the club and between mathematics clubs of different schools in debates and in the

playing of mathematics games and puzzles. Medals and cups, trophies or prizes could be donated to be won in such competitions.

(e) Teaching computer language and technology.

3.3 Sex Differences in the learning of Mathematics

The implication of the fact that boys perform generally better than girls

especially in activities requiring spatial ability Lassa, (1978) is that, special care should be taken by mathematics teachers when dealing with girls.

This calls for use of good methods, materials and teaching strategies. More patience should also be exercised by the teacher when dealing with girls.

Also since the environment in which a child grows has effects on cognitive development, the home as a variable has an important role to play. Parents and guardians should endeavour to provide challenging environment in the home so as to aid appropriate cognitive development. Such should include provision of stimulating educational materials such as toys, books, magazines, mathematical games and puzzles. Parents should encourage their children to read and play these games and puzzles. They should even play with their children.

The knowledge of primary and secondary school teacher should also be updated periodically through attendance at seminars, workshops and conferences. It is at such occasions that the results of current research on mathematics/mathematics education should be made known to them. Teacher's promotion should be tied to attendance at such seminars, workshop and conferences. They should be mounted by the Ministry of Education in conjunction with Universities, Polytechnics and Colleges of Education at Local Government, States and Federal Government levels.

4.0 Self-Assessment Exercises

1. Mention any one feature of a positive attitude towards mathematics"?
2. Mention any one observable behaviour that show negative attitude towards mathematics?

5.0 CONCLUSIONS

Developing a positive attitude should be the underlying aim or objective of all mathematics teaching and learning. It should be kept in mind by all mathematics teachers. It will enable the students to be intrinsically motivated to learn and enjoy mathematics and reduce the number of those of them who will drop by the way side.

6.0 SUMMARY

We have enumerated the steps that will help in developing positive attitudes toward mathematics. I have also suggested the establishment or starting of what I call "mathematic club" for all secondary schools students with the aims and activities listed. This too will go a long way in making the teaching and learning of mathematics interesting, enjoyable and practical.

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8.0 Suggested Solutions toSAEs

1. Some features of positive attitude towards mathematics teaching and learning.
   I. Possession of confidence toward the knowledge of mathematics
   II. Low level of math. anxiety
   III. Aware of the usefulness of mathematics
   IV. Belief in personal ability to succeed in mathematics
   V. Show of satisfaction or pleasure in mathematics
2. Observable negative behaviour toward mathematics.
   i. Dislike for mathematics activities
   ii. High level of math. anxiety
   iii. Low level of confidence in mathematical activities.
   iv. Low level of interest in learning mathematics
   v. Do not see the usefulness of mathematical knowledge

MODULE 3

Unit 1 Learning Aids: – Definitions and Types
Unit 2 Learning Aids: Criteria for Choosing and Uses
Unit 3 The Mathematics Laboratory
Unit 4 Discovery Approach to Teaching Mathematics

UNIT 1 LEARNING AIDS – DEFINITIONS AND TYPES

CONTENTS

1.0 Introduction
2.0 Intended Learning Outcomes
3.0 Main Content
  3.1 Learning and Teaching Aids
  3.2 Concrete Objects
  3.3 Models
  3.4 Computers
  3.5 Mathematical Games
  3.6 Mathematical Laboratory
  3.7 Instructional Technology
4.0 Self –Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

In unit 7, you learnt how to prepare course planning and the daily lesson note or notes of lesson. In this unit, you will deal with instructional resources which form an important part of classroom teaching and the learning process.

You will learn various types of teaching aids. How to make some locally with available materials.

2.0 INTENDED LEARNING OUTCOMES

By the end of this unit, you will be able to state the meaning of teaching aids and categorize different types of teaching aids in mathematics.

3.0 MAIN CONTENT

3.1 Leaning and Teaching Aids

Learning is defined as any relative permanent change in behaviour due to a result of practices or experience. On the other hand, learning or teaching aids are any type of material that can assist or speed up the process of learning with or without any assistance of a second person for example a teacher.

There are many types of instructional resources in mathematics such as

1. Books
2. Concrete objects
3. Models
4. Computer
5. Mathematics games
6. Instructional Resources
7. Mathematical laboratory

The above aids belong to different categories by classification. We shall therefore classify them accordingly.

(a) Textbooks: This is the book which provides the various contents for a mathematical course of study.
(b) Course material: such as this one for mathematics methods for Open and Distance study in mathematics education.
(c) Encyclopaedia: A type of book meant for reference purpose where information in respect of mathematics and other subjects can be found. They are published in volumes.
(d) Newspaper: Dailies meant for readership of the general publics some of them include columns for treating school mathematics topics. These columns are known as mathematics corners.
(e) Home study magazines: type of books designed for individual study at home. It normally contains worked problems in mathematics to assist independent study. It also includes simple illustrations of the subject matter.
(f) Workbook: This is a type of textbook designed to help students carry out self evaluation with reference to a text.
(g) Laboratory materials: This is the type of book designed to guide student to carry out experiments in the laboratory (mathematics or science laboratory) for mathematics. It is useful in explaining the completion of tasks in a mathematics laboratory.

(h) Journals: type of book which usually contains published research papers and are for references for further studies. Some journals provide for teacher notes.

(i) Teachers Guide: This is a type of book designed to guide the teacher's methodology in the class. This is usually different but related to the recommended textbook for the pupils.

(j) Handbooks: This is usually a small textbook that can be kept in the pocket e.g. teach yourself books.

(k) Thesis: This is a kind of book that contains the record of research work conducted by an individual.

3.2 Concrete Objects

They include:

(i) Beads
(ii) Counters

These are solid materials for counting. They lead to place value systems Counters can includes objects such as stones, bottle tops, square blocks, match sticks etc. The abacus is also a concrete object.

3.3 Models

There are objects which are concrete and are utilized by teachers and students to demonstrate mathematical concepts.

Some models are made of opaque materials such as cones, cylinders, cubes etc. while others are made of transparent materials such as glass, cellophanes, water proof etc. e.g. cuboids, spheres for longitude and latitude and triangular prism.

3.4 Computer

It is a mechanical electronic device used for computing. They are based on special programmes which yield results of special algorithms operation etc. They have made the world a global village via the

internet. www.worldwideweb, E-learning is the vogue today - Educational technology.

3.5 Mathematical Games

These are games puzzles for primary and secondary school pupils/students. They stimulate their interests in mathematics and they

encourage thinking and creativity. Through playing them, students develop positive attitude toward mathematics and they are intrinsically motivated.

3.6 Mathematical Laboratory

This is a special room or space reserved in a school for the purpose of conducting practical task in mathematics. Such tasks may include building blocks, dismantling objects, constructing models, making charts and concrete things. Items in the laboratory will include cardboards, wood blocks, nails, scissors, threads, strings, rulers, compasses, dividers, protractors, counters, abacus etc.

3.7 Instructional Resources or Technologies

They are usually divided into two groups namely print and non print.

1. **Print:** Books, charts, Graphs
2. **Non Print**:
(a) Radio
(b) Television
(c) Tape recorders
(d) Films
(e) Photograph slides
(f) Overhead projectors

4.0 Self –Assessment Exercises

1. Mention the four major classifications of instructional aids?

5.0 CONCLUSIONS

Learning aids are many and varied and classified into types. The common ones have been mentioned, defined and classified into categories.

6.0 SUMMARY

The classifications are first, books then concrete objects, models, computers, mathematics games, mathematical laboratory and lastly Instructional Resources – prints and non prints

We are in the age of E-learning and the computer through the internet.

7.0 REFERENCES/FURTHER READINGS

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8.0 Suggested Solutions to SAEs

Classification of instructional aiVisual aids (ii) auditory aids (iii) audio-visual aids (iv) simulation devices

UNIT 2 LEARNING AIDS: CRITERIA FOR CHOOSING AND USES

CONTENTS

1.0 Introduction
2.0 Intended Learning Outcomes
3.0 Main Content
    3.1 Criteria for Selecting Learning Aids
    3.2 Uses of Learning Aids
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
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1.0 INTRODUCTION

The selection and use of learning and teaching aids are important factors in effective teaching of subject matter in mathematics. A bad lesson can occur due to wrong choice of the teaching aid or wrong application of an appropriate one.

In the last unit, we defined teaching aids and their types. In this unit, we shall discuss the criteria for choosing mathematical teaching aids and their uses.

2.0 INTENDED LEARNING OUTCOMES

By the end of this unit, you will be able to:

- Select the appropriate learning aid for a given lesson and
- State the uses of given learning aids

3.0 MAIN CONTENT

3.1 Criteria for Selecting Learning Aids

(a) Relationship to the Topic

The learning aid must be relevant to the topic for which it is prepared. It will help to achieve the objective of the lesson. So when choosing the aid, you should make sure it presents the idea of the lesson well and makes it interesting.

(b) Readiness and ability of the pupils

Before selecting an aid for any planned lesson, the intellectual ability of the class must be considered. It must not be too advanced for them otherwise it may not achieve the objective of the lesson. It must not also be too simple otherwise the pupils may not see the necessity of such a learning aid.

(c) Teacher's ability to use the Aid

Certain aids may be appropriate for the lesson but the teacher may not be able to access it or explain its application. This will prevent the students from getting the correct knowledge from the lesson.

(d) Cost of the Learning Aids

The cost of the aids must be borne in mind, as some schools may not be able to afford them because of the cost, even if they are available especially if the number of aid required is large.

(e) Complexity

Some learning aids are complicated to explain even when the teacher can operate them. Such cannot easily be followed and comprehended by pupils. Care must be taken to avoid such complex aids.

(f) Availability of Materials

Some aids are available to be bought from markets or by constructing them locally from acquired materials. Some may not be available although there is money to buy them. So the teacher must emphasize more on the use of local materials for learning aids which are available and can easily be obtained

(g) Size of learning Aids

Some learning aids are very small, such that the important parts are not easily visible. They should be large enough so that the essential parts are visible to the pupils.

(h) Durability

Some aids can be used in two or three attempts and must be replaced because of the materials used. Such do not usually cost much and care must be taken to choose more permanent materials that can be stored and used repeatedly.

(i) Storage facilities

Some materials used need constant maintenance and repair. Some need to be stored in a drawer, a closed cupboard or room with shelves.

(j) Accuracy

There is need for accuracy of information which is needed with some aids. The date of production must be checked. The messages contained in the materials should not be outdated because of change in school programmes or curriculum.

(k) Class Size

Some learning aids need to be given to individual pupil, so each has his or her in order to feel and participate in the lesson. When these do not

go round, it is difficult to achieve the objective of the lesson. This should not be the case.

3.2 Uses of Learning Aids

Learning or Teaching Aids can be used to illustrate one or more mathematical concepts. I am giving here a list of many learning aids and their uses.

The list can be increased.

1. **Abacus:** For counting leading to place value system
2. Beads or counter or bottle tops for counting, solving simple addition or multiplication problems involving whole numbers
3. **Clinometers:** Used for finding angles or elevation and depression.
4. **Concrete model of sphere:** To calculate its surface areas, solve problems of latitude and longitude
5. **Cuboids blocks:** for calculating the total surface areas, volume, angle between two planes or lines under three dimensional system.
6. **Coins and dice:** For statistical experiments or probability
7. **Compass:** For geometrical construction
8. **Protractor:** for measuring angles in a plane.
9. **Concrete Model of cone:** To calculate its surface areas, volumes, height, base, radius etc
10. **Geo-Board:**For demonstrating geometrical shapes for calculating areas of plane shapes, such as

parallelograms, regular polygon, triangle, trapezium etc.

11. **Spring balance:** For measuring mass in grammes, kilogrammes for showing process of solving linear equations
12. **Rules:** For measuring distance in metres, centimeters etc.for drawing straight edges.
13. **Cardboards diagrams of parallelogram, triangle, trapezium.** To calculate areas and dimensions
14. **Graphs:** To represent mathematical functions in pictorial

form e.g. curve sketching, pie and bar charts, histogram, point of intersection of curves to be determined.

15. **Divider**:To measure distances when learning geometric construction. E.g. bisecting angles, line etc.

4.0 Self-Assessment Exercises

1. State any two importance of the use of instructional materials in teaching and learning mathematics.
2. Mention any two factors you will consider in selecting any teaching aid for a Group of learners. .

5.0 CONCLUSIONS

Some criteria for selecting learning aids were stated and the uses of some learning aids were outlined. More aids could be mentioned and their uses.

6.0 SUMMARY

In the unit, we listed many factors for helping the teacher in selecting learning aids for mathematics lessons. In addition we listed learning aids and their uses. The factors included the following:

Relevance to the topic
Durability

Accuracy
Size of the class
Size of the aids
Cost of the aid
Complexity and
Storage facilities.

7.0 REFERENCES/FURTHER READINGS

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Cable, R. (1972) Audio Visual Handbook, University of London Press, London.

John, D. A. and Rising, G.R. (1969) Guideline for Teaching Mathematics (2nd Edition) Wadworth Pub. Co. Belmont-California.

8.0 Suggested Solutions to SAEs

1. Importance of using instructional materials
   (i) They gain and hold the attention of the learners
   1. Provision of visual aspects to a process.
   2. Creation impact on the learners.
   3. Saves time that would have been used in the lengthy explanation.
   4. Learning is practical and real.
   5. There is opportunity for interaction between learners and between learners and materials.
   2. Factors that influence selection of materials.
   1. Relationship to the topic
   2. Ability of the teacher to use the material
   (ii) Readiness and ability of the pupils

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UNIT 3 THE MATHEMATICS LABORATORY

CONTENTS

1.0 Introduction
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3.0 Main Content
3.1 It's Definition
3.2 Features of a Laboratory Approach of Teaching Mathematics
3.2.1 Class Arrangement and Organisation
3.2.2 Learning materials
3.3 Laboratory Lessons and Procedures
3.4 It's Importance
3.5 Examples of Laboratory Lesson
3.6 Appraisal of the Method
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References /Further Readings
8.0 Suggested Solutions to SAEs

2.0 INTRODUCTION

Mathematics has been a very abstract subject despite its many utilitarian uses. It is very useful and application in real life situation as stated in Module 1 unit 4 section 3.2 page 14 of this course. Despite its usefulness, majority of our pupils/students dread it and so perform woefully in it. This has led to the search by Mathematicians and

Mathematics Educators for better methods of teaching it. It is this search for very good methods different from the traditional method of teaching it that has led to the quest for other methods among which is the laboratory approach of teaching mathematics. It is a method that makes mathematics meaningful and pleasurable. It is very suitable at both primary and secondary school levels. You are encouraged to use this method in teaching your pupils.

2.0 **INTENDED** LEARNING OUTCOMES

At the end of this unit, you should be able to:

- Define what is meant by "the laboratory approach of teaching mathematics.

- Highlight features of a laboratory approach of teaching mathematics
- Give examples of a laboratory approach of teaching mathematics
- It's importance and the success of the methods

3.0 MAIN CONTENT

3.1 Definition

The laboratory approach of teaching mathematics is a method of instruction that takes place in what is known as a "mathematical laboratory." It is a room in a school set apart for students to go in and work individually or in small groups. The mathematical laboratory lesson is an avenue that gives the pupils/students a means of manipulating concrete objects, materials, guided by the teacher in

formulating generalizations, deductions, and concepts. It allows the pupils to think for himself, interact with fellow pupils through practical experiences. It also helps him to communicate with them and the teacher. The activities performed depend on the objectives of the lesson. In turn, it makes his/her study of mathematics interesting, pleasurable and permanent. It helps in developing a positive attitude toward mathematics.

3.2 Features of a Laboratory Approach of Teaching Mathematics

It assists in catering for individual differences and enriches pupils with

important mathematical skills. The possibilities for personal independent work makes it interesting for talented and creative students. The group work involves encouraging and sharing of ideas and knowledge.

In the end, it brings joy to the learner provides evidence of progress and guarantees a great transfer of learning through classroom procedure.

3.2.1 Class Arrangement and Organization

In a laboratory, approach of teaching mathematics, works are usually given through cards in which problems to investigate are written. The problems almost always require using some of the materials in laboratory for performing activities such as making models, measuring, cutting, sorting, comparing, and questioning. Such assignments may call for individual work or group work. Working in groups provides opportunities for both first hand experience and discussion of the problem. Since learning involves carrying out various activities and

experiment, sitting arrangement differs from those of the conventional classrooms. Chairs and tables are usually arranged, so that children can sit according to their working groups and also have free and quick access to the working materials. A freer permissible classroom atmosphere exists so that pupils/students can move freely about and discuss their problems with each other.

3.2.2 Learning Materials

For good work to be effected in the laboratory setting, many mathematical materials would be needed. The materials should be such that pupils can see, touch, handle, measure, etc. so as to develop mathematical ideas. For primary school level, material needs include stones, match boxes, counters, abacus, wooden blocks, counting sticks, empty tins, empty bottles, glass jars, tape measures, papers of all kinds, cardboards, strings, ropes, cotton, threads, rubber bands, nails, razor blades, scissors etc. Materials for measurements include: rulers, metre sticks, weights, balance scales, tape measures, micrometers, protractors, compasses, set squares, stop watches, clocks and plastic containers of various sites. Secondary level needs some of the above and in addition the following: centimeter cubes, geoboards, graph-and-grid-sheets, surveying equipments, mosaic tiles, student's projects folders and so on. Most of these materials can be obtained or produced locally. Some others are not available in Nigeria and may need to be ordered from abroad. As is evident from this list, we no longer need just, desk, chair, chalk-board, and chalk. Books are used in this approach of teaching but are not all important as in the traditional way of teaching and learning. They mainly serve as source of example and questions for assignments for practice after the lesson at home. Instead, problem in the mathematical laboratory, learning situations are given in the form of assignment cards or worksheets.

3.3 Laboratory Lessons and Procedures

In order to ensure the success and effectiveness of a laboratory lessons, very careful planning is needed. The teacher needs to prepare very well and though it is more demanding on his time, effort and skills than in a

normal class, it is worth all the effort because it's rewards. He must ensure that all the materials needed for a given lesson are in place before the lesson begins. Some of the materials might have been made by the teacher himself locally and in some with the students. While in some cases, some are ready-made, bought or imported guide or worksheets are also to be provided. Guide sheets should include:

(i) Statement of lesson objectives
(ii) Students' necessary instructions
(iii) Exercise to evaluate the achievement of the stated objectives

In a laboratory lesson, the teacher acts as a guide or a supervisor to give instructions. He makes sure there is enough space for the activities, maintains orderliness and moves around the class to assist individual students needing help and answer pupils questions. He tells them when to start cleaning up and ensures that all equipment are returned to where they belong.

The Procedures

The procedures include the following:

(a) There should be provided guide sheets and these should be made up in such a way that pupils know what they are to investigate and the materials needed.
(b) All equipment and materials needed for the lesson are ready and in place before the lesson starts. Guide sheets and such materials as would be needed for the particular lesson.
(c) The laboratory should be in place with adequate seats and tables for the pupils. There should be running water available for construction and washing purposes. There should be enough space for the work to be done, either in groups or as individuals.
(d) The pupils must take full responsibilities for laboratory work for example, caring for equipment, sharing in group work when necessary working on their own independently, ready to do cleaning up, and to assist others when required. Students need sheets for keeping records, recording results and recording conclusions.

3.4 Its Importance

The laboratory approach to teaching mathematics assists in catering for individual differences and enriches pupils with important mathematical

skills. The possibilities for personal independent work makes it interesting for talented and creative students. The group work involves encouraging and sharing of ideas and knowledge. In the end, it brings joy to the learners, provides evidence of progress and guarantees a great transfer of learning through classroom procedures.

3.5 Examples of Laboratory Lesson

Two examples of a laboratory lesson is given below

Example 1

Class: JSSI (Sec. School)
Duration: 70 mins. (Double Period)
Topic: To find an approximate value for π
Objective: Using the circumference and diameter of a circle, we can compute the value of π.

Where c = circumference
r = radius
d = 2r (diameter)

$C = 2\pi r \quad = C = C$

$\frac{}{2r} \quad \frac{}{d}$

Material

Sheet of cardboard, rulers, compass, strings, protractor, scissors, divider, pencil, Can of Peak Milk, Bournvita Can, Milo Can and other cylindrical can.

Previous Knowledge

Students have learnt about the circle, its radius, circumference, diameter, area of circle.

Procedure

The students can be divided into groups of 5 students each. Some group may wok on drawing different circles on cardboard, while other groups may work on cylindrical tins or can of different shapes. They measure with string circumferences circles and length of the diameters.They then computer the approximate value of π from their measurements.

They take at least 5 measurement of each of them. See below.

Example 2

Class: JSSII (Sec. School) **Time:**

No min (double period)

Topic: Sides of right angled triangles**Objectives**

To deduce that the length of a right-angled triangle are 3n, 4n, 5n if n is a natural number such as 1, 2, 3,4, etc.

Material

Cardboard, rulers, compass, protractor, divider, pencil, set-square, paper

Previous Knowledge

Pupils have leant the properties of a triangle. They have learnt how to draw and construct triangles e.g. isosceles, equilateral, right-angle triangles.

Procedure

Draw right-angles triangles on cardboard papers by giving different values for n. then construct the triangles using points of intersections of the sides. The right angle will face the longest sides, when measured. Different groups will draw right-angle triangles of different length (n). See below.

Lessons to be taught in mathematics laboratory approach are many and varied. They include areas of mathematics such as 2-and 3-dimensional

geometry, statistics, probability, trigonometry, numeration, conic section, etc.

3.6 Appraisal of the Method

For the purpose of assessing the success and effectiveness of the method of teaching, some researches have been undertaken. These researches have confirmed that among the three methods

(iii) The mathematics laboratory method
(iv) The discovery method (it is noted that a discovery method does not mean a laboratory method, though all laboratory methods are discovery methods).
(v) Traditional method.

It was found that if the three methods were used, the achievement of the students in the group taught using the laboratory approach had the highest achievement scores. In addition, their attitude towards mathematics seems to be slightly better than those of the other two

groupswhen measured by a standard attitude instrument. This particular research was conducted in Canada. Other researches have been conducted by others which confirmed these results.

This clearly indicates the great potential and promising using the laboratory approach of teaching mathematics. This method is therefore highly recommended to all our teachers teaching this all important subject. It will apart from leading to better achievements for our students, also change their attitude from negative to positive. They will in addition enjoy learning mathematics at both the primary and junior secondary levels.

4.0 self-Assessment Exercises

1. Mention any two merits of the use of laboratory approach in teaching and learning mathematics
2. Mention the two ways mathematics laboratory in explained.

5.0 CONCLUSIONS

The laboratory approach of teaching mathematics is a very good method of teaching and learning mathematics, as can be seen from this unit. It is nonetheless, time-consuming and involves a lot of preparations by the teacher and students. But it is worth the effort because of its merits which include better achievement, a positive attitude toward mathematics, and enjoyment in learning the subject. This is a method of teaching which I recommend to all teachers and learners of mathematics.

6.0 SUMMARY

In laboratory approach, the emphasis is on personally discovering through individual or group activities. The student should interact with the material so as to achieve his objectives. The effectiveness and success of this method have been highlighted.

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8.0 Suggested Solutions to SAEs

1. Any two merits of laboratory teaching and learning method in mathematics.
3. Learning is explorative and collaborative
(iv) Ensures the development of positive attitude toward the learning of mathematics.
(v) Learning activities can both be structured and unstructured.
(vi) Materials are available and can be accessed.
(vii) Provides opportunity for independent learning.
(viii) Enriches the learners with important mathematical skills. Etc
2. Two ways of explaining mathematics laboratory are;
(g) It is seen as a place or room where mathematical activities can be carried out.
(ii) It is also seen a methodology based on the use of structured activities integrated with a number of strategies.

UNIT 4 DISCOVERY APPROACH TO TEACHING MATHEMATICS

CONTENTS

1.0 Introduction
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  3.2 Guided Discovery
  3.3 Advantages of Discovery Method
  3.4 Disadvantages of Discovery Method
  3.5 Discovery Lessons
  3.6 Precautions for Discovery Lessons
4.0 Self-Assessment Exercises
5.0 Conclusion
6.0 Summary
7.0 References/Further Readings
8.0 Suggested Solutions to SAEs

1.0 INTRODUCTION

It has been found by research that there is no one best method of teaching, John and Rising (1971 p.43). They indicate that the method to be used depends on "the topic, the class, the objectives and the

procedure known to the teacher." Some guidelines are however available to the teacher. These will help him in selecting the method and strategy to be used. These guidelines include

(i) familiarity with the method
(ii) believe in the importance and efficacy of the method
(iii) the method must be easily understood by the children
(iv) the children must be actively involved in the lesson. The 6-3-3-4 system must get the students active if they are to utilize the concept.

2.0 INTENDED LEARNING OUTCOMES (ILOS)

By the end of the unit, the students should be able to

- define discovery teaching methods
- identify the good qualities in the use of discovery methods
- explain its characteristics

- describe a typical discovery lesson
- state precautions teachers should take in discovery teaching.

3.0 MAIN CONTENT

3.1 Principles behind Effective Teaching Methods

Some authors have summarized the principles behind effective teaching methods under these three headings:

(a) **The Dynamic Principles:** A learning concept grows or develops in a dynamic way in the child's mind. For a child to learn, he needs to handle, observe, experiment with materials, compare past experiences with the newly discovered ones and take new decisions – amending the old precepts or adding a new one. Therefore, the child needs concrete materials, objects, semi-abstract diagrams of the objects, as well as some form of directed experimentation to arrive at the required results.

(b) **The Constructive Principle:** This is related to the dynamic principle in that it also requires practical situation before the use of reflexive thinking by the child to analyze the patterns or common properties for generalizations. Playing with materials first is what this principle implies by the word constructive.

(c) **Perceptual Variability Principles or Multiple embodiment Principle:**This principle requires variability in methods, recognition of individual differences between students. The relational meaning of mathematical symbols and expressions must be emphasized. For example, the formula $D = 2(a + b)$ should be recognized as a possible formula for the perimeter of a rectangle. The use of $P = 2(L + W)$ should be compared with the former formula during the lesson on perimeter.

3.2 Guided Discovery

Guided discovery aids problem solving. In it, the teacher explains exactly what the students must do, allows them a free hand to carry out the activities but gives suitable guides to prevent students from going astray. In this method, success is often assured provided the teacher gives sufficient hints to the discovery.

Another variation is the Open Discovery. In this, the teacher allows the students free hand to play with materials and come up with whatever discovery that comes their way. By this, the discovery made by the students may be new to the teacher. The use of this in our system of mass education is minimal.

Guided discovery should be preferred. Discovery teaching is instruction that focuses attention on the student. One of its first advocates was Socrates, and eminent teachers have been using the method for many past generations. However, it is not an easy technique, because it must be continuously adapted to the students' responses, questions and experiences as they occur in the classroom. This means that it cannot be highly structured in advance. Howbeit, in applying this method, the teacher himself, may discover ideas that are novel to him, and questions that he cannot answer readily without referring to textbook materials. This is particularly so in mathematics in which problems that read simple and non-hypothetical may turn out to be difficult for the teacher to solve on the spot.

Trial and error, guesses and conjectures are used in the discovery method to search for ideas and to relate these new ideas to previous concepts. Thus, the number line quickly relates negative numbers to the corresponding positive numbers (the former being mirror images of the latter set of numbers), and trips on the number line represent addition. When the student reactions are verbal or written, he needs the give and take of discussion to clarify his ideas because he might not as yet attained a high level of mastery of mathematical vocabulary to state mathematical ideas in correct language.

Discovery of an idea independently gives the student a sense of confidence, which motivates him to continue to explore. Discovery fosters desirable attitudes because it encourages curiosity for further learning. Discovery method is one of the best means of building positive attitudes of appreciation, enjoyment and commitment.

In preparing a discovery lesson, the teacher outlines a number of searching logical questions, problems on laboratory exercises. The lesson might then start with an introduction, so as to let the student have a clear idea of what he is to explore, what facts he has at his disposal (i.e. the givens) and what method seems appropriate.

After the teacher poses a problem, he has to awaken the thinking by asking open-ended questions. Students responses should be encouraged by such statements as "You are nearly right", "That is a wise idea" or "Keep going" or even "I see" or "Oh?" such comment reduces his fear of being wrong or being discouraged or embarrassed by a rejection of a poor suggestion.

The experienced and skilful teacher will use half-formed ideas as a bridge or stepping stones to correct ideas. The teacher must ask questions that must force (or induce) the student to test his answers, find

contradictions, identify special cases or state a generalization. His role is that of guiding the student up the ladder of ideas to the generalization at the top. He guides their thought by helping them to block their own blind alleys or dead ends.

3.3 Advantages of Discovery Approach

Here are some of the merits of Discovery Approach to teaching mathematics.

i. Students who use their energy to discover knowledge, increase their ability to organize resources in attacking problems become more courageous at problem solving and receive self satisfaction at the success of discovery. This leads to internal motivation and therefore positive attitude toward mathematics.
ii. Most students will remember and retain knowledge learnt through discovery approach than those learnt by other methods.
iii. It also leads to transfer of knowledge or application to other areas.
iv. Discovery helps students' participation and interaction in class. They put in their best. None of them is passive in a guided discovery lesson.

3.4 Disadvantages of Discovery Approach

The method has these disadvantages:

i. They usually are noisy. The teacher needs to curtail this.
ii. It is time consuming, so the teacher must be ready to give hints at the right time so as to direct discovery and reduce time wastage.
iii. The teacher will realize that not all students will come out with the discovery and he should be able to stop the class when the majority of the students have discovered the result.
iv. The method demands much from the teacher by way of planning, leading and directing and guiding the students. So, not many teachers can successfully use it but with practice and proper planning, many teachers will make a headway.

3.5 Discovery Lesson

Learning through discovery could be stimulated by the teacher in the following manner to produce some mathematical generalizations:

Stimulate through dialogue; guide their thinking by asking questions, giving hints very sparingly so as to find relationships to known ideas and supplying reasons. Make them participate through the questions.

Example 1

Discovering Pascals triangle in Binomial Expansion of $(a + b)^n$ use n = 5 maximum.

Example 2

What is the next row in the following number pattern?

$$1 = 2^2$$

$$1 + 3 = 2^2$$

$$1 + 3 + 5 = 3^2$$

$$1 + 3 + 5 + 7 = 4^2 \quad 1 + 3 + 5 + 7 + 9 = 5^2$$

Generalize.

Use test items that allow a student to use ability to discover new ideas. This will emphasize to him the need for learning how to discover new ideas.

Example

Solve for x:

$\frac{x}{} > \frac{r}{}$ and r > s *s x s*

3.6 Precautions for Discovery Lesson

These cautions need to be taken so as to avoid the problems that arise in using the discovery method:

(a) Do not expect all the students to discover every generalization or conclusion.

(b) The conclusions or end results should be correct generalizations.
(c) Discoveries should be expected to take time.
(d) Avoid making generalizations on the basis of a few samples or trials.
(e) Do not appear to be critical destructively or negative. Wrong responses must not be accepted as true and nonsense or disruptive explorations must be eliminated. Students must be assured that their status is not threatened by incorrect answers.

(f) Keep the student aware he is making progress. He should expect difficulties, disappointments or failures.
(g) Student must know why each of his discovery is significant, and how the ideas are incorporated in the structure involved.

4.0 Self-Assessment Exercises SAEs

1. State any three good qualities of discovery method of teaching.
2. Mention any two precautions the teacher should take in discovery teaching.

5.0 CONCLUSIONS

Discovery method of teaching mathematics has been shown to be a very good approach. It lends itself to giving the student positive activities to be engaged in. It keeps them active and focused. It enables them to interact with concrete materials and leads to permanent learning and therefore transfer of learning. It nonetheless keeps the teacher guiding and planning by asking relevant questions and encouraging the pupils to continue on the right path by responding appropriately to his or her right progress in the desired direction. Its merits outweigh its demerits when properly planned and executed.

6.0 SUMMARY

Method of discovery approach has been defined and illustrated. The three principles of teaching methods have also been given. This method of teaching mathematics has been shown to be very old as Socrates himself approved of it. It has been successfully employed in teaching mathematics over the years. It should therefore be continued to be used especially where the number of students do not problem to effective classroom management.

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8.0 Suggested Solutions to SAEs

3. It facilitates recall and retention of knowledge.
4. Encourages effective participation and interaction by the learners.
5. Helps in the transfer and application of knowledge.
6. Precautions to be taken can include;
7. All the learners may not discover conclusions or generalizations.
8. Discovery may take a longer time.
9. The teacher should not too fast to generalize based on few samples.
10. Let the learners understand why their discovery is significant.