

CHAPTER 5

ASSESSMENT IN MATHEMATICS EDUCATION

ERAIKHUEMEN, LUCY¹, ONOH, DAVID,² ARAMUDE, EROMOSELE VICTOR³, ANIBUEZE, CHIGOZIE⁴ & ENEZE, BLESSING⁵

¹Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City.

²Department of Mathematics and Computer Education, ESUT, Enugu.

³Department of Curriculum and Instruction, Faculty of Education, Ambrose Alli University, Ekpoma.

⁴Mathematics and JUPEB, Department of Computer Science, Madonna University, Elele

⁵Department of Vocational and Science Education, Godfrey Okoye University, Enugu.

Abstract

Assessment refers to the process of systematically investigating the status of an individual, a group or procedure with reference to predefined goals or expected outcomes. It is often done through various methods such as tests, quizzes, assignments and observational strategies. Assessment of students in Mathematics is one of the major ways of monitoring the quality and standards of teaching and learning of Mathematics in schools. Assessment provides the logic and justification for instructional procedure in schools. Thus, this chapter exposes the pre-service Mathematics teachers to the meaning of assessment, types of assessment based on purpose and format, the meaning and processes of formative and summative assessments.

Keywords: Assessment, Mathematics, Teachers, Pre-Service

INTRODUCTION

Mathematics education takes a paramount place in shaping the intellectual and analytical capabilities of learners from a young age through adulthood. As a foundational discipline, it not only prepares and equips learners with essential problem-solving skills but also enhances logical reasoning and critical thinking abilities that are indispensable in today's complex world. From basic arithmetic to advanced calculus, mathematics education spans a continuum that empowers students to comprehend abstract concepts, apply mathematical principles in real time in practical scenarios, and engage with quantitative data critically. Also, it helps the student to cultivate a mindset that values precision, creativity, and perseverance in tackling challenges, thereby preparing individuals to navigate a wide range of academic, professional, and everyday situations with confidence and competence. Assessment in mathematics education is a critical component that shapes the teaching and learning processes.

Assessment refers the process of investigating the status of an individual, a group or procedure with reference to predefined goals or expected outcomes. It involves the gathering and analysis of information, based on which decision can be made. Learners' academic performance, value, attitude, interest, motivation and other educational qualities and objectives can be assessed. The worth of instructional materials and methods as well as the overall effectiveness of a mathematics education programme can also be assessed. Different forms of assessment exist

for various purposes in the education industry, but, “an important goal of assessment should be to make students effective self-assessors, teaching them how to recognize the strengths and weaknesses of past performances and use them to improve their future work” (National Council of Teachers of Mathematics, NCTM, 2014. P.95).

Assessment in mathematics education is supported by a body of research that highlights its impact on student achievement and engagement. Studies have shown that effective assessment practices can significantly enhance student motivation and self-efficacy in mathematics, leading to improved outcomes. As the nation strives to meet its educational goals, the importance of effective assessment mechanisms becomes increasingly evident, particularly in relation to the policies and curricula that guide teaching and learning. The Nigerian educational landscape is influenced by various bodies, including the West African Examinations Council (WAEC), the National Examinations Council (NECO), and the Joint Admissions and Matriculation Board (JAMB), each contributing to the framework of assessment and evaluation.

Furthermore, the integration of technology in assessment processes is gaining attraction, with tools like online quizzes and interactive platforms being employed to facilitate a more engaging learning experience. Assessment in mathematics education in Nigeria is a multifaceted endeavor. It is an essential tool that not only measures student’s performance but also drives the continuous improvement of teaching practices, ultimately aiming to equip students with the necessary mathematical skills for future challenges.

In this chapter, assessments in mathematics education focused on measuring students’ performance against curricular goals with emphasis on formative and summative assessments. The why, how as well as techniques for assessment in mathematics education are discussed.

OBJECTIVES OF THE CHAPTER

Having studied this chapter, teacher trainees should be able to explain the:

1. meaning of assessment in the classroom,
2. types of assessment in Mathematics based on purpose,
3. types of assessment in Mathematics based on format,
4. meaning and processes of formative assessment and
5. meaning and processes of summative assessment

ASSESSMENT IN THE CLASSROOM

The target of teaching is to achieve defined objectives. The way to ascertain whether objectives have been achieved is to conduct assessment. Assessment is a process of collecting information on students’ performance to determine if intended learning objectives have been achieved. Assessment links learning to teaching and the outcome of assessment can be used for various purposes such as grading, promotion, certification, enhancing teaching and learning processes.

TYPES OF ASSESSMENT IN MATHEMATICS BASED ON PURPOSE

Assessment has a comprehensive meaning based on the purposes served by the assessment outcomes. Thus, assessment can be used for following purposes:

1. **Assessment of learning (AOL):** Assessment of learning refers to a review process which occurs at the end of the learning unit. It provides measures of achievement for the purpose of grading. It informs students, teachers and parents, as well as other

stakeholders of the community about achievement at a certain point of time to provide information regarding success in mathematics. Thus, AOL is emphasized, to the detriment of assessment for learning as it is done at the end of the term, level and programme and the assessment is used to judge against the class, district, or nationwide benchmark or standard (Okoye, 2023). Earl (2013) noted that its purpose is summative, intended to certify learning and report to parents and students about Students' progress in school, usually by signaling students' relative position compared to other students. Assessment of learning could therefore be regarded as the traditional conception of assessment.

2. **Assessment for learning (AFL):** Proponents of this types of assessment hold the notion that assessment is part and parcel of the Mathematics teaching learning process, and as such it should be properly integrated into it (Okoye, 2023). This is an alternative assessment mode to AOL. Assessment for learning occurs during the mathematics learning process. According to Earl (2013), assessment for learning shifts the emphasis from summative to formative assessment, from making judgment to creating descriptions that can be used in the service of the next stage. Earl stated that marking is not designed to make comparative judgments among the students but to highlight each student's strengths and weaknesses, and provide them with feedback that will further their learning. The feedback obtained by this type of assessment is used by the mathematics teachers to modify their teaching strategies, and students use it to make changes in their learning strategies. This approach of assessment helps the mathematics teachers to appraise the students to monitor their learning in mathematics; and guide the mathematics instruction at process and provide feedback helpful to the students. It provides opportunities for the students to develop an ability to assess themselves; make judgments about their own performance and make necessary improvement in mathematics.
3. **Assessment as learning (AAL):** Assessment as learning means an awareness of students regarding how they learn and use that awareness to make necessary adaptations in their learning process in mathematics. Schwier, Barenberg & Dutke (2017) viewed AAL as a robust empirical finding in research on learning and instruction, demonstrating that taking tests during the learning phase facilitates later retrieval from long-term memory. According to Okoye (2023), it can be referred to as effect of retrieval practice. This means that if a student is exposed to situations that constantly require them to retrieve what they have learnt, learning is more likely to be enhanced as well as the ability to retrieve such material when demanded in future. Therefore, the more frequently a student is exposed to AAL the more likely that learning is to be enhanced. Therefore, they take an increased responsibility for their learning of mathematics. It involves setting of goal, monitoring the progress and contemplating on results. It occurs throughout the learning process in mathematics.

TYPES OF ASSESSMENT IN MATHEMATICS BASED ON FORMAT

Assessment of students in Mathematics take place in the Classroom, however, assessment of students in Mathematics can still take place at institutional and curriculum levels. Classroom assessment involves teachers determining what students are learning and how and to what extent they are learning in the classroom (Steward, Brumm and Mickelson, 2014). The purpose of classroom assessment is to explore how assessment can be used to improve the quality and efficiency of teaching and learning of Mathematics with the objective of improving student

outcomes in Mathematics. Classroom assessment of students can either be formative or summative assessment. Formative and summative assessments are usually distinguished in terms of function and purpose. Formative assessment is sometimes referred to as assessment for learning, and summative assessment, as assessment of learning (Looney, 2021). The former is about aiding learning, the latter has a primary function of grading or measuring.

MEANING AND PROCESSES OF FORMATIVE ASSESSMENT

Formative assessment refers to the recurrent, interactive valuation of student progress to identify learning needs and shape teaching. Formative assessment refers to tools that identify misconceptions, struggles, and learning gaps along the way and assess how to close those gaps. It includes effective tools for helping to shape learning, and can even bolster students' abilities to take ownership of their learning of Mathematics when they understand that the goal is to improve learning and not to apply decisive grading. It can entail student assessing themselves, peers or even the teacher, through writing, graded or ungraded quizzes, conversation and more. Formative assessment is designed to generate feedback on student performance in Mathematics. This is because Mathematics teachers can make changes in teaching and learning of Mathematics based on the needs of students in Mathematics. It involves the Mathematics teacher using a communicative process to finding out what the students know and do not know in Mathematics, and continually monitoring student progress during learning of Mathematics. Both teachers and students are involve in decisions about the next steps in learning of Mathematics while teachers use the feedback from formative tasks to identify what students are struggling with and adjust instruction appropriately (Lane, 2018). This could necessitate the teacher re-teaching key Mathematics concepts, changing how s/he teach or modifying teaching resources to provide students with additional support in Mathematics. Students also use feedback from formative tasks to reflect on and improve their own work. The quality of formative assessment therefore rests, in part, on strategies teachers use to elicit evidence of student learning related to goals and with the appropriate level of detail to shape subsequent instruction (Heritage, 2020). There are many logistical barriers to making formative assessment a regular part of classroom practice, which are large class size, extensive curriculum requirements, external pressure for accountability and the difficulty of meeting diverse and challenging students individual need. Mathematics teachers should help students grow as learners in Mathematics by actively encouraging them to self-assess their own skills and knowledge, and by giving clear instructions and feedback. In practice, Nicol and Macfarlane-Dick (2017) outlined seven principles that can guide teacher strategize for an effective formative assessment as follows:

1. **Keep Criteria:** The Mathematics teacher should keep criteria for what makes a good performance in Mathematics. Teachers can explain criteria for A-F graded papers, and encourage student discussion and reflection about these criteria (this can be accomplished through, rubrics, post-grade peer review, or exam/assignment. Mathematics teachers may also hold class-wide conversations on performance criteria at strategic moments throughout the term.
2. **Encourage Students' Self-reflection:** Mathematics teachers can ask students to utilize Mathematics criteria to assess their own or a peer's work, and to share what kinds of feedback they find most valuable. S/he can ask students to describe the qualities of their best work, either through writing or group discussion.
3. **Give Students Detailed and Actionable Feedback:** Mathematics teachers can

consistently provide specific feedback tied to predefined criteria, with opportunities to revise or apply feedback before final submission. Feedback may be corrective and forward-looking. Examples are: commenting on the multiple paper drafts, providing discussions during 1-on-1 conferences.

4. **Encourage Teacher and Peer Dialogue Around Learning:** Mathematics teachers can invite students to discuss the formative learning process together. This practice primarily revolves around midterm assessments and small group feedback sessions, where students reflect on the Mathematics and Mathematics teachers respond to student concerns. Students can also identify examples of feedback comments they found useful and explain how they helped. A particularly useful strategy, Mathematics teachers can invite students to discuss learning goals and assignment criteria, and weave student hopes into the syllabus.
5. **Promote Positive Motivational Beliefs and Self-esteem:** Students will be more motivated and engaged when they are assured that the Mathematics teacher cares for their development in Mathematics. Mathematics teachers can allow for rewriting/resubmitting which signals that the assignment is designed to promote development of Mathematics learning. These rewrites might utilize low-stakes assessments and (if appropriate) allows for unlimited re-submissions.
6. **Provide Opportunities to Close the Gap Between Current and Desired Performance:** Mathematics teachers can improve student motivation and engagement by making visible any opportunities to close gaps between current and desired performance. Examples include opportunities for re-submission, specific action points for writing or task-based assignments, and sharing study or process strategies that a Mathematics teacher would use in order to succeed.
7. **Collect Information Which can be Used to Help Shape Teaching:** Mathematics teachers can feel free to collect useful information from students in order to provide targeted feedback and instruction. Students can identify where they are having difficulties, either on an assignment or test, or in written submissions. This approach also promotes metacognition, as students are asked to think about their own learning. School staff can also perform a classroom observation or conduct a small group feedback session that can provide Mathematics teachers with potential student struggles. According to Garrison and Ehringhaus (2016), some of the instructional strategies that can be used for formative assessment includes the following:
 - i. *Criteria and Goal Setting:* Engage the student with the goal and criteria set in Mathematics in Mathematics instruction and the learning process by creating clear expectations. Students need to understand and know the learning target/goal In Mathematics and the criteria for reaching it in Mathematics. This can be done by establishing and defining quality work together, asking students to participate in establishing norm behaviors for Mathematics classroom culture, and determining what should be included in criteria for success. Using student work, classroom tests, or exemplars of what is expected helps students understand where they are, where they need to be, and an effective process for getting there.
 - ii. *Observations:* Observations of the students go beyond walking around the classroom to see if students are on task or need clarification. Observations assist the Mathematics teachers in gathering evidence of student learning to inform instructional planning of the Mathematics lessons. This evidence can be recorded and used as feedback for students

- about their learning or as anecdotal data shared with the students.
- iii. *Questioning Strategies:* Questioning strategies should be embedded in Mathematics lesson/unit planning. Asking good questions gives the students the opportunity for deeper thinking in Mathematics and provides teachers with significant insight into the degree and depth of understanding of the concept in Mathematics. Questions of this nature engage students in Mathematics classroom dialogue that both uncovers and expands learning. An “exit slip” at the end of a class period to determine students’ understanding of the day’s Mathematics lesson or quick checks during instruction such as “thumbs up/down” or “red/green” (stop/go) cards are also examples of questioning strategies that elicit immediate information about student Mathematics learning. Helping students ask better questions is another aspect of this formative assessment strategy.
 - iv. *Self and Peer Assessment:* Self and peer assessment helps to create a learning community within the Mathematics classroom. When students have been involved in criteria and goal setting, self-evaluation is a logical step in the learning process. With peer evaluation, students see each other as resources for understanding and checking for quality work against previously established criteria.
 - v. *Quizzes and Exit Tickets:* Short assessments at the end of a lesson to check comprehension.
 - vi. *Homework:* Assignments that reinforce daily lessons and provide insight into students’ grasp of the material.
 - vii. *Class Discussions:* Facilitate discussions where students explain their thinking and reasoning.
 - viii. *Student Record Keeping:* Record keeping of student performance in Mathematics lessons helps students understand better their own learning as evidenced by their classroom work. This process of students keeping ongoing records of their work not only engages students, it also helps them, beyond a “grade,” to see where they started and the progress they are making toward the learning goal in Mathematics.

Methods of Implementing Feedback

Written Comments: Provide detailed feedback on assignments and assessments.

Verbal: Discuss student performance one-on-one or in small groups.

Rubrics: Use rubrics to outline clear criteria for success and exact status of learners.

Conferencing: One-on-one or small group meetings to discuss progress and areas for improvement.

Modeling: Show examples of good work and discuss what makes them good.

Self and Peer Review: Create opportunities for students to give and receive feedback from each other.

Integrating Formative Assessment and Feedback

To use formative assessment and feedback in secondary school mathematics effectively:

- i. *Plan Ahead:* Design lessons with specific formative assessments in mind.
- ii. *Be Consistent:* Use formative assessments regularly to keep track of students.
- iii. *Involve Students:* Get students engaged in the assessment process, helping them understand the aim and benefits of formative assessments.
- iv. *Use Data:* Analyze the data collected from formative assessments to make informed instructional decisions.
- v. *Foster a Growth Mindset:* Encourage students to view feedback as a tool for growth and improvement, not just as criticism.

Example Application

- I. *Diagnostic Assessment*: Assess students' prior knowledge and skills before starting a new topic. Use pre-tests, concept maps, or KWL charts (Know, Want to know, Learned).
Example: Before teaching quadratic equations, ask students to complete a short quiz on their understanding of linear equations and basic algebra. The students can be asked, "What is factoring, and how is it used to solve equations?"
- II. *Interactive Activities and Real-Time Feedback*: Engage students in activities that provide immediate insights into their understanding. Use classroom response systems (clickers), online quizzes, or interactive apps (e.g., Kahoot, Quizlet).
Example: During a lesson on geometric transformations, use an app where students can manipulate shapes and receive instant feedback on their understanding.
- III. *Collaborative Learning and Peer Assessment*: Foster collaboration and critical thinking through peer interactions. Encourage group work, peer review sessions, and collaborative problem-solving tasks.
Example: Assign group projects where students must solve complex problems and present their solutions. Peers then provide feedback using a structured rubric.
- IV. *Self-Assessment and Reflection*: Develop students' metacognitive skills and self-regulation. Use self-assessment checklists, reflective journals, and goal-setting activities.
Example: After a lesson on probability, ask students to complete a self-assessment checklist on their understanding and write a reflection on areas they found challenging.
- V. *Formative Quizzes and Exit Tickets*: Check in with students and adjust instruction. Use short, focused quizzes or exit tickets at the end of a lesson or topic.

Example: After a lesson on functions, have students complete an exit ticket with one question about the day's topic and one question about something they still don't get.

Note: An exit ticket is a formative assessment tool used at the end of a lesson or class to check in with students. It's a short, focused task or set of questions students complete before they leave the classroom. Exit tickets give the teacher immediate feedback on the lesson and the student's understanding of the concepts so they can adjust instruction.

MEANING AND PROCESSES OF SUMMATIVE ASSESSMENT

Summative assessment is an overall assessment usually conducted at the end of the programme of instruction. It is for the purpose of providing data to inform judgment on the issue under consideration, say students' achievement. The purpose for which data collected will be used for is what differentiates summative assessment from formative assessment. If the purpose is to gather data to make judgment, it is summative. But, if the purpose is to gather data to inform better instruction in order to enhance learning, the assessment is formative. Ways of gathering data for summative assessment includes test, observation, anecdotal record, checklist and rating scale.

Test

A test is a kind of device or instrument for measuring achievement, ability, interest, attitude or aptitude. In this discourse, only achievement test is discussed. Test scores are measurement data which are used for the assessment of students' learning. An achievement test could be of objective type or essay type.

Objective Type Achievement Test

An objective test consists of many questions all of which are to be answered within a specific time frame. The students are required to choose between various answers supplied by the test constructor. The test is said to be objective because the marking is objective. This means that exactly the same mark is awarded no matter who does the marking. This kind of test is best for assessing knowledge of facts, terms, principles & concepts and it ensures wide coverage of syllabus. There exist four major types of objective test, which includes multiple choice, matching items, filling in the gap and true or false.

Multiple Choice Objective Test: In this type of test, a question is asked, three to five response options are provided of which only one is the correct option. This correct option is called the key while the other options are called the dis-tractors. Multiple choice objective test items can either be a direct question or an incomplete statement. For example, what is the square root of 4? Or the square root of 4 is When constructing multiple choice objective test items, the test constructor should ensure the same number of options per question all through the test, for each question, the dis-tractors must be as attractive as the key and the position of the keys in the different items must not follow a regular order.

Matching Items Objective Test: This type of test requires the recall of relationship between pairs of items. Such tests consist of two unequal columns of pairs of items. Testees are expected to correctly match the items in one columns to the other column. Consider the following: match items in column A to column B.

A	B
Hexagon	Four sided
Pentagon	Five sided
Octagon	Six sided
Quadrilateral	Seven sided
	Eight sided

Filling in the Gap Objective Test: In this type of test, an incomplete sentence is made with a gap or gaps. Testees are required to provide the information that will correctly fill the gap and make the sentence complete. Consider the following examples:

- i. A quadrilateral has ----- sides
- ii. The perimeter of a rectangle is given by the formula ----- and ----- is the formula for calculating the area of a parallelogram.

True or False Objective Test: This requires the testees to recall the correct or incorrect information. For example, the product of 32 and 23 is 55, True or False? In this type of test, controversial questions must be avoided.

Advantages of objective test

1. It is easy to mark
2. Scoring is objective eliminating bias and less time consuming
3. Fair to all candidates particularly to the slow writers
4. Not prone to leakage,
5. Covers large content area
6. Scoring is more reliable
7. Is appropriate for measuring knowledge of facts
8. Comparability of students performance is achieved

Disadvantages of Objective Test

- 1 Difficult to set
- 2 Weak in measuring, students depth of knowledge, his ability to analyze and present facts logically,
- 3 Prone to cheating and copying during test administration
- 4 Setting the test is time consuming

Essay Test

Essay test are subjective test. The questions are usually few. Each testee composes his answer the way he think best. Choice questions are often provided so that the testees do not all have to answer the same set of questions. Essay test may be of extended response type or restricted response type.

Extended Response Essay Test: In this type of test, the testees are not restricted in their responses. They can express themselves in the way they like. For example, ‘Explain the meaning of assessment.’ In this question, there is no restriction on the number of words or pages of the response. Testees may want to use diagrams for illustration.

Restricted Response Essay Test: An essay test of the restricted response type, require testees to give their responses under certain conditions. For example, ‘In not more than half a page, explain the meaning of assessment’. In this case, any testee who gives an explanation of more than half a page will be penalized. Essay test are used for evaluating the qualitative aspect of instruction such as hand writing, logical presentation of facts and so on.

Advantages of Essay Test

1. Easy to set
2. Good for assessing understanding and depth of knowledge on given topics
3. Measures such abilities as writing, expression, logical organization and originality
4. Minimizes guesswork

Disadvantages of Essay Test

1. Difficult and time – consuming to mark
2. Scoring is difficult and subjective
3. Scoring is inconsistent
4. Prone to leakage and cramming
5. Unfair to slow writers

Observation: Observation entails a careful and purposeful watch over the students to obtain information on their performance and affective behavior in mathematics. It is useful for collecting information on things that need to be seen, smelt, felt or touched, tasted or heard. Direct observation has been used as a way to assess mathematical skills since the establishment of formal classrooms. This is because Mathematics is a subject that consists of step-by-step procedures and direct observation can be used in conjunction with rubrics. By this technique, the pre-service mathematics teacher can observe the interest, skill, competency in mathematics. It is a continuous process. Through observations, pre-service Mathematics teachers can assess students' abilities to communicate mathematically, apply Mathematics concepts and skills, solve mathematical problems and work with others in solving mathematical problems. The pre-service Mathematics teacher prepares observation schedules which serve to systematize information accruing from the observable phenomena. A few effective and efficient means for collecting information through observation include the following:

- Determining what skills or comprehensions are to be assessed.
- Carrying paper and a pen for recording observations.
- Using a checklist of desired behaviors and actions. A sample is shown in Table 1.
- Using a video camera to record observations

Table 1: Observation Schedule for Quadratic Equation Class

S/N	Descriptors	Score out of 5
1	Depth of knowledge of the Quadratic Equation	
2	Strength in teaching Quadratic Equation to other students	
3	Zeal to acquire the knowledge of Quadratic Equation	
4	Ability to interpret Quadratic Equation problems	
5	Ability to take correction	
6	Ability to communicate mathematically	
7	Ability to work with others in solving Mathematical problems involving Quadratic Equations	
9	Comportment in Mathematics class	

Anecdotal Record: Anecdotal record is an observation method used frequently in the classrooms in which the pre-service mathematics teacher summarizes a single developmental incident after mathematics lessons. A pre-service mathematics teacher records about what students are learning, their academic performance, learning behaviour, their achievements and social interactions in mathematics. It is an informal note but can help the mathematics teacher to keep a record of each student in the mathematics class in a comprehensive manner. Anecdotal notes should be used to record the day-to-day development of students, as well as their specific behaviors like student's problem solving ability, measurement ability, experimentation ability etc. These behaviours/ observations need be recorded within two days of being observed to ensure accuracy of information as shown in table 2.

Table 2: Anecdotal Record of Okolo Ngozi

Student's Name: Ngozi Okolo
Class: SSS 1 A
Mathematics Teacher: Mr. Faco Francis
Date: June 7, 2024
Setting: Classroom
Purpose: To observe if the student is able to solve Quadratic Equations
Observational Question: Is the student able to solve Quadratic equation?
Observational Details: Ngozi Okolo has developed the ability to solve Quadratic equations using Factorization method and perfecting the square method but she is not too conversant with the General Method. From time to time, omit signs and substitute wrongly.
Analysis She is of the average state in solving Quadratic Equations but more effects are needed to boost her understanding in solving Quadratic Equations

Checklist: Check list is an observational technique, which offers systematic ways of collecting data about specific behavior, knowledge, performance and skills in Mathematics. Check lists have two parts, in the first column statement and the latter is response yes/no related to the statement. An example of checklist is shown in table 3.

Table 3: Checklist for Quadratic Equation Class

S/N	Descriptors	YES	NO
1	Did the student accept challenges in solving Quadratic equations willingly?		
2	Did the student apply knowledge learned from previous learning tasks?		
3	Did the student reason and explain Quadratic equations appropriately?		
4	Did the student see and or analyze relationships and make connections between Quadratic equations and Indices/Logarithms?		
5	Did the student complete response in Quadratic equations to other students with clear explanations?		
6	Did the student answer completely using correct mathematical terms and symbols?		

Rating Scale: Rating scales are extended form of checklists, in which standard criteria for assessing a performance is created and each standard has a definite level of competence and we rate learners according to how well they perform on each standard as they complete the task. An example of rating scale students in Quadratic Equations is given in table 4.

Table 4: Rating Scale for Experimental Work in Quadratic Equations

Student's Name: _____					
Class: _____					
S/N	Skill observed	Level of Mastery			
		Never (1)	Sometimes (2)	Average ly (3)	Mostly (4)
1	Student identifies the equations that are quadratic equations				
2	Student has understanding on Quadratic Equations				
3	Student identifies the coefficients and powers of the lettered				
4	Student sorts and identifies different forms of Quadratic equations				
5	Student construct quadratic equations using the given roots				
6	Student works with precision and neatness				
TOTAL					

CONCLUSION

This chapter discussed assessment in mathematics education. The meaning of assessment, the types of assessment based on purpose and format were discussed. This was followed by a discussion of the meaning and processes of different forms of assessment in the classroom which included formative and summative assessments.

Assessment in Mathematics must be planned, keeping in mind its goals. Assessment for and of learning, each has a role to play in supporting and improving learner's learning, and so, must be appropriately balanced. Assessment must be embedded in the learning process and interconnected with curriculum and instruction.

STUDY QUESTIONS

- 1) What do you understand by assessment?
- 2a) Explain the meaning of formative assessment showing how it links learning to teaching.
- (b) Explain any four ways formative assessment can be carried out in the classroom.
- 3a) What is summative assessment? Give any two examples.
- (b) Differentiate between formative and summative assessments.
- 4a) What is a test?
- (b) Raise six test items to demonstrate the different types of test you know.
5. How does preparation of table of specification help a mathematics teacher?

6. Prepare a check list to assess reasoning ability of students.
7. Prepare a rating scale for any topic in mathematics
8. How are anecdotal notes recorded?
9. What are the benefits of observation schedule?

Reference

- Earl, L. (2013). Assessment of learning, for learning, and as learning. <http://www.tag.education.tas.gov.au>
- Garrison, C. and Ehringhaus, M. (2016). *Formative and Summative Assessment in the Classroom: Association for Middle Level Education*. <https://www.amle.org>
- Heritage, M. (2020). *Formative Assessment: Making It Happen in the Classroom*. Corwin Press, Thousand Oaks, CA
- Lane, R. (2018). Explainer: What's the difference between formative and summative assessment in schools? Paper submitted to the Conversation: Academic Rigour, Journalistic flair by Rod Lane, Senior Lecturer in Educational Assessment, Macquarie University.
- Looney, J. (2021). Integrating Formative and Summative Assessment: Progress toward a Seamless System? *OECD Education Working Papers*, No. 58, OECD Publishing, Paris. <http://dx.doi.org/10.1787/5kghx3kbl734-en>
- National Council of Teachers of Mathematics (2014). Principles to Actions: Ensuring Mathematical Success for all. USA: National Council of Teachers of Mathematics
- Nicol, D.J. and Macfarlane-Dick, D. (2017) Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Studies in Higher Education* 31(2): 2-19
- Okoye, R.O. (2023). Issues in Educational Assessment in Nigeria. *International Journal of Studies in Education*, 19(1); 13 – 24.
- Schwieren, J., Barenberg, J. & Dutke, S. (2017). The testing effect in the psychology classroom: A meta-analytic perspective. *Psychology Learning and Teaching*, 16 (2), 145 – 167.
- Steward, B. L., Brumm, T. J. and Mickelson, S. K. (2014). Formative and Summative Assessment in Agricultural Engineering and Technology Courses. *Agricultural and Biosystems Engineering Conference Proceedings and Presentations: Iowa State University Digital Repository* http://lib.dr.iastate.edu/abe_eng_conf