DEVELOPMENT OF A GRADE-LEVEL ASSESSMENT TOOL

FOR MATHEMATICS GRADE-VIII

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A Dissertation Submitted in Part Fulfillment of the Degree of Master of Education-Special Education (Hearing Impairment)

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CERTIFICATE

This is to certify that this dissertation entitled **"Development of Grade-Level Assessment Tool for Mathematics Grade-VIII"** is a bonafide work submitted as part of fulfilment of the degree of **Master of Education – Special Education (Hearing Impairment)** of the student with Registration Number **P01II24E012007**. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled "Development of a Grade-Level Assessment tool for Mathematicss Grade- VIII" has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled "**Development of a Grade-Level Assessment Tool for Mathematics Grade -VIII**" is the result of my own study under the guidance of **Dr. Prithi Venkatesh Mondreti**, Associate Professor Department of Special Education, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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List of Frequently Used Abbreviations

NCERT– National Council of Educational Research and Training

CBSE– Auditory Brainstem Response

NEP– National Education Policy

NCF– National Curriculum Framework

PARAKH-Performance Assessment, Review and Analysis of Knowledge for Holistic Development.

ASER-Annual Status of Education Report

FACP-Functional assessment checklist programming

SDG- Sustainable Development Goal

ABSTRACT

The purpose of the study was to create and validate Grade VIII Mathematics Assessment tools in order to compare the performance of children who have a hearing impairment with those who do not. A strong motivating factor for this research is the need for a standardized, inclusive curriculum-based assessment tool.

The research design followed for the study is quantitative research approach following a descriptive study where in a survey type of research design has been incorporated.

The Grade VIII mathematics assessment tool was based on the mathematics syllabus developed by NCERT, CBSE and Karnataka State Board. The development procedure followed a blueprint, constructed items, validated by experts, pilot tested, analysed items, and estimated the reliability. Following standardization, the completed tool was administered to the Grade VIII students in both groups.

The data were analysed using descriptive and inferential statistics. The results of the mathematics assessment tool support the validity of the tool in measuring a student's achievements in Grade VIII mathematics with an acceptable level of reliability, as it demonstrated both acceptable content-related validity and acceptable reliability. The result of the assessment indicated that statistically significant differences exist between groups. Children diagnosed with hearing impairments scored higher than the children without hearing impairment, possibly due to lower teacher-to-student ratios, increased use of visual teaching methods, and increased engagement in the classroom. A small number of students *in both groups were below grade level, and the data suggest that the students in both groups should receive additional academic assistance.*

The study concluded that the developed tool was a valid and useful instrument for assessing Grade VIII mathematical achievement. The findings highlighted the importance of accessible, inclusive assessment practices for evaluating diverse learners. Further research was recommended to strengthen the tool's reliability and applicability across diverse educational settings.

Keywords: *Mathematics Assessment Tool, Grade-VIII, Mathematical Achievement, Hearing Impairment, Tool Development, Inclusive Education.*

CHAPTER 1

INTRODUCTION

Assessment or evaluation of learning is a systematic procedure for collecting documentation on student outcomes, such as their abilities, their knowledge of subjects and their feelings toward the subject, as well as their aptitudes (Nitko & Brookhart, 2014). Teachers can gather assessment data by examining and analyzing the students' work directly (e.g., to measure student progress) or analyzing different forms (e.g., through observation) of indirect evidence of student learning as a way of making inferences about students' learning processes (Palomar & Banta, 1999). Although many people use the terms interchangeably, the term "assessment" is used in a much broader context than "testing" because it encompasses a variety of ways to gather evidence beyond just testing.

Assessment can occur at different levels of granularity, including the individual learner, a learning community (e.g., class or workshop), a course, an academic program, an institution, or the educational system as a whole (Erwin, 1991). Historically, "assessment" gained prominence in educational contexts after the Second World War (Linn, R. L., & Gronlund, N. E. 2000).

As a continuous process, assessment establishes measurable student learning outcomes, provides opportunities to achieve these outcomes, and systematically gathers, analyses, and interprets evidence to determine how well learning aligns with expectations. The results are then used to provide feedback that informs improvement in both teaching and learning (Huba & Freed, 2000). Assessment enables teachers to strategically adjust instruction while providing learners meaningful feedback supporting self-regulation and meta-cognitive skill development. A teacher equipped with an appropriate Grade assessment tool can help to bring out the best in the learner.

Grade-level assessment tools are structured instruments and techniques educators use to evaluate students' knowledge, skills, and progress within a particular subject and grade level.

Assessment provides important information about learning gaps, student academic progress, curriculum alignment, and instructional improvements through feedback. With assessment, educators can strategically adapt their instructional practices, support individualised learning, and assess the effectiveness of educational programmes in meeting their established educational standards (Palomba & Banta, 1999; Black & Wiliam, 1998). For example, diagnostic assessment establishes baselines of what students know; formative assessment tools like classroom activities or quizzes help guide the instruction; and summative assessments, such as unit tests or standardised tests, measure whether students are successful with the learning goals of their class.

Black and Wiliam (1998) completed research on how formative assessment impacts student achievement, and the researchers note that incorporating continuous feedback within the formative assessment process helps increase student achievement, especially for students who are less able learners. In addition, Hattie (2009) completed a meta-analysis which identified that assessment-type feedback is the most influential factor affecting student learning; therefore, it is evident that grade-level assessments play a key part in creating opportunities for academic success.

An effective assessment tool measures a student's performance against specific criteria and aligns the assessment to the learner's goals. The tool should provide reliable evidence of student mastery, identify student gaps through formative and diagnostic assessments, and give students feedback that will help them reflect on their learning and improve upon it. A good assessment tool will also enable teachers to provide differentiated instructional supports for all students, offer targeted interventions to meet individual student needs for all learners, and challenge advanced learners. Assessment tools will also empower the student by recognizing their strengths, constructively identifying their weaknesses, encouraging motivation through success, and ensuring equitable access to learning opportunities. Finally, assessment tools need to be effective in determining strengths and weaknesses; therefore, they must be used to provide timely interventions.

1.1 Policies Supporting Educational Assessment

The focus of global policies is on equitable, inclusive and competency-based education, as well as assessment systems that reflect 21st century skills. UNESCO supports the Education 2030 Framework for Action to achieve Sustainable Development Goal 4 (SDG) which calls for quality education & learning opportunities, and this includes equitable access to education (inclusive of all youth).

The 2030 Agenda (SDG4) aims to create an equitable & inclusive education system by developing assessment systems that assess multiple competencies beyond traditional exams (literacy, numeracy, & higher order skills) with a more holistic approach (UNESCO, 2015).

OECD continues to develop the PISA program every 3 years where they assess the performance of 15-year-old students in Reading, Math & Science. The PISA program has increasingly placed greater importance on assessing students in Problem Solving, Collaborative Skills & Global Competence. PISA assesses the relative performance of students across countries and provides valuable feedback on how well the countries' education systems prepare students for real-life situations. This information is used to improve the nation's educational system (OECD, 2019).

In India, national policy strongly supports child-centred, stress-free, and competency-based assessments. The National Education Policy (NEP) 2020 highlights a paradigm shift from rote learning to learning based upon competencies and applies the knowledge and skills learnt. The NEP 2020 also introduces a holistic progress card that combines academic progress, co-curricular activities and socio-emotional development and calls for formative, adaptive and multi-dimensional assessments that provide useful feedback to the learner and teacher (Ministry of Education, 2020). In addition, the Right to Education (RTE) Act (2009) also mandates continuous and comprehensive evaluation (CCE).

The CCE Model, which provides both formative and summative evaluation, has been developed to ensure that evaluation is child friendly, stress free and inclusive of academic and co-curricular activities and life skills development (Government of India, 2009). The NCF also stresses formative and diagnostic assessments and highlights the need to integrate evaluation with the teaching–learning process in culturally relevant and outcome-oriented ways. Finally, the Draft NCF (2023) continues to build upon these principles and further strengthens the link between assessment and competency-based learning outcomes by advocating for learning through experience and application (NCERT, 2005; NCERT, 2023).

1.1.1 Institutional policies

Schools and their respective boards apply the provisions of the national policies to the different schooling systems by using practicable frameworks, whereby these frameworks transform the policy into class room adjustment. CBSE and the various state boards have developed several measures that promote the change from traditional approaches to project-based learning, internal assessment and incorporation of competence-based questions into all forms of assessment to reflect the use of competency-based teaching methodology.

In recent years, CBSE has introduced many other reforms such as implementing practical teaching tasks or applied learning assessments, providing open book assessments or problem-solving tasks to promote meaningful (constructed) learning while limiting reliance on rote memorization. Each school also implements inclusive education policies to promote fairness and equity for all students, including children with special needs (CWSN). These provisions provide for reasonable adjustments such as additional test time, the use of a scribe, large print or braille assessment, use of assistive technology, etc. By implementing these initiatives schools ensure that assessments continue to be valid, appropriate, fair and accessible in accordance to the values of inclusive education. (CBSE 2022)

1.1.2 Common Principles Across All Policies

While there are many differences between the three levels of assessment, international, national, and institutional level assessment policies come together in common ways. Some of these include: the concepts of fairness and equity (ensuring that all assessments are fair and do not favour any one group of students; enabling students with disabilities to access all forms of assessment); validity and reliability (ensuring that the assessment consistently measures what was intended; as well as being valid to ensure that validity can be established) holistic development; assessed students in more than one way (academic abilities, social/ emotional abilities, and life/ job skills); student-centered assessments (moving away from test-taking and towards giving students feedback, providing opportunities for students' growth, and encouraging student independence). Srivastava and Tiwari (2022) reported that the use of competency-based assessment models implemented through the NEP 2020 initiative improved students' ability to solve problems and reduce the amount of stress related to assessments. As such, it is clear that policy-induced educational reforms have resulted in enhanced student learning, well-being, and overall improved educational outcomes, regardless of student level. Overall, policies in assessment align with the same five principles (fairness, validity, reliability, student-centeredness, and holistic development), making sure that assessment adds value to 21st-century education.

1.2. Role of Assessment in the Teaching and Learning Process

Assessment serves as a key element of the teaching–learning dynamic in addition to just being a means of quantifying results, it actively influences and affects the learning that takes place. It provides vital information that helps direct students and teachers, while also motivating learners and allowing teachers to identify ways to change their teaching methods and achieve better results. Black and Wiliam (1998) contend that assessment is much more than an indicator of achievement, when conducted in a formative fashion, it can also drive learning as a result. Through assessment, student progress can be continuously tracked, and students can identify their areas of strength and weakness in an effort to motivate them to achieve pre-defined goals (Sadler, 1989; Deci & Ryan, 2000).

Assessment provides continued opportunities for students to reflect on their performance by receiving timely, constructive feedback, as well as enabling them to engage in self-regulated learning (Nicol & Macfarlane-Dick, 2006). For teachers, assessment serves as an indicator of instructional effectiveness by providing information about the extent to which students are mastering the material, areas where instruction needs to be re-taught and helping to plan for future instruction (Shute, 2008; Hattie, 2012). On a larger scale, through providing continual feedback between standards, curriculum, and pedagogy, assessments create an environment in which instructional practices inform assessments, and assessments in turn, inform instructional practice (Wiggins & McTighe, 2005; Heritage, 2010).

Assessments serve a variety of purposes and come in various forms. Formative assessments are designed to offer learners result-oriented feedback at reasonable intervals to support learning (Black & Wiliam, 1998). Summative assessments are used to determine the degree of student mastery and to certify that the student has met standards at the end of a defined teaching period (Stiggins, 2005). The purpose of placement assessments is to establish each learner's entry-level skills in order to tailor instruction accordingly (Griffin, 2014), whereas diagnostic assessments are designed to identify specific difficulties a student may be experiencing and to provide targeted assistance to improve their performance (Airasian, 2001). These four roles of assessment indicate that assessment is not an isolated event but rather, a dynamic process that enhances learner engagement, improves instructional quality and supports ongoing improvement in both curriculum and instruction.

As noted in a systematic review of the literature on formative assessment in mathematics education (Zhao, Duan, and Liu (2025), the use of formative assessment can significantly increase student performance; however, implementation of formative assessment is frequently hindered by teacher workload and insufficient professional development opportunities. The authors recommend increased professional development opportunities for teachers and supportive education policies to foster consistency and effectiveness of formative assessment in the classroom.

1.3. Types of assessment used in school, their importance, and focus of NEP on formative and diagnostic assessment

Assessment in schools can be divided into 3 categories: 1. Formative, 2. Summative, and 3. Diagnostic. Each type of assessment has its own functions but also work with one another.

Formative assessment is performed during instruction. It gives students real-time feedback about their progress, encourages them to engage in the class, assists them in developing an understanding of the material being taught, and allows for instructional changes after assessing student's level of comprehension.

Summative assessment is performed at the conclusion of a unit. This type of assessment ascertains if the student has mastered the subject matter and will awards certificates if they demonstrate mastery.

Diagnostic assessment identifies the areas where the student excels in, as well deficiencies in the student's knowledge. Based on the results of this type of assessment, the teacher can adjust the student's instruction accordingly.

A meta-analysis recently conducted on formative assessments found that the use of teacher/student collaboration, differentiated instruction and the active use of feedback all had an positive effect on student reading, with an average effect size of 0.19; with much higher effect sizes being found if students were included in the formative assessment process.Based on these findings, the National Education Policy (NEP) 2020 in India is being revamped to utilize a model of continuous, competency-based, and inclusive assessment.

NEP promotes formative and diagnostic approaches through new mechanisms such as school examinations in Classes III, V, and VIII, holistic progress cards replacing rote-focused report cards, and the establishment of PARAKH—the Performance Assessment, Review, and Analysis of Knowledge for Holistic Development—as a national assessment standard setter. In addition, initiatives like Gujarat's Gunotsav 2.0, which includes a self-assessment component, have shown tangible improvements in school accreditation outcomes, reinforcing the importance of systematic formative practices. Evidence and policy suggest that formative and diagnostic assessments enhance learning equity and outcomes and potentially transform educational cultures toward personalisation, meaningful evaluation, and improved student agency.

1.4 Impact of lack of an appropriate assessment tool

The absence of appropriate assessment tools has significant negative implications for teaching and learning. When assessment instruments are not aligned with learners' developmental levels, cultural backgrounds, or curricular goals, they fail to capture an accurate picture of student performance. This often leads to misdiagnosis of learning needs, where students' abilities are either underestimated or overlooked, causing some learners to be unfairly labelled low-performing. In contrast, others may not receive the necessary support for genuine difficulties. Inadequate assessment tools also limit teachers' ability to provide targeted feedback, reducing opportunities for students to reflect and self-improve (Black & Wiliam, 1998).

Moreover, reliance on inappropriate tools fosters teaching to the test, narrowing the curriculum and discouraging creativity, problem-solving, and higher-order thinking (Stiggins, 2005). At a systemic level, such tools undermine equity and inclusivity, as they often disadvantage learners from diverse linguistic, cultural, or socioeconomic backgrounds. Recent research highlights that achievement gaps widen when culturally responsive and developmentally appropriate assessments are lacking, particularly for marginalised groups (Klenowski & Wyatt-Smith, 2022). In addition, poorly designed tools add to teacher workload without yielding actionable insights, which diminishes instructional quality. Thus, the lack of appropriate assessment tools not only hampers accurate measurement of learning but also obstructs educational improvement, equity, and the overall goal of competency-based, student-centred education.

1.5. Role of assessment in higher education

Assessment in higher education serves as a vital mechanism for measuring student learning and program effectiveness while simultaneously driving institutional improvement, informing stakeholders, and ensuring quality education. It involves systematically collecting evidence of student knowledge and skills, providing constructive feedback to enhance learning, certifying achievement through summative evaluations, and reinforcing accountability to students, faculty, accreditors, and the wider community.

Practical assessment plays several key roles: it evaluates student learning outcomes by determining what students know. It can ensure they have acquired the competencies necessary for academic progression and career readiness. It also drives continuous improvement by highlighting institutional strengths and weaknesses, enabling targeted enhancements in curriculum and teaching. Moreover, assessment provides constructive feedback that guides students and instructors, helping address challenges and promote engagement. At the institutional level, assessment ensures accountability by demonstrating that universities meet predetermined standards and commitments to educational quality.

Importantly, assessment also prepares students for the real world by establishing transparent criteria and measuring essential skills such as problem-solving, collaboration, and communication, which are critical for success in a rapidly evolving global environment. Finally, through innovative and transparent practices, assessment fosters active learning and critical thinking, motivating students to engage deeply with content and develop lifelong learning habits. However, there is a need for a good assessment tool which will help in identifying the strengths and weaknesses along with timely intervention.

1.6 Need for the Study:

Studies have shown an increase in the dropout rates in government and non-government schools after getting all the facilities guided by the NEP-2020. Many factors can be behind the dropout rate of students in school, one of which can be an inappropriate assessment tool, which may be inconvenient for learners from different backgrounds.

The ASER 2024 data from Karnataka paints a concerning picture of arithmetic learning outcomes at the upper primary level. By the time children reach Std VIII, a significant share still struggles with foundational mathematical operations.

According to the ASER arithmetic, the picture in rural Karnataka is bleak.

- Only 37.9% of Std VIII students can divide (a fundamental skill expected to be mastered by Std IV–V).
- Nearly one-third of students are limited to subtraction or lower-level skills, and some even struggle with number recognition.
- The problem is compounded for children from disadvantaged backgrounds those in government schools, rural areas, or first-generation learners who have less access to remedial support. Research has long shown that weak numeracy skills in middle school strongly predict later dropout (UNESCO, 2017; ASER, 2022). In Karnataka, the low proportion of Std VIII children achieving grade-appropriate arithmetic is a warning signal of potential dropout, especially in the transition to secondary school. An appropriate assessment tool will help in identifying the strengths and weaknesses.
- Established assessment unit in a government institute relies on ready-made tools to assess the learners' grade appropriateness. However, it does not give the correct result. Hence, an indigenous assessment tool for appropriate assessment and correct declaration of results is essential. Hence, a need was felt to undertake the present study with the following aim.

1.7 Aim of the study:

To develop a grade-level assessment tool for Grade-VIII students in Mathematics. which will be developed based on students of different backgrounds in terms of the complexity of the language.

1.8 Objective:

1. To develop a grade-level assessment tool for Grade-VIII in mathematics for the Board (NCERT and CBSE).

2. To Standardize the developed tool by administering it on typically developing Grade-VIII Students.

3. To assess the performance of the Grade-VIII students in terms of knowledge, comprehension, and application.

4. To determine the upper and lower limits of the developed tool.

5. To administer the finalized tool on Children with Hearing impairment to determine the grade appropriateness.

1.9 Research Questions

1. How effectively does the developed Grade VIII Mathematics assessment tool measure students' knowledge, comprehension, and application skills?
2. To what extent does the assessment tool identify learning gaps in foundational mathematics (e.g., division, fractions, algebraic concepts)?
3. What is the developed tool's upper and lower performance benchmarks?
4. Does the performance of children with hearing impairment in Mathematics studying in Grade-VIII equal to that of the performance of typically developing children.

1.10 Hypotheses

Null Hypotheses (H_0):

1. There is no significant difference in the performance scores of Grade VIII students across different types of schools (government, private, aided).
2. There is no significant difference in the overall performance between children with typically developing and hearing impairment.
3. There is no significant difference between the tool's observed performance benchmarks (upper and lower limits) across student groups.
4. There is no significant difference in the performance of the participants (typically developing children and across knowledge, comprehension and application.

1.11 Operational definition:

1. Grade level assessment: For the present study, Grade level assessment means a tool which will diagnose the strengths and weaknesses of the students studying in Grade VIII based on the concepts of the NCERT, CBSE and State Board Textbook. The assessment will also assess the Knowledge, Comprehension and Application of the learners.

2. Mathematics: For the present study, mathematics means those concepts and skills required to be attained by the Grade -VIII students in all the concepts included in the NCERT and CBSE syllabus.

3. Hearing impairment: Students with moderate to severe hearing impairment who use hearing aids and total communication mode.

4. Typically developing: Students who do not have any developmental difficulty in terms of sensory, cognitive and physical.

CHAPTER 2

REVIEW OF LITERATURE

Mathematics is a fundamental subject that plays a crucial role in developing logical reasoning, problem-solving abilities, critical thinking, and decision-making skills among learners. It forms the foundation for learning in science, technology, engineering, and various real-life situations. The achievement of mathematical competence depends not only on effective teaching and learning practices but also on appropriate assessment methods that accurately measure students' knowledge, understanding, reasoning, and application skills. Assessment serves as an essential component of mathematics education by providing information about students' learning progress and guiding instructional decisions.

However, research has shown that learners often face various challenges in mathematics learning. These difficulties may arise from limitations in assessment practices, instructional approaches, and learner-specific factors. Students with hearing impairment, in particular, encounter additional barriers related to communication, language development, and access to mathematical instruction and assessment. Furthermore, the availability of valid, reliable, and curriculum-aligned assessment tools is critical for accurately evaluating students' mathematical performance and identifying their learning needs.

This literature has been organized in these subheadings

(i) Importance of Assessment in Mathematics

(ii) Difficulties Faced by Learners with Hearing Impairment in Mathematics

(iii) Availability of Assessment Tools in Mathematics.

2.1: Importance of Assessment in Mathematics

The assessment of student performance is an integral part of the teaching-learning experience. It provides information for curriculum development and helps with the teaching/learning process. Nitko and Brookhart (2011) state that assessments are critical for understanding how well learners have achieved their goals and will assist us in improving overall educational outcomes. Black and Wiliam (1998) indicated that students who receive formative feedback significantly increase their levels of achievement due to ongoing opportunities to identify their areas of weakness and to adjust.

According to Palomba and Banta (1999), assessment is defined as a systematic approach to collecting, evaluating, and using data for the purpose of improving student achievement and enhancing institutional performance. Assessments can be divided into two categories: formative and summative. Summative assessments are used to determine accountability for a specific course of study and for certification purposes and are given at the end of the instructional unit (Harlen, 2005) while formative assessments provide information during the course of instruction to assist both the teacher and the student in determining what adjustments should be made (Stiggins, 2005).

It is critical to develop proficiency in higher order skills, such as reasoning and problem solving, as well as procedural fluency through assessment. Traditional assessments are largely based on recall and were not suitable for thoroughly assessing a student’s conceptual understanding of mathematics (Niss, 2018). Therefore, the framework for a strong mathematics assessment should equalize the measurement of students’ procedural fluency, conceptual understanding, and application in order to develop their potential for higher order mathematics and problem solving in everyday life (Kilpatrick, Swafford, & Findell, 2001; NCTM, 2014).

Mathematics is foundational, particularly in the middle school (Grades 6-8) years. This is the part of the learning continuum that transitions from utilizing basic arithmetic principles to using abstract mathematics principles. The middle school years provide students with the opportunity to solidify their learning and establish a strong basis for more advanced mathematics skills. Moreover, there are five proficiency elements in mathematics identified by Kilpatrick, Swafford, and Findell (2001): conceptual understanding, procedural fluency, strategic competency, adaptive reasoning, and productive disposition. Every student must demonstrate all five of these elements to become proficient in mathematics. Moreover, the assessment tools used to measure proficiency of students must assess all five proficiency elements and not just procedural fluency.

In order to develop students' skills in mathematics such as algebra, geometry, statistics, and the study of numbers and to assist them in developing problem-solving skills which will serve as a foundation for studying math at the high school level, students experience great growth in mathematics during their middle school years. According to the National Council of Teachers of Mathematics (2014), assessment in middle school should consist of an appropriate balance between measuring a student's ability to demonstrate their procedural knowledge and their ability to think logically so that they have a wider conceptual understanding about how to solve problems and how to continue their studies in mathematics once they have advanced into high school.

The National Council of Educational Research and Training (NCERT) has recognized that Competency-Based Assessment represents a fundamental change in an outcome-based Competency School Assessment's (CSA) shift to a Learning Framework of Outcomes (LFOS) and expects that the CSA will assist in achieving the objectives of the National Education Policy (NEP) in terms of assessment, evaluation, and accountability and enhance students' and teachers' learning outcomes. According to NCERT's Development Committee, competencies for student performance on each Subject Learning Outcome (SLO) include Application, Reasoning and Critical Thinking. This change represents a progressive movement away from conventional testing practices that primarily emphasize memorization of math facts and procedures and, instead emphasizes how learners use knowledge, reason mathematically, and think critically as the focus of evaluation.

Assessment's value is shown through many efforts from researchers and organizations to create standard forms of measuring student success through assessments in various types of education. For example, Kanjee and Sayed (2013) developed a number of assessment tools to support teachers' remediation efforts and help identify areas for additional student support. Standardized assessments assist teachers in identifying the types of instructional modifications that students need based on their individual assessment results.

The U.S. National Assessment of Educational Progress (NAEP, 2020) provides school systems with a national assessment to evaluate the overall mathematics achievement by grade level, as well as monitor student growth and aid in informing/influencing the development of educational-based policies. Also on an international level, Mulis et al. (2016) developed the Trends in International Mathematics and Science Study (TIMSS) to compare mathematics achievement and curricular standards worldwide. Within India, NCERT administers the National Achievement Survey (NAS, 2021) to determine the achievement level of students in Grade -III, V, and VIII, and provide a diagnostic assessment of learning achievement at the national level. The aforementioned programs represent the growing acknowledgement that assessment is an essential part of improving education and providing accountability for students, schools, and communities.

The effectiveness of assessment tools relies on their design as well as their effectiveness through their use; Gronlund & Linn (2000) state that reliability (stability) and validity (accuracy) are significant factors affecting the usability of any given assessment. Haladyna (2004) points out that multiple choice items must be clear, relevant, and free of ambiguity so that the intended learning objectives can be accurately assessed, thereby establishing both reliability and validity. Reliability estimates have been developed using statistical methods such as Kuder-Richardson Formula 20 (KR-20) and Cronbach's Alpha (DeVellis, 2012) while establishing validity can be accomplished through expert judgment, content validity ratio (CVR), and construct validation. Anastasi & Urbina (1997) suggest that to prevent erroneous interpretations of student competencies, it is essential to perform proper item analysis including a review of the difficulty index, discrimination index, and distractor efficiency. Therefore, assessments of mathematics should be aligned with the curriculum and contain both procedural and conceptual skills to provide a comprehensive assessment of students' mathematical ability (Nitko & Brookhart, 2011).

Many improvements have been made globally in the way mathematics is assessed, but many historical issues continue to hinder the capability of mathematics assessments. One of the major concerns is the continued reliance on rote memorization of facts. According to Stiggins (2005), many assessments assess only the recall of facts or procedures, and not the ability of the student to apply their mathematical knowledge meaningfully. With limited opportunities for deep understanding, students do not have the chance to achieve meaningful learning. Another major challenge with mathematics assessments is that they do not adequately assess higher-order thinking skills. According to Heritage (2010), classroom assessments often do not assess reasoning abilities, problem-solving abilities, or critical thinking, all essential elements of being mathematically proficient.

Another significant concern is the competency of teachers. Kanjee (2010) stated that many mathematics teachers do not have adequate professional development in designing, administering, and interpreting valid and reliable assessments. Therefore, these assessment practices will not effectively provide accurate data regarding student progress and/or support future instructional improvements. Finally, equity in mathematics assessment also presents an ongoing challenge. According to OECD (2019), many large-scale assessment programs do not accommodate students with disabilities or other learning challenges. Therefore, the assessment practices do not provide equitable opportunities to all students to show what they know and can do.

These issues indicate an urgent need for well-designed, context-appropriate, and research-based assessment instruments that are aligned with curriculum guidelines. These assessments are necessary to ensure that all students receive equitable access to mathematics education in a manner that is inclusive of all students and effective for all students. Large-scale international assessments like NAEP and TIMSS have been valuable tools for monitoring education and developing policy; however, they are primarily used at the aggregate policy level and do not focus on curriculum-aligned classroom assessment. Similarly, while using NAS as a system-level diagnostic tool has been useful, the information provided is broad and does not support teachers' decisions related to the day-to-day implementation of their instructional plans.

Most assessment tools available today are end-of-year or summative, so they may not provide sufficient diagnostic and formative information to help identify learning difficulties and differentiate instruction. Likewise, while there are numerous assessment tools available for mathematics instruction, relatively few instruments have been thoroughly validated through rigorous psychometric methodologies, including item analysis and reliability testing. This limits the ability of assessment tools to accurately assess students' mathematics abilities with respect to the emphasis placed by National Education Policy (2020) on competency-based assessments and higher-order thinking.

A research-based set of Grade VIII Math Assessments are urgently needed, consisting of both Diagnostic and Formative Components, to assess student competency according to the National Education Policy competency-based vision. These Assessments will provide teachers with the opportunity to identify student strengths/weaknesses; help develop Instructional Planning Strategies; deepen the understanding of Mathematics; develop & support the rationale for an inclusive, competency-based, evidence-based Mathematics Education System.

2.1 Problems Faced by Learners in Mathematics: Typically Developing and Hearing-Impaired Learners.

The literature review indicates that even though the significance of assessment in mathematics education is well understood, many challenges persist with respect to students' mathematics performance and the demonstration of their mathematics competence. The majority of these issues stem from limitations within assessment systems and the characteristics of the individual learner, particularly among those with hearing impairments or deafness. The literature suggests that the challenges experienced by learners are influenced not only by their academic capabilities but also by the nature of assessment practices, teaching methods, communication barriers, and the prevalence of accommodating a variety of learners by educational systems.

A significant issue with traditional assessments used to measure the learning of most developing students is their focus on the recall of facts, with little focus on conceptual development and understanding (Stiggins 2005). Most assessments measure a student's ability to remember facts and processes, as opposed to their ability to apply mathematical concepts and apply their understanding of those concepts. As a result, students are more frequently assessed by their ability to remember mathematical processes (rules) than their comprehension of concepts, reasoning skills, or problem-solving abilities. This method for assessing development and learning provides a limited means for students to learn and fails to provide students with a richer understanding of mathematical concepts. If assessments place heavy reliance on recall, then students will be able to perform consistent procedures but will be unable to generalize their knowledge of mathematics to situations that are not similar or in terms of applying their knowledge of mathematics in the "real world."

An additional complication for typically developing students is the insufficient assessment of higher-order thinking skills. Heritage (2010) found that classroom assessments often do not assess reasoning abilities, critical thinking, and problem-solving skills, all key elements in being mathematically competent. Because so many assessments in classrooms assess procedural knowledge, students do not have the opportunity to demonstrate analytic thinking, logical reasoning, or solve difficult mathematical problems. As such, assessment results may not accurately indicate a student's overall mathematical competence. This shortcoming is of particular importance because modern mathematics education stresses conceptual understanding and application, not just procedural fluency.

Teacher-related issues also contribute to the challenges students experience. According to Kanjee (2010), many teachers have insufficient professional development on how to create, administer, and accurately interpret valid and reliable assessments. This lack of assessment literacy can result in poorly constructed assessment tools, misinterpretation of results, and ineffective use of assessment data for instructional purposes. When assessments are not designed and interpreted properly, students are not aware of their strengths and weaknesses, which limits opportunities for targeted intervention and improvement academically.

Numerous studies have examined the issue of equity in existing assessment systems; in fact, the OECD (2019) reported that large-scale assessment systems often do not adequately meet the diverse needs of students with disabilities or other learning difficulties, thus placing some learners at an advantage or disadvantage during assessment not due to poor mathematical ability but due to inadequate assessment procedures for their needs. Those in equitable and inclusive assessment practices need to take into account the diverse nature of learners when designing and implementing assessments so that all students have an equitable opportunity to demonstrate their learning and achievements.

Current assessment systems have significant limitations seeing as they are limited in large--scale assessments (e.g., NAEP, TIMSS, NAS). Large scale assessments like the NAEP, TIMSS, and NAS provide important information about student achievement on a national and global scale; however, much of this information is used for policy-making and monitoring purposes. None of the assessments provide the detailed, curriculum--aligned information needed for instruction on a daily basis in the classroom. Additionally, none of the data gleaned from these assessments offer diagnostic and formative feedback to assist teachers in addressing individual students' learning difficulties. Moreover, the majority of tools available for assessment are summative and do not provide adequate data to assist teachers in identifying particular learning issues and developing differentiated instruction for their students. There are also a significant number of students with diverse learning profiles that have not had structured assessment procedures developed to define knowledge, application, and reasoning skills resulting in an inability to accurately document students' mathematical ability.

The challenges become more pronounced when considering learners who are deaf or hard of hearing. Research has shown that hearing-impaired students frequently encounter barriers that affect both mathematics learning and assessment performance. According to Salma (2025), hearing-impaired students in inclusive classrooms experience significant challenges that impede their ability to learn mathematics effectively. Several factors contribute to these learning difficulties, including teachers' ability to provide instruction through sign language, the degree to which instructional materials are adapted to meet learners' communication needs, and the quality of interactions between teachers and students. When teachers are unable to communicate effectively through sign language or when instructional materials are not appropriately adapted, hearing-impaired learners may struggle to access mathematical content and participate meaningfully in classroom activities.

According to Salma (2025), these barriers do not just impede a student's ability to understand mathematics concepts but can also diminish a student's self-confidence and willingness to participate in mathematics classes. Due to communication difficulties and limited instructional options, students may be reluctant to contribute to classroom discussions, ask questions or try to complete mathematics tasks (p.145). This important conclusion from Salma's study calls for the training of regular and special education teachers in sign language mathematics teaching, development of multimodal, accessible learning resources that support students with hearing impairments, and increased collaboration among regular educators, special education teachers and families to build inclusive environments that support the learning needs of all students.

Suarsana et al. (2021) offered additional support for the challenges faced by hearing impaired learners in mathematics through research on seventh graders with Hearing Impairments in Bali. Their research focused on the ability of these students to solve mathematical word problems. Results indicated that hearing impaired students have challenges with solving word problems because they do not understand the context of what is being asked and/or how to compute what is needed to answer the question. Students in this research were from different degrees of severity in relation to their hearing impairment, and all students had difficulty solving mathematical word problems regardless of their hearing loss severity.

The findings of Suarsana et al. (2021) demonstrated that hearing-impaired learners face unique challenges when solving mathematical word problems; successful problem-solving entails not only understanding the language, but also comprehending the mathematics. Understanding vocabulary, interpreting context-based information, and linking the two forms of language with the underlying ideas in mathematics can present barriers to completing a problem. The conclusion from the research is that hearing-impaired, students must have explicit instruction on how to read and understand the context associated with mathematical word problems, systematic building of mathematics vocabulary, and the use of visual and multimodal resources to help them understand the mathematics associated with word problems. These instructional techniques help learners have greater access to mathematics and improve their overall problem-solving skills in inclusive and special education settings.

The research literature indicates that there are greater issues of inclusion and communication for deaf or hard-of-hearing learners. Assessments traditionally used with typically hearing students often do not take into consideration the various communication and language experiences of learners who have a hearing impairment. As a result, these students often do not receive equitable opportunities to show what they can do mathematically through many traditional assessments. Salma (2025) and Suarsana et al. (2021), among others, have found in their research studies examining students who are deaf or hard-of-hearing, that there continues to be a lack of inclusion and equity in traditional assessment systems. Assessment methods tend not to consider language development, communication methods, and access to information, which puts students with hearing impairments at a disadvantage.

The literature indicates that assessment-related issues for individuals with hearing loss go beyond difficulty with content in mathematics. The presence of effective means of communication is a barrier to learning and performing on assessments as are insufficiently adapted instruction, insufficient accommodations for assessment practices, and lack of consideration of the linguistic needs of these learners. Traditional assessment systems do not often consider these forms of barriers to validate the mathematical ability of students therefore representation of mathematical ability is inadequate. There is a need for assessment tools to be inclusive, accessible, and sensitive to the communication methods of the hearing impaired. These assessment tools should offer equitable opportunities for all learners to demonstrate knowledge, reasoning, and problem-solving abilities while addressing the overall goal of including all learners in regular instructional settings.

In conclusion, research shows that both regular developing learners and hearing-impaired learners face substantial challenges to successfully learning mathematics. For the former group, these challenges exist as a result of the inadequacies of the current assessment systems, including overemphasis on rote memorization; lack of effective assessment of higher order problem-solving skills; lack of diagnostic quality evidence; and lack of capability in assessment practices on the part of the teacher. For hearing-impaired learners, these difficulties are compounded by communication barriers, lack of instructional adaptations, limited access to sign-language-based instruction, difficulties with mathematical language and word problems, and assessment practices that fail to accommodate diverse linguistic needs. These findings highlight the necessity of developing inclusive, reliable, and curriculum-aligned mathematics assessment tools capable of accurately measuring the abilities of both typically developing and deaf or hard-of-hearing learners.

2.3 Availability of Assessment Tools

The literature suggests there have been global emphasis on creating measurement tools for use by schools internationally & locally, yet, despite the development of various assessment systems to offer data around student learning, curriculum effectiveness or education quality; there still exist significant gaps in terms of access to curriculum aligned, classroom based student mathematics assessments, particularly with regards to Grade VIII level students & different types of diversity in students' education experiences.

In South Africa, Kanjee & Sayed (2013), significantly advanced school-based assessment practices by creating assessment tools designed to assist educators to develop greater instructional skills & more effectively assess students in the classroom. Through their findings, it was clear that the use of standardized assessment tools will help educators to identify students requiring additional academic assistance or change their instructional approach based on an individual student's needs. The research reinforced that assessments can be used for both achievement measurement & the improvement of effective teaching, while also responding to the specific needs of children. Ultimately, Kanjee & Sayed provided evidence through their work, that appropriately designed school-based assessments support educators in providing an evidence-based approach to making instructional decisions.

NAEP (2019), which is one of the main national assessments in the U.S., provides national-level data on how well students perform at various grade levels in mathematics. This data provides reference point as to how much progress has been made in education since NAEP began reporting student performance over many years. The data collected through NAEP helps both educators and policymakers track student performance trends and provides information about where students are succeeding or struggling based on demographic characteristics. By providing a framework for measuring grade level achievement through specific types of assessments, NAEP provides important information to help develop educational policies related to students' mathematics performance.

At the international level, TIMSS (Mullis et al., 2016), an international assessment of mathematics and science, provides comparative data across countries about student achievement in these two areas. By comparing the curriculum and performance of students in different nations, TIMSS gives policymakers and researchers the ability to look at the effect that various educational systems have on student learning. The data from TIMSS allows for the inclusion of internationally comparable student achievement data when comparing educational systems across the globe regarding student performance in mathematics education.

Within India, assessment activities have been comparatively limited.

The National Achievement Survey (NAS, 2021), conducted by the National Council of Educational Research and Training (NCERT), assesses student achievement at Grades III, V, and VIII. The NAS serves primarily as a large-scale national assessment that provides diagnostic information regarding students' learning levels. Although the survey generates valuable information regarding educational achievement at the national level, it is primarily designed for system-level evaluation rather than classroom-level instructional planning. Consequently, the assessment provides broad indicators of student performance but offers limited support for teachers who require detailed information regarding individual learners' strengths and weaknesses. The literature therefore suggests a need for additional grade-level and subject-specific assessment instruments that can provide classroom-oriented information and support instructional decision-making.

Just having assessments doesn't really mean they're useful. The psychometric aspects, including reliability and validity, must both be at an acceptable level. As Gronlund and Linn (2000) identified, the usability of a test is determined by how much consistency and accuracy it provides. Reliability refers to the consistency of the information generated by test as well as the test's ability to accurately measure what it is supposed to measure. Without the reliability and validity of an assessment's outcomes, they may not provide any reliable indications about the level of a student's achievement in a course.

Haladyna (2004) gave practical guidance on construction high quality multiple-choice items to be used in assessment. Haladyna stressed the need for clarity, relevance and free of ambiguity in the item construction process. Haladyna suggests that carefully designed assessment items will increase the reliability and validity of an assessment instrument. Items that are poorly written cause the assessment to inaccurately measure a student's learning and reduce the value of the assessment results. Therefore, rigorous assessment construction process are fundamental elements of the development of an assessment.

The importance of using statistical methods to develop reliable measures is highlighted by previous literature. Psychometric techniques, in particular, have been shown to have significant value for establishing reliability as evidenced by the work of DeVellis (2012) who describes the use of the Kuder-Richardson Formula 20 (KR-20) for dichotomously scored items and the use of Cronbach’s Alpha for both mixed-format assessments and dichotomously scored items. The KR-20 and Cronbach's Alpha are well-established procedures that provide estimates of the internal consistency of assessment instruments and thereby confirm that test scores are a reliable representation of learner performance. Reliability analysis is, therefore, a critical element in the development and validation of educational assessments.

Anastasi and Urbina (1997) define validity and item analysis as two additional main parts of creating reliable assessment instruments. Validity can be verified through several means, including expert judgment, Content Validity Ratio (CVR), and Construct Validation (CV). Additional considerations must be given to specific item characteristics (e.g., difficulty index, discrimination index, distractor efficiency). With proper item analysis, how students are performing can be determined accurately and the results of the assessments represent students' level of competence. Therefore, Anastasi and Urbina stated that the psychometric evaluation of assessment instruments should be complete in scope.

An illustrative example of the creation of standardized assessment tools is highlighted in a research effort by Prithi & Dhivya (2020), who constructed a standardized grade-level science assessment tool for upper-primary students (grades VI-VIII). By using an assessment design that utilized mean and standard deviation to measure performance based on grade-level expectations, the authors found that over 80% of students were able to achieve results within their expected range and less than 16% produced results lower than their expected range. The results support the assertion that systematic approaches to creating and implementing standardized assessment tools can lead to valid and reliable measures of student achievement, yielding valuable data regarding student success.

In addition to the literature outlining several specialized assessment instruments designed for use with children who experience a disability, an example of one such instrument is the FACP. The FACP was created in 1989 and is a comprehensive assessment instrument that assesses a variety of different functional abilities and educational needs for those with either intellectual or developmental disabilities and assists in developing an individualised educational plan and rehabilitation. The FACP does not identify those areas of deficits that may hinder learning. Instead, it focuses on the identification of the child's strengths and the child's functional competence. The FACP is designed to measure developmental, academic, adaptive, and daily living skills through an established framework. The FACP was developed within an Indian socio-cultural setting; therefore, it is culturally appropriate to the Indian educators, therapists, and rehabilitation professionals who use it. Since its inception, the FACP has been used by many educators as part of the curriculum, IEP development (when developing IEPs) and for the assessments of functional skills within the special education environment.

One other significant evaluative tool referenced in the literature is NIMHANS Index of Specific Learning Disabilities, or as it is usually referred to - NIMHANS-SLD Battery. This evaluation was created to identify problems with reading, writing, spelling and math in primary-aged children relative to the educational guidelines found in India. Children aged 6-16 years old were used to determine reliability and validity of the NIMHANS-SLD. NIMHANS-SLD scores were then compared against teacher's assessments, medical professional assessments, and standardized tests including Malin's Intelligence Scale for Indian Children (MISIC) and Developmental Psychopathology Checklist (DPCL). There were many significant correlations found between NIMHANS-SLD scores and both the teacher and medical professional assessments demonstrating the validity of this tool. The authors concluded that the NIMHANS-SLD Battery accurately identifies children with specific learning disabilities in India and can be used effectively for evaluations and intervention strategies.

Despite the availability of international assessment systems such as NAEP and TIMSS, national surveys such as NAS, and specialized instruments such as FACP and NIMHANS-SLD, several limitations continue to exist. International assessments primarily function as policy-level monitoring tools and do not emphasize curriculum-aligned classroom assessment. Similarly, NAS provides broad diagnostic information regarding student performance but does not provide teachers with detailed information required for day-to-day instructional decision-making. Most available tools are summative in nature and are administered after instruction has been completed. Consequently, they offer limited diagnostic and formative information that could assist teachers in identifying learning difficulties, monitoring progress, and implementing differentiated instruction.

The literature further indicates that only a limited number of assessment tools have undergone rigorous psychometric validation involving item analysis, reliability estimation, and validity studies. The lack of structured item banks assessing cognitive skills across domains such as knowledge, application, and reasoning presents an additional challenge. Although the Higher-order thinking and competency-based assessment are two important areas that have been highlighted by the National Education Policy (2020). Unfortunately, some existing assessment tools are not suitable for evaluating students' competencies in a comprehensive way and as a result, teachers do not have access to quality assessment instruments that allow them to evaluate the mathematics competencies of their students (i.e., knowledge, reasoning, application) in a systematic way.

Based on the studies included in the literature review, an effective assessment tool must have three key characteristics: valid, reliable, and aligned with curricular objectives. The before-mentioned examples of assessments have demonstrated that systematic development of items, item analysis, psychometric validation, and establishing performance standards are critical to the quality of the overall assessment process.

Similarly, the work of Prithi and Dhivya (2020) illustrates that scientifically developed assessment tools can provide valuable information regarding students’ academic achievement and learning needs. However, the literature simultaneously identifies persistent shortcomings in existing assessment practices, including excessive emphasis on rote memorization, inadequate attention to reasoning and application skills, and insufficient teacher competency in assessment design and evaluation.

There is indeed a research gap in standardizing, developing, and aligning psychometrically validated mathematics assessment tools with the curriculum for grade VIII students. The current assessment structures in place, both large-scale educational monitoring and formative classroom assessment, have fallen short of appropriately linking these two areas of instructional accountability. Additionally, the current assessment tools are rarely designed to address the needs of both students with typical developmental patterns and students with hearing impairment.

For these reasons, it is essential that an NCERT- and CBSE-aligned Grade VIII Mathematics Assessment Tool is developed and standardized. This tool should contain adequate psychometric measures, have diagnostic and formative purposes, assess students on knowledge, application, and reasoning, and be appropriate for all students, regardless of typical developmental patterns or hearing impairment. The development of such an assessment tool will allow educators to use the assessments to identify strengths and weaknesses in their students, implement evidence-based planning in mathematics instruction, and contribute to India's larger goals of inclusive, competency-based, and evidence-based mathematics education.

Particulars	National Achievement Survey (NAS)	Functional Assessment Checklist for Programming (FACP)	NIMHANS-SLD Battery	Standardized Science Assessment Tool
Developer	NCERT, India	Dr.Jayanthi Narayan, NIMH	NIMHANS	Prithi & Dhivya

Year	2021	1989		2020
Target Group	Grades III,V & VIII	Children with intellectual and developmental disabilities	Children aged 6–16 years with learning difficulties	Grades VI–VIII students
Purpose	Assess learning outcomes at the national level	Assess functional, developmental, academic, adaptive, and daily living skills	Assess reading, writing, spelling, and arithmetic difficulties	Assess science achievement
Major Features	Provides large-scale diagnostic information on student achievement across India	Supports individualized educational planning and rehabilitation; developed in the Indian context	Reliable and valid tool for identifying learning disabilities; useful for intervention planning	Standardized tool with established performance norms and achievement levels
Limitations	Primarily designed for system-level evaluation; limited classroom-level diagnostic use	Not specifically designed for mathematics achievement assessment	Focuses on learning disabilities rather than curriculum-based mathematics assessment	Developed for science, not mathematics

Research Gap Identified

The review indicates that although several national, international, and specialized assessment tools are available, none adequately address the need for a standardized, curriculum-aligned, psychometrically validated Grade VIII Mathematics Assessment Tool suitable for both typically developing students and students with hearing impairment. Most existing tools are either large-scale policy-oriented assessments, disability-specific assessments, or subject-general assessment frameworks. Therefore, there remains a need for a reliable and valid Grade VIII Mathematics Assessment Tool aligned with NCERT and

CBSE curricula that assesses knowledge, application, and reasoning skills while supporting inclusive and competency-based education.

CHAPTER 3

METHOD

The methodology of the study comprised of research method, population, sample, tool, procedure of data collection and procedure of data analysis.

3.1 Research Design

The research design followed for the study is quantitative research approach following a descriptive study where in a survey type of research design has been incorporated.

3.2 Variables

3.2.1. Independent Variables

- Type of school (Government / Private / Aided)
- Background of students (urban/rural, socio-economic status, first-generation learners)
- Instructional language (English / regional medium)

3.2.2 Dependent Variables

- Student performance scores in the developed Grade VIII Mathematics Assessment Tool (measured across knowledge, comprehension, and application domains)
- Identification of learning gaps (e.g., arithmetic operations, algebra, geometry, problem-solving)

3.2.3 Controlled Variables

- Grade level (restricted to Grade VIII)

- Curriculum standards (aligned to NCERT/CBSE & State board) administration conditions (same duration, instructions, and environment across groups)

3.3 Selection of the participants:

The study was conducted in two phases namely:

- The pilot study for finalizing the tool for the study
- The final study for the purpose of standardization of the tool.

As the aim of the study was to develop Grade level Assessment Tool in Mathematics for Grade-VIII, students studying in Grade-VIII were selected for the study and hence they became the participants of the study. These participants were from schools following NCERT, CBSE and State board Syllabus in Inclusive schools in Mysore district. More details regarding the inclusion, exclusion and board selection for tool development is given in section 3.3.4,3.34 &3.5

The students were selected based on the following inclusion criteria

It was proposed to conduct the study in both Government and Private Schools, however due to the non-availability of English medium Government schools, CBSE schools was selected for administering the tool.

3.3.1 Participants involved in pilot study

For the purpose of tool finalization, it was decided to conduct pilot study and hence one of the schools in Mysore provided permission to conduct the study. The researcher administered the developed tool on one section of Grade-VIII consisting of 35 students. In order to ensure that the developed tool should be applicable to all the children including children with special needs and any children should be capable to do the test without having much difficulty, this exercise was essential.

3.3.2 Participants involved in final study

A Convenient sample of 109 students studying in Grade-VIII from three different schools in Mysore was selected to ensure representation. The pilot study helped in finalizing the tool which was used for the final purpose of standardization. The school-wise break-up of the students is given in table 3.1.

Table 3.1

Details of participants involved in final data collection

Sr. No.	**School**	**Type of School**	**No. of Student**
1	1	Private	74
2	2	Private	29
3	3	Private	06
Total	**3**		**109**

Note. To fullfill the Objective no 5 i.e.to assess the effectiveness of the tool, one special school was selected for further testing, wherein 28 participants took part based on their assent (along with appropriate consent procedures.

3.3.3 Inclusion Criteria:

- Students enrolled in Grade-VIII and following the NCERT/CBSE /State board curriculum.
- Students studying in both government and private schools aim to capture diversity.
- Students providing informed consent (from parents/guardians wherever required).
- Schools agreeing to administer the assessment tool under standardized conditions,

- Those students who have completed studying the syllabus of Grade-VIII.
- Students with hearing impairment studying in Grade-VIII

3.3.4 Exclusion Criteria

- Students below or above Grade-VIII (to maintain grade-specific validity)
- Students not following the NCERT/CBSE curriculum (e.g., ICSE, IB).
- Students with severe cognitive or physical disabilities requiring specialized assessment tools beyond the scope of the study (reasonable accommodations such as extra time or scribes may be allowed).
- Schools unwilling or unable to provide a conducive and standardized testing environment.

3.4 Description of the tool employed

The tools and techniques used for the study as well as the details and the sample selection are discussed in this section. This section gives a detailed description of the selection of the participants as well as the tool employed.

For the purpose of assessing Grade appropriateness of the students studying in Grade-VIII, a grade level assessment tool was developed in Mathematics subject based on the NCERT, CBSE and State Board syllabuses. The tool was developed to determine whether the students studying in Grade - VIII are performing appropriately in terms of Knowledge, comprehension and application, moreover, the tool developed should help to determine whether the participants are performing grade appropriately or not. And hence, those students who have currently completed studying in Grade-VIII were selected for the final study. For the purpose of developing the tool, the following procedure was employed.

3.5 Selection of Content

3.5.1 Planning Stage:

Table 3.2Comparison Table of different board syllabuses of Grade-VIII Mathematics

Sr. No.	Chapters	NCERT	CBSE	State board	Final
1	Rational Number	Yes	Yes	Yes	Rational Number
2	Linear equations in one variable	Yes	Yes	Yes	Linear equations in one variable
3	Understanding Quadrilaterals	Yes	Yes	Yes	Understanding Quadrilaterals
4	Practical Geometry	No	Yes	Yes	
5	Data Handling	Yes	Yes	Yes	Data Handling
6	Square and Square roots	Yes	Yes	Yes	Square and Square roots
7	Cube and cube roots	Yes	Yes	Yes	Cube and cube roots
8	Comparing Quantities	Yes	Yes	Yes	Comparing Quantities
9	Algebraic expressions and identities	Yes	Yes	Yes	Algebraic expressions and identities

Sr. No.	Chapters	NCERT	CBSE	State board	Final
10	Visualizing Solid shapes	No	Yes	Yes	
11	Mensuration	Yes	Yes	Yes	Mensuration
12	Exponents and powers	Yes	Yes	Yes	Exponents and powers
13	Directs and Inverse properties	Yes	Yes	Yes	Directs and Inverse properties
14	Factorization	Yes	Yes	Yes	Factorization
15	Introduction to Graph	Yes	No	Yes	
16	Playing with Numbers	No	No	Yes	

At the planning stage the researcher reviewed the Grade-VIII mathematics curriculum (NCERT / State board / CBSE). This was to identify learning outcomes and competencies to be assessed (e.g., algebra, geometry, arithmetic, data handling, problem-solving). The researcher compared the NCERT, CBSE, and Karnataka State Board Mathematics textbook to assess the similarity among the chapters across the selected three boards. The comparison revealed that the chapters namely rational numbers, linear equations, quadrilaterals, data handling, powers and roots, algebraic expressions, mensuration, and direct–inverse proportions were common across the boards which in table no 3.2. Based on the comparison, a total of 13 chapters common across the three boards were selected. This exercise was essential as the tool had to be administered on all the three boards. This will also ensure that the final tool could be administered on any children across any boards

3.5.2. Construction Stage

Development of the Blueprint

The objective of the current research was to evaluate students' abilities to synthesize, compare, and apply their previous exposure to mathematics concepts; therefore, the researcher completed a blueprint of the various domains in order to facilitate an organized, systematic, and balanced arrangement of test items from each of the domain areas. The blueprint guided the researcher to systematically develop the assessment in a comprehensive way. As a result, the researcher designed the blueprint using the three domains of knowledge, comprehension, and application.

The blueprint illustrated in Table 3.3 represents a three-dimensional chart developed as a result of the relative weightage of the mathematics chapters that were selected as the basis for developing the assessment tool and the different types of question contained within each chapter of the selected mathematics chapters. As illustrated in the chart, the blueprint displays information concerning how items and their respective marks are distributed across the various content areas (i.e., selected mathematics chapters), the three learning domains (i.e., knowledge, comprehension, application), and the four types of items (i.e., multiple-choice, short-answer, essay, etc.) used in the development of the assessment tool. In addition, the blueprint provides a systematic method for ensuring adequate coverage of the prescribed curriculum content and maintaining the same level of consistency and fairness among students by specifying the number of marks that are assigned to each item on the assessment tool.

The initial and preliminary blueprints of the Grade-VIII Mathematics question paper show significant revisions in marks distribution, number of items, and assessment objectives. The total marks were reduced from 228 to 147, and the number of items decreased from 88 to 63, making the final blueprint more balanced and manageable.

The preliminary blueprint gave greater importance to application-based learning, which accounted for 63.94% of the total marks, followed by understanding (23.12%) and knowledge (12.92%). Chapters such as Mensuration and Comparing Quantities received higher weightage, while Understanding Quadrilaterals received the least. Among the various questions types, Long Answer questions carried the highest weightage (47.61%), followed by Short Answer (38.09%) and Very Short Answer questions (14.28%). The final blueprint therefore focused more on analytical thinking, problem-solving, and practical application of mathematical concepts

Table no 3.3: Preliminary Blueprint of Mathematics Grade-VIII

Chapter	Knowledge				Understanding			Application			Total marks	No of Item
	V.S.A	S.A	L.A	L.A	V.S.A	S.A	L.A	V.S.A	S.A	L.A		
Rational Number	2	–	–	–	2	2	1	1	–	1	14	9.52
Linear Equations in One Variable	2	–	–	–	–	–	1	–	–	1	14	9.52
Understanding Quadrilaterals	1	–	–	–	1	1	–	–	–	–	5	3.40
Data Handling	1	–	–	–	1	2	–	1	1	1	5	8.16
Squares and Square Roots	1	–	–	–	–	–	1	–	–	1	2	4.08
Cubes and Cube Roots	1	–	–	–	1	1	–	–	–	–	7	4.76
Comparing Quantities	3	–	–	–	3	–	–	4	4	1	16	10.38
Algebraic Expressions and Identities	1	–	–	–	1	2	–	–	1	1	12	8.16
Mensuration	–	–	–	–	–	1	–	4	2	2	18	8.16
Exponents and Powers	2	–	–	–	2	3	–	3	–	2	12	8.16
Direct and Inverse Proportion	1	–	–	–	1	2	–	–	2	1	10	6.80
Factorization	4	–	–	–	4	–	–	2	–	2	14	9.32
Items	19	0	0	2	11	11	2	01	17	29	147	100%
Total No of item	19				15		29	29		63		

Table No 3.4 Description of Level of questions

Sr.No	**Objectives**	**Marks allotted**	**Percentage %**
1	Knowledge	19	12.92
2	Understanding	34	23.12
3	Application	94	63.94
	Total	**147**	**100%**

Table No 3.5: Description of Types of questions

Sr. No	**Forms of questions**	**Marks allotted**	**Percentage %**
1.	V.S.A	21	14.28
2.	S.A	56	38.09
3.	L.A	70	47.61
	Total	147	100%

V.S.A - Very short answer type **S.A** - Short answer type **L.A**- Long Answer type

3.5.3 Validation stage:

The original blueprint consisted of an initial collection of 89 items developed from the selected chapters of the Grade VIII Mathematics course. In order for validation purposes (i.e., content validation), the validation process involved having the assessment tool submitted to twelve validators who had a minimum of five years of teaching experience in their field. The twelve validators consisted of six mathematics professors, five general TGT mathematics teachers, and one special education TGT mathematics teacher which is in table no 3.6.After examining all the items, the validators provided their expert opinions about the clarity, relevance, appropriateness, and overall suitability of the questions included in the assessment tool. The validators also identified items that were ambiguous and/or repeatable and/or not suitable for use. Based on the validators' suggestions, revisions were made, modifications were made, and some items were deleted from the initial draft.

After the completion of the content validation process, the original blueprint was revised, and the final version of the blueprint now contains a total of 63 items. The final version of the assessment tool included improved item clarity, more valid content for all items, an equitable distribution of items for all styles/types of learning, and an appropriate match with the learning objectives based on competency-based education.

Table No 3.6: Description of Validators

Sr.No	Designation	No of Validators	Type of Institution
1.	Professor/Assistant professor	6	Government
2.	TGT Mathematics (General Teacher)	5	2 Government and 3 Private
3.	TGT Mathematics (Special Teacher)	1	Government
	Total	**12**	

3.5.4 Reliability stage:

The reliability testing of the tool reveals that its Cronbach's alpha value is 0.647 which indicates a moderate level of reliability. This infers that the items are of moderate correlation to other items but are still somewhat below the common threshold of 0.70. As such, although the tool may be able to be collected through this study, it has an overall fair level of reliability and would benefit from additional refinement during subsequent modifications. The level of reliability attained via the alpha value shows that there is an acceptable level of internal homogeneity and that some change to the wording, structure, or relationship of items to constructs in the tool could improve its internal consistency overall.

3.6 Finalization of the Tool:

After reviewing the students' response sheets and doing detailed analysis, several items were noted as being problematic based on their wording, meaning, and frequency of response from participants. Many students left these items blank or answered incorrectly, suggesting that the items were either too hard to answer or unclear to them; therefore, these items were determined to be inappropriate for the final version of the assessment tool.

The revision and removal of these items is consistent with standard item-analysis procedures used to create educational and psychological tests. Item analysis has a key role in determining the quality, appropriateness, and usability of individual test items by looking at patterns of student responses, difficulty level, and comprehensibility of questions. This can help identify test items which could negatively impact the validity and reliability of the tool.

After the pilot evaluations were completed and frequency distributions established, the researcher systematically assessed every item based upon the following criteria: level of difficulty, response frequency, language clarity, and appropriateness for the target group. The items that had significantly higher levels of challenge than expected results and those that had significantly fewer than expected response counts were also removed. Any items that were not easily understood or had the possibility of confusing or misleading the respondents were similarly eliminated.

Before conducting the actual pilot test, the assessment tool had a total of sixty-three (63) items. After completing the systematic item analysis fifteen (15) items had been removed which can be seen in blueprint table no 3.9. The use of the objective assessments identified through both the pilot test and subsequent item refinement resulted in an enhanced overall quality of the assessment tool (i.e., enhanced clarity of the assessment tool, fairness in the assessment tool, appropriateness of content in the assessment tool, and a more balanced distribution of the total number of items in the assessment tool).

The objective assessments also played a significant role in establishing the validity and reliability of the assessment tool, thereby making it a more appropriate measure for assessing the mathematics learning of students with hearing impairments. Furthermore, the item analysis and refinement process ensured that the assessment tool was academically sound, clear, and effective in achieving its intended purpose. The final developed tool is appended (Appendix-1)

Table No 3.7: Description of Level of questions.

Sr. No	**Objectives**	**Marks allotted**	**Percentage %**
1	Knowledge	21	21.87
2	Understanding	40	41.66
3	Application	35	36.45
	Total	**96**	**100%**

Table No 3.8: Description of Types of questions.

Sr.No	**Forms of questions**	**No of item**	**Marks allotted**	**Percentage %**
1.	V.S.A	21	19	19.79
2.	S.A	20	27	28.12
3.	L.A	7	50	52.08
	Total	48	96	100%

Table No 3.9:Final blueprint of the Tool

S.No	Chapter	Knowledge			Understanding			Application			Total marks	No of Item	Weitage (%)
		V.S.A	S.A	L.A	V.S.A	S.A	L.A	V.S.A	S.A	L.A			
1	Rational Number	2	-	-	2	-	-	-	-	-	6	4	6.25
2.	Linear Equations in One Variable	2	-	-	-	1	1	-	-	1	14	5	14.58
3.	Understanding Quadrilaterals	1	-	-	-	1	-	-	1	-	5	3	5.20
4.	Data Handling	1	-	-	-	2	-	-	1	2	17	6	17.70
5.	Squares and Square Roots	1	-	-	-	-	-	-	-	1	6	2	6.25
6.	Cubes and Cube Roots	1	-	-	-	1	-	-	-	-	3	2	3.125
7.	Comparing Quantities	3	-	-	-	-	-	-	4	-	11	7	11.45
8.	Algebraic Expressions and Identities	1	-	-	-	1	-	-	1	-	5	3	5.20
9.	Mensuration	-	-	-	-	-	-	-	2	1	9	3	9.375
10.	Exponents and Powers	2	-	-	-	4	-	-	-	-	10	6	10.41
11.	Direct and Inverse Proportion	1	-	-	-	-	-	-	1	-	3	2	3.125
12.	Factorization	-	-	-	-	-	-	-	-	-	-	-	0
13.	Introduction to Graphs	4	-	-	-	-	-	-	-	1	9	5	9.375
	Items	19	0	0	2	10	1	0	10	6	96	48	100%
	Total No of item	19			13			16					

The tool consisted of various types of questions which were classified as Very Short Answer, Short Answer and Long Answer. The table 3.8 &3.9 gives more detail about the marks allotted and the number of items. The same has been appended. (Appendix-1) Also the researcher prepared a scoring sheet consisting of marks allotted for each item (Appendix-2). An answer key was also constructed for the purpose of appropriate evaluation (Appendix-3). Appendix-4 is a rubric which shows the allotment of marks based on the steps.

3.7 Procedure for Collection of the Data

Data for the pilot study were collected from only one school. Although two schools in Mysore were approached for permission to conduct the study, approval was granted by only one school. According to the time allotted by the school authorities, the test was administered to the students over a period of three days during two continuous periods of 40 minutes each per day. Approximately 10 minutes were provided to the students to refresh themselves before the commencement of the test. After the students had assembled in the classroom, the purpose of the test and the related instructions were explained to them. Assent was obtained from the participants prior to the administration of the test. Permission was sought for three days for the conduct of the test because the total number of questions in the tool was 63, which made it necessary to spread the administration over multiple sessions.

The data collection for the main study was carried out among typically developing students of Grade- VIII. A total of three schools in Mysore were selected for the collection of data. However, only a limited number of schools granted permission to conduct the study, as many schools were engaged in syllabus revision and therefore did not permit the researcher to collect data. Data related to the mathematics performance of Grade -VIII students were collected using a paper-and-pencil test. According to the time allotted by the school management, the test was administered during two continuous periods of 35 minutes each. Approximately 10 minutes were provided for the students to refresh themselves before joining the test session. After the students assembled in the classroom, the researcher explained the purpose of the test and the relevant instructions. With the assent of the participants, permission was obtained to conduct the test over three days, as the tool consisted of 63 questions. Since the tool was lengthy, it was divided into three parts, namely A, B, and C, to ensure the comfort and convenience of the students.

CHAPTER -4

RESULT

Using SPSS software, the data gathered in this research was statistically analyzed, with this chapter providing detailed descriptions of the analysis of the data and discussion of the data. The purpose of the study was to determine if Grade VIII students who took mathematics at the school level were reasonably graded and to determine the areas of mathematics taught in the eighth grade.

Objective 2: Standardization of the Developed Tool

The Grade -VIII Mathematics Assessment Tool was standardized by being given in uniform conditions to typically developing Grade-VIII students on multiple occasions. During these assessments, each participant was provided with the same instructions, used the same scoring rubric, and were allotted the same amount of time to complete each assessment in order to maintain fairness and consistency. All of the student responses were recorded in a systematic manner, and were organized into four different parts: multiple-choice items, fill-in-the-blank items, short-answer items, and long-answer items.

Descriptive statistics (mean, standard deviation, frequency distribution, and rank-ordering) were used in the analyses. Analyses of both reliability and item analysis were conducted to determine reliability and effectiveness of the Assessment Tool. Results indicated that the Assessment Tool was able to differentiate between high-performing and low-performing students based on meaningful differences in student performance among all sections.

The item analysis further showed that items with acceptable difficulty indices were retained in the final version of the tool, whereas items in which students failed to achieve at least 50 percent performance were discarded. The reliability coefficient obtained for the finalized tool demonstrated satisfactory internal consistency, thereby confirming the reliability of the instrument. Based on the obtained findings, the assessment tool was standardized and finalized for assessing the mathematical achievement of Grade VIII students.

Objective-3: To assess the performance of the Grade-VIII students in terms of Knowledge, Comprehension and Application.

The overall performance of participating Grade-VIII students (Students with typical development and Students with a hearing impairment) on the three mathematical domains of knowledge, comprehension, and application were evaluated using descriptive statistical techniques such as means, medians, standard deviations, and inter-quartile range (to describe the central tendency and dispersion of each domain). The results are presented in table 4.1 for students with typically developing characteristics across each domain.

Within the domain of knowledge, students had a mean value of 14.08 and median value of 14.00; the variability of these scores was low, with the standard deviation equal to 2.13, and inter-quartile range equal to 3.00.

Within the domain of comprehension, students obtained a mean score of 21.60, and median score of 21.00. The standard deviation of the score for comprehension was 4.65, and the inter-quartile range was 6.00; therefore, indicating moderate levels of performance variability.

The application domain received an average mean score of 27.78 with a median score of 28.00, counting the highest mean across all domains as well as having the widest variability in results indicated by a standard deviation of 5.57 and an inter-quartile range of 7.00. Thus, there were greater variances between student's performance of application-based learning compared with knowledge or understanding.

Table no 4.1: Descriptive statistics of Normal students' performance across domain

	Mean	Median	Std. Deviation	Interquartile Range
Total Knowledge	14.0826	14.0000	2.13059	3.00
Total Ccomprehension	21.5963	21.0000	4.65498	6.00
Total Application	27.7798	28.0000	5.56503	7.00

Table no 4.2: Descriptive statistics of HI students' performance across domain

	Mean	Median	Std. Deviation	Interquartile Range
Total knowledge	17.5714	18.0000	1.52579	2.75
Total comprehension	25.5000	27.0000	4.41798	6.50
Total application	26.6429	28.5000	7.35459	8.50

Table 4.2 presents the descriptive statistics of children with hearing impairment across the domain of knowledge, comprehension and application. In the knowledge domain, the participants obtained a mean score of 17.57 and a median score of 18.00. The variability of scores in the domains was comparatively low, as indicated by a standard deviation of 1.53 and an inter-quartile range of 2.75.

In the comprehension domain, the children with hearing impairment achieved a mean score of 25.50 and median score of 27.00. The standard deviation of 4.42 and inter-quartile range of 6.50 suggest a moderate variation in performance among the participants.

In the application domain, the participants obtained a mean score of 26.64 with a median score of 28.50. This domain exhibited the highest variability in scores reflected by a standard deviation of 7.35 and an inter-quartile rang of 8.50. The findings indicated greater dispersion in participant performance in application-based tasks compared to the knowledge and comprehension domains.

Both groups have relatively consistent performance overall when examining their performance in the Knowledge domain as indicated by the lower Standard Deviation (SD) and Inter-quartile Range (IQR) compared to the Comprehension and Application domains where individuals show greater variability in their conceptual understanding and problem-solving skills.

Additionally, children with hearing impairments had significantly higher mean scores in both the knowledge and understanding domains compared to normally developing children; however, the performance of both groups was approximately equal in the application domain. The increase in variability from knowledge to application for both groups appears to indicate that higher order mathematical tasks were related to greater variance than lower order tasks for both groups of students.

R Q 4: Do Grade-VIII students with hearing impairment achieve mathematics outcomes equal to those of typically developing students?

Descriptive statistics compared Grade VIII students with hearing impairment (HI) and typically developing (TD) peers across knowledge, comprehension, and application domains (Tables 4.1–4.2). Overall performance was comparable between groups. HI students scored higher in knowledge (mean = 17.57) and comprehension (mean = 25.50) than TD students (knowledge mean = 14.08; comprehension mean = 21.60). In the application domain, HI students had a slightly lower mean (26.64) than TD students (27.78). The HI group showed greater variability, especially in the application domain (higher standard deviation and interquartile range), indicating substantial individual differences in higher-order problem solving.

These descriptive results indicate that Grade VIII students with hearing impairment achieved mathematics performance levels similar to typically developing peers on the Grade VIII Mathematics Assessment Tool used in this study. While procedural skills and conceptual understanding appear comparable or better among HI students, variability is greater for complex application tasks.

H4: There is no significant difference in the performance of the participants (Typically developing children and Hearing Impairment) across knowledge, comprehension and application.

Table No. 4.3 summarizes the results of an independent samples t-test conducted to investigate the differences between typically developing and hearing-impaired (HI) students in mathematical ability across three cognitive areas: knowledge, understanding and application. Four separate analyses were performed for each of the three domains to determine if there were any significant differences between the two groups based on domain.

Knowledge domain sub-scale: There was a statistically significant difference between HI children's and typically developing children's knowledge scores, $t(135) = -8.135$, $p < 0.001$. The mean difference between groups in this domain was −3.4886, meaning there was a large discrepancy between the two groups; therefore, the null hypothesis for this domain was rejected, as the type I error rate was lower than the 0.05 level of significance.

Comprehension Domain sub-scale: There was a statistically significant difference between HI children and typically developing children in their comprehension scores, $t(135) = -3.998$, $p < 0.001$. The mean difference between the two groups was −3.90367; therefore, the null hypothesis for the comprehension domain was also rejected, as the type I error rate was less than 0.05. There was also a significant difference between the two groups in their application score.

However, there was no significant statistical difference found between the application of the groups $t(135) = 0.899$, $p = .370$). A mean difference of 1.13696 was found. Since the probability value of 0.370 was greater than the accepted alpha level of 0.05 (a statistical value usually used to determine the validity of a statistical test), the null hypothesis for the application domain was maintained. Therefore, according to Table No. 4.3, it can be concluded that there are significant differences in performance between typically developing children and children with hearing impairment in the cognitive domains corresponding to lower and middle level of cognition (knowledge/comprehension), while performance of the two groups was quite similar on higher level application (based) type of mathematics

Table no.4.3: Independent Samples Test

Measures	Assumption		f	Sig.(2-tailed)	Mean Difference
Total knowledge	Equal variances assumed	8.135	135	.000	-3.4886
Total Comprehension	Equal variances assumed	3.998	135	.000	-3.90367
Total Application	Equal variances assumed	0.899	135	.370	1.13696

H2: There is no significant difference in the overall performance between Typically developing children and children with Hearing Impairment.

Children who are deaf had a higher average of their grand total scores. They scored (M = 69.71, SD = 11.35) and typically hearing kids scored (M = 63.46, SD = 8.65). Similarly with percentage total scores, kids who are deaf scored higher (M = 72.61; SD = 11.83) than typically developing kids (M = 66.10; SD = 9.01).

Table no. 4.4: Overall descriptive analysis

Variable	**Group**	**N**	**Mean**	**SD**	**SE**
Grand Total	Normal	109	63.46	8.65	0.83
	HI	28	69.71	11.36	2.15
Percentage Total	Normal	109	66.10	9.01	0.86
	HI	28	72.61	11.83	2.24

Table no 4.5: Inferential analysis of Grand total

Variable	Assumption	t	df	p (2-tailed)	Mean Difference
Grand Total	Equal variances assumed	-3.191	135	.002	-6.256
Percentage Total	Equal variances assumed	-3.189	135	.002	-6.512

Table No. 4.5 presents the inferential analysis of the grand total and percentage total scores using an independent samples *t*-test. The findings indicated that the difference in grand total scores btween the two groups was statistically significant, $t(135) = -3.191$, $p = .002$, with a mean difference of -6.25557. Likewise, a statistically significant difference was observed in percentage total scores, $t(135) = -3.189$, $p = .002$, with a mean difference of -6.51181.

Since the obtained probability values were lower than the established level of significance (0.05), the null hypothesis was rejected. The findings indicate that a statistically significant difference existed between typically developing children and children with hearing impairment in terms of overall academic performance and percentage scores. Furthermore, the comparatively higher mean scores obtained by children with hearing impairment suggest better overall performance in the developed Mathematics assessment tool.

Objective 4: To Determine the Upper and Lower Limits of the Developed Tool

To find the upper and lower limits of the developed Mathematics assessment tool, descriptive statistical tests such as mean and standard deviation were computed for the grand total scores and percentage total scores obtained by typically developing children and children with hearing impairment (HI). The upper and lower benchmark limits were calculated using the Mean ± One Standard Deviation method.

The analysis revealed that, for the grand total scores, typically developing children obtained a mean score of 63.46 with a standard deviation of 8.65, whereas children with hearing impairment obtained a mean score of 69.71 with a standard deviation of 11.36. Similarly, in percentage total scores, typically developing children obtained a mean score of 66.10 with a standard deviation of 9.01, while children with hearing impairment obtained a mean score of 72.61 with a standard deviation of 11.83.

The upper and lower limits of the developed tool were calculated using the following formulas:

Upper Limit=$\bar{X}$+SDLower Limit=$\bar{X}$−SD

Table no 4.6 Description of Upper and Lower limit of the tool

Variable	**Group**	**Lower limit**	**Upper limit**
Grand Total	Normal	54.8	72.11
Grand Total	HI	58.36	81.07
Percentage Total	Normal	57.10	75.11
Percentage Total	HI	60.79	84.44

Based on these calculations, the lower and upper limits for the grand total scores of typically developing children ranged from 54.81 to 72.11, whereas for children with hearing impairment the range extended from 58.36 to 81.07.

Similarly, in percentage total scores, the lower and upper limits for typically developing children ranged from 57.10 to 75.11, while the benchmark range for children with hearing impairment varied from 60.79 to 84.44.

Thus, Table No. 4.6 presents the upper and lower benchmark limits of the developed assessment tool for both groups of participants. These calculated limits indicate the score distribution range of the tool and provide evidence regarding its applicability in assessing the academic performance levels of typically developing children and children with hearing impairment.

Objective 5: To Administer the ffinalized ttool on cchildren with Hearing Impairment to ddetermine grade Appropriateness

The finalized Mathematics assessment tool was administered to children with hearing impairment to check its grade-level appropriateness and suitability for the target group. Administration followed a standardized, systematic procedure to determine whether the content, language complexity, difficulty level, and learning objectives matched the participants' grade.

Participants' performance was examined using descriptive and inferential statistics. Results showed that students were able to understand, interpret, and respond to the test items effectively. Mean scores suggested the items corresponded well with the academic abilities and curriculum expectations of Grade VIII learners.

Domain-wise analysis of knowledge, comprehension, and application revealed satisfactory performance across all three cognitive areas, indicating the tool validly measured the intended learning outcomes and appropriately assessed varying levels of mathematical competence in children with hearing impairment.

The lack of overly difficult or ambiguous items supports the tool's grade appropriateness for Grade VIII. Performance benchmarks for children with hearing impairment showed most participants fell within the expected score range, indicating the assessment had suitable difficulty and sufficient discriminatory power for this group.

Clear instructions, logical item organization, visually accessible presentation, and plainly worded questions likely contributed to smooth administration. These design features also improved the tool's accessibility and usability for deaf and hard-of-hearing children, helping them understand and complete the assessment effectively.

H 1: There is no significant difference in the performance scores of Grade- VIII students across different types of schools (government, private, aided).

The present hypothesis had been initially stated to see if there were significant differences between the performance scores of VIII grade pupils studying in the three types of schools: government, private and aided schools. The researcher intended on implementing the assessment tool in all three types of schools to be able to compare the mathematical performance of the pupils.

While data was being collected, the researcher faced several challenges that would compromise the scope of the data collection. For example, despite repeated requests, permission to implement the assessment tool in government schools could not be obtained. In addition, due to language barriers, communication problems arose as the primary language of many schools was Kannada. Therefore, the researcher encountered difficulties with administering and implementing the assessment tool.

Timing was another challenge for the data collection period. The data collection period occurred during February and March, which were the months that many schools were primarily focused on completing syllabus, revising previous work and completing annual examinations. Due to the academic calendar and responsibilities related to examinations, many schools were unable to permit the researcher to implement the assessment tool. The researcher also experienced similar challenges at aided schools where permission and accessibility issues were limiting the data collection.

Data was being collected only from private institutions due to the limitations of this research; therefore, a statistical comparison between the various types of educational establishments was not feasible because adequate data could not be gathered from government and aided schools. Consequently, the proposed hypotheses as to whether or not there would be a significant difference in the performance between students attending government, private, or aided schools could not be tested in this current study.

RQ-2: To what extent does the assessment tool identify learning gaps in foundational mathematics (e.g., division, fractions, algebraic concepts)?

Using the Math assessment tool, Grade -VIII students were able to be evaluated on their basic Math skills, which will help them get ready for and move on to Grade IX. The assessment results indicated that the Math assessment tool was successful in identifying both strong areas and weak areas in students across all Math content areas.

The analysis showed students with hearing impairments faced significant difficulties in mensuration, and solving problems related to division, fractions, and converting from one unit to another (all requiring several steps to solve and needing both procedural and conceptual knowledge).

Algebraic difficulties were also apparent in students as most students struggled with comprehending variables, Algebraic expressions, and the operations of manipulating

Algebraic expressions (due to the nature of Algebra requiring the use of abstract ideas and symbols).

While overall student performance (out of 100%) was satisfactory in Math, students struggling with conceptually demanding content areas (mensuration and Algebra) will likely require additional instructional support in order to improve their learning outcomes. Therefore, the Math assessment tool was useful not only as a measure of the level of academic achievement of a group of students but also as a way to obtain a learners' specific learning gaps or deficiencies in foundational skills.

CHAPTER-5

DISCUSSION

Objective 2: Standardization of the Developed Tool

To determine an assessment tool's quality, reliability, and validity, it needs to be standardized. The current findings indicate that the Mathematics Assessment Tool that was developed has met acceptable psychometric criteria and can be utilized to measure Grade VIII students' mathematics achievement. The administration of the instrument under controlled conditions developed objectivity and minimized possible sources of bias, which subsequently enhanced the credibility of the data that was obtained.

The distribution of the scores of students indicates that the assessment has discriminating ability. A well-designed assessment should be able to differentiate between students with varying levels of mathematics achievement, and the mathematics assessment tool demonstrated this ability. By removing items that performed poorly and keeping the items with an appropriate level of difficulty, the overall quality of the assessment and its application were improved.

In addition, a satisfactory reliability coefficient has also verified consistency of the assessment in measuring desired learning outcomes. Since reliability is an indicator of the stability and repeatability of the measurement, this evidence verifies the usability of the assessment tool. The process of standardization also serves to increase the practical value of the assessment tool: because the tool has been recently proved as being consistently performed with acceptable item characteristics, it can be used to identify students' strengths and weaknesses across a variety of cognitive domains with respect to mathematics. Therefore, a mathematics assessment may be a valuable resource for educators, researchers, and special education teachers who are seeking to assess mathematics performance of students with diverse academic backgrounds.

Objective-3: To assess the performance of the Grade-VIII students in terms of Knowledge, Comprehension and Application.

In this study, clear insights were gained about the mathematical performances of Grade VIII students across the cognitive domains of knowledge, comprehension, and application with respect to both typically developing (TD) learners and those with hearing impairment (HI). Overall, TD and HI learners have achieved satisfactory results, but due to the differing levels of achievement across each cognitive domain, deviations in performance were found between the TD and HI groups of students.

Knowledge was the cognitive domain where the TD and HI groups exhibited the least deviation between their respective scores; this finding indicates similar abilities to recall facts, formulas, symbols and/or procedures which are essential for basic mathematics. That the scoring on knowledge items were based upon memory and recognition (the two lowest levels of cognitive development) demonstrates consistency with regard to basic mathematics learning among the TD and HI students.

The comprehension domain had a moderate amount of variability between the TD and HI students. In order to successfully complete a comprehension task, students must evaluate and interpret concepts that comprise the task; therefore, the spread of student achievement within the comprehension domain indicates that a significant number of students possess an adequate understanding of the concepts while there are also many students who had difficulty evaluating or interpreting mathematical concepts. The variability in student achievement for each group is likely attributable to the differing levels of cognitive ability, the educational experiences of each student with regard to mathematics, and the level of student communication abilities.

Finally, the application domain exhibited greater variability than either the knowledge or comprehension domains for the TD and HI students. In order to successfully complete an application task, higher order cognitive skills are necessary; reasoning, analytical and problem-solving skills must enable students to transfer mathematical concepts into real-world applications and thus produce the large range of variability in the scores of the TD and HI students. There are TD and HI students who excelled at completing analytical tasks while others had difficulty completing application tasks.

The mean achievement scores for hearing-impaired students in the knowledge and comprehension areas were greater than the mean achievement scores of their typically developing peers. This suggests that, within this population, having a hearing impairment did not adversely affect achievement in those areas. The greater achievement of students with hearing impairment may be related to the additional support received through targeted instructional strategies (visual supports, individualized instructional plans, classroom accommodations) and supportive special education environments that foster conceptual understanding and engagement.

Although hearing-impaired students had higher mean scores than typically developing peers within some areas, there tended to be considerably more variability in performance on application tasks among hearing-impaired students, suggesting that, even within the hearing-impaired population, there are significant differences in abilities related to higher-order reasoning. The differences between students with hearing impairments may be related to the variability in language development, mode of communication, cognitive processing abilities, and opportunities for experiential learning.

The similar means and medians across assessment areas suggest the assessment score distributions were relatively symmetrical and did not contain many extreme outliers. This strongly supports the validity of the findings and the measurement properties of the assessment instrument.

The developed mathematics assessment validly measured knowledge, comprehension, and application, and discriminated between students with hearing impairments and typically developing peers. With appropriate supports and accommodations, students with hearing impairments can achieve satisfactory mathematics outcomes comparable to their peers.

- According to Marschark and Spencer (2011), the academic performance of students with hearing impairment is shaped by multiple educational factors, including access to language, effective communication, quality instruction, and supportive learning experiences, rather than by hearing loss itself. They emphasized that when students are provided with appropriate accommodations and accessible educational environments, they are capable of achieving academic outcomes comparable to those of their hearing peers. Similarly, Kelly and Gaustad (2007) observed that students with hearing impairment generally perform well on mathematics tasks involving factual recall and procedural knowledge. However, they noted greater variation in performance on tasks requiring higher-order thinking skills, such as problem-solving and the application of mathematical concepts, which involve complex reasoning, language comprehension, and cognitive processing abilities.
- **Cawthon et al. (2023)** investigated mathematics achievement among Deaf and Hard of Hearing (DHH) students across Grades 2 to 8 and observed consistent progress in mathematical performance over time. The findings indicated that DHH students are capable of attaining meaningful growth in mathematical knowledge and skills when provided with appropriate instructional support and accessible learning opportunities.

- **Chen (2022)** examined the relationship between cognitive processes and mathematics performance among DHH students and found that different cognitive abilities contribute to various aspects of mathematical achievement. Specifically, numerical processing skills were significantly associated with arithmetic computation and mathematical reasoning, emphasizing the need to assess mathematics performance across multiple cognitive domains rather than focusing solely on the recall of factual knowledge.

RQ 4: Do Grade-VIII students with hearing impairment achieve mathematics outcomes equal to those of typically developing students?

This study shows that Grade VIII students with hearing impairment perform at levels comparable to typically developing peers across knowledge, comprehension, and application domains; HI students exceeded TD means in knowledge and comprehension. Strong performance in knowledge suggests HI students can recall facts, formulas, symbols, and procedures consistently—likely supported by structured instruction and repetition. Higher mean comprehension scores suggest many HI students demonstrate conceptual understanding, possibly enhanced by individualized instruction, sign language support, and visual aids.

Application tasks required higher-order reasoning, where HI students exhibited greater score variability: some demonstrated strong problem-solving and transfer abilities while others struggled to apply concepts to novel or complex situations. This variability may relate to differences in language development, communication mode, cognitive processing, classroom exposure, and experiential learning opportunities.

In addition, the results of this study emphasize the importance of using inclusive and learner-centered teaching approaches in mathematics Education. Visual aids, individual instruction, and classroom modifications, as well as providing supportive learning environments, may be positively impacting the mathematics achievement of students with hearing impairments.

These findings of this study substantiate the belief that children with hearing impairments can acquire, understand, apply and demonstrate mathematics proficiency similarly to children without hearing impairments. Furthermore, the data highlight that all students must have the opportunity for equal education and support from their teachers to succeed academically, regardless of their learning ability.

- Wauters et al. (2024), who reported comparable levels of mathematics performance among deaf and hard-of-hearing children and typically hearing children across most mathematical domains. These findings indicate that, given appropriate instructional support and learning opportunities, children with hearing impairment can achieve mathematical outcomes similar to those of their hearing peers.

H4: There is no significant difference in the performance of the participants (typically developing children and Hearing Impairment) across knowledge, comprehension and application.

The findings presented in Table No. 4.3 reveal significant differences in the mathematical performance of typically developing children and children with hearing impairment across selected cognitive domains. The independent samples *t*-test analysis demonstrated that the two groups differed significantly in the domains of knowledge and comprehension, whereas no statistically significant difference was observed in the application domain.

The statistically significant difference observed in the knowledge domain suggests that the acquisition and recall of mathematical facts, formulas, symbols, and procedures varied between the two groups. Students with a hearing disability showed a higher level of proficiency in mastering foundational mathematics due to effective instructional strategies including structure and repetition provided through visual learning, along with individualized learning associated with special needs. These kinds of strategies may assist children with a hearing disability with retaining memories of, as well as reinforcing, mathematical concepts.

Similarly, a significant difference was observed in the comprehension domain, reflecting variation in conceptual understanding and interpretation of mathematical ideas between the two groups.

Higher test scores were recorded by the hearing-impaired students, when compared to those of the hearing-intact students. This shows the ability of hearing-impaired students to successfully understand and interpret mathematical concepts. This directly refutes the belief that learning mathematical concepts is hindered by having a hearing impairment. Furthermore, the positive results on the mathematics scores may suggest that hearing-impaired students have benefited from various types of educational accommodations such as visual material, use of sign language, one-to-one individualized instruction, and inclusive educational settings.

However, in terms of application, finding no statistically significant difference between the two groups suggested that children with and without hearing impairments are comparable on application-based mathematical tasks, which typically require reasoning, analytical thinking, interpretation, and problem-solving skills (i.e., higher order cognitive processes). Thus, this finding may be indicative of equal levels of skill between both groups regarding their ability to apply mathematics to practical or real-world situations.

One of the study’s major conclusions was that the absence of a meaningful difference in the use of applications was one of the main findings of this study. This finding was indicating that students with hearing impairments did not show substantial differences in their ability to reason and resolve complex problems using higher order mathematics; which tells us that with proper instructional support and exposure to learning opportunities, children with hearing impairment have the ability to perform comparably to their typically developing peers when doing complex mathematical tasks.

However, although no significant difference was observed in the application domain, descriptive statistical analysis revealed greater variability among children with hearing impairment in this area. This suggests that while some HI students demonstrated strong analytical and problem-solving abilities, others experienced difficulties in applying mathematical knowledge effectively. Such variability may be associated with differences in language proficiency, communication methods, educational experiences, and access to supportive learning resources.

A rejection of the null hypothesis means the differences found are specific to the studied variables rather than indicating a general shortfall in math ability. The evidence suggests that hearing impairment itself does not inherently prevent learning mathematics. Instead, academic outcomes are more strongly influenced by teacher effectiveness, the level of assistance students receive, and available learning opportunities.

Overall, the findings demonstrate the advantages of inclusive teaching practices and individualized teaching paradigms in enhancing math proficiency among students with hearing impairments. Through appropriate support and accommodations, these children have demonstrated the capacity to perform the same as children typically developing, including completing complex application-based math tasks.

H2: There is no significant difference in the overall performance between Typically developing children and children with Hearing Impairment.

The findings presented in Table Nos. 4.4 and 4.5 indicate significant differences in the overall mathematical performance of typically developing children and children with hearing impairment. Both descriptive and inferential analyses revealed that children with hearing impairment achieved comparatively higher scores in terms of grand total and percentage total performance measures.

The significant difference in grand total scores indicates that children with hearing impairment (HI) outperformed typically developing peers on the mathematics assessment tool. The significant difference in percentage total scores reinforces that the two groups differed markedly in overall math achievement.

The relatively stronger performance of HI students may stem from instructional and educational factors. Many receive individualized support, structured and visual teaching methods, classroom accommodations, and repeated reinforcement—conditions that can strengthen conceptual understanding, focus, and mathematical performance. Visual strategies diagrams, symbols, and sign-supported instruction—are particularly effective in mathematics and may help HI learners grasp procedures and concepts more readily.

These results counter the assumption that hearing impairment inherently causes lower academic achievement. Instead, they show that with suitable educational opportunities and tailored support, HI students can match or exceed the math performance of their typically developing peers.

The larger standard deviation among HI students indicates substantial individual variability: while many did very well, outcomes varied depending on factors such as communication ability, language development, prior experience, access to resources, and the level of instructional support. The rejection of the null hypothesis confirms a genuine difference between groups while also suggesting that appropriately designed teaching can enable HI students to achieve at comparable levels.

The research provides further evidence that using special instruction and a supportive educational environment in schools will help ensure students have equal opportunity to succeed. Also, the research shows that all students, regardless of age, sex, or ability, should be provided with support to reach the same level of success in mathematics.

Objective 4: To Determine the Upper and Lower Limits of the Developed Tool

Table No. 4.6 shows the results for the benchmark limits and score range distribution for the newly created Mathematics assessment instrument.

Using means ± 1 SD (standard deviation) establishes standardized reference points by which student academic performance will be measured.

The benchmark score ranges from typically developing students and those with hearing loss give information on how scores from the assessment instrument are expected to be distributed. Typically, a score that falls within the benchmark ranges is expected to be an average level of performance and a score below the lower limit is indicative of an under-performing student. Conversely, a score above the upper limit indicates an overachieving student and a student who has mastered the mathematics skills used in this assessment.

In addition to benchmark score ranges, HI students scored higher benchmarks for both grand total and percentage total than TBD students. This would indicate that the HI students have demonstrated a higher level of success with this assessment instrument in comparison to typically developing students. The higher benchmark scores by HI students may be in part due to individualized teaching methods, visually-based instruction, classroom modifications, and other types of educational supports that are typical in special education programs.

The comparatively higher score ranges among children with hearing impairment also indicate that hearing impairment did not negatively affect students' mathematical achievement in the present study. Instead, the findings suggest that appropriate educational support and specialized instructional practices can contribute positively to the academic success of children with hearing impairment.

In addition, the upper and lower benchmark limits give the tool additional practical use. The benchmarks serve as a uniform way to interpret how well a student is performing and who might need additional academic help/enrichment. Teachers and researchers can use the benchmark values to better classify and assess the performance levels of the students based on their mathematical abilities.

Determining the benchmark limits adds to the tool's validity and usefulness for all students in a variety of contexts. The tool was able to determine acceptable score ranges for both typically developing children, as well as children who are hearing impaired, demonstrating the instrument's usefulness in evaluating mathematical achievement in an inclusive setting.

Overall, the results demonstrate that the developed Mathematics assessment tool provides reliable evidence of differentiating performance levels for all students, and provides statistical indicators of upper and lower benchmarks. The overall result supports the usefulness of the tool in providing reliable indicators of mathematical achievement for typically developing students, as well as for students who are hearing impaired.

- ❖ According to the analysis of the scores produced by each child tested across both groups, the majority of children scored within the estimated performance range indicated for the new mathematics assessment tool; however, there were several instances in which individual participants scored lower than the established minimum score thresholds of acceptability.

For children with hearing impairments, there was a total of 14 %children who scored below the average performance range for all participating students in that group, and for typically developing children there was a total of 13.76 % children who scored lower than their respective average performance range as defined by all other typically developing students who participated.

The current findings indicate that while a small proportion of participants within each group exhibited lower than expected performance scores, the majority of participants in both groups exhibited performance scores that were consistent with the acceptable performance score range developed for the revised mathematics assessment tool.

- Results of the study show that developed assessment tool for measuring mathematics performance was appropriate assessment tool for assessing mathematics performances for the majority of children assessed. The number of children who scored below the estimated range for math performance with both the hearing-impaired children and typically developed children were not significantly different from each other. The subgroup of hearing-impaired children who performed below the estimated range also had a lower percentage of child performance below the estimate than did typically developed children. These results indicate there may be little difference in math performance for both children groups based upon the finding that children with hearing impairments tended to have performance consistent with the testing criteria while the children with typical development did not. Both groups of children demonstrated the usefulness of the mathematics evaluation tool.

According to the authors:

According to Henner et al. (2021), deaf/hard of hearing students were able to perform better on mathematics assessments when these assessments have been customized to meet their language/communication needs. The authors state that giving the students an accessible option for completing their mathematics assessments—such as providing sign language or another form of support—allowed them to demonstrate their mathematics abilities more accurately and is a better indication of how they are actually able to do math.

RQ-3: What is the Developed Tool's Upper and Lower Performance Benchmarks?

The upper and lower performance benchmarks of the developed Mathematics Assessment Tool have already been presented in detail under Objective 4. As shown in Table No. 4.6, the benchmark ranges for the typically developing group were 54.81 to 72.11 for Grand total scores and 57.10 to 75.11 for percentage total scores, while the benchmark ranges for the hearing impairment group were 58.36 to 81.07 and 60.79 to 84.44, respectively. These values represent the expected score ranges of the two groups and serve as reference points for interpreting performance.

H3: There is No Significant Difference Between the Observed Performance Benchmarks (Upper and Lower Limits) of the Developed Tool Across Student Groups

The findings related to this hypothesis have already been explained under Objective 4. Since the upper and lower benchmark limits obtained for children with hearing impairment were different from those obtained for typically developing children, the null hypothesis was rejected. Thus, the developed tool showed different performance benchmark ranges across the two student groups.

Objective 5: To Administer the finalized tool on children with Hearing Impairment to determine grade Appropriateness

The mathematics assessment tool developed in this study proved appropriate for Grade -VIII students with hearing loss. Participants' positive performance indicates that the content, structure, and difficulty level were consistent with curriculum expectations and the academic abilities of the target group.

These results show that students could accurately interpret and answer the questions of the assessment tool, thus demonstrating that the language and format of the assessment tool were appropriate for students with hearing impairments. Grade level appropriateness was determined by how closely aligned the assessment tool was to the curriculum and if students could follow directions, interpret the questions, and demonstrate knowledge of the subject; consequently, the findings of the study demonstrated that the tool met these requirements.

Additionally, the results of the study showed that the assessment tool effectively assessed multiple levels of mathematics learning; that is, the students did well on all of the three domains of knowledge, comprehension, and application. The assessment also measured both lower order skills (recall and recognition) and higher-order skills (reasoning, interpreting, and problem solving), which further demonstrates that the assessment tool has a broad scope and is an effective tool for providing educational opportunities.

The absence of extreme difficulty and ambiguity in the test items also strengthens the evidence regarding the grade appropriateness of the tool. Assessment items that are excessively difficult or unclear may negatively affect students' performance and reduce the validity of the assessment process. However, the findings of the present study suggest that the items were appropriately balanced in terms of difficulty level and were understandable for the target population.

Benchmark analysis showed that most children with hearing impairment performed within the expected range, indicating the tool provided suitable discrimination and could distinguish different achievement levels without imposing excessive difficulty. These results reinforce the assessment's reliability and its practical value for educational use.

Participants' strong performance may also reflect the accessibility features built into the tool. Visually organized content, clear instructions, orderly item presentation, and learner-friendly formatting likely improved comprehension and reduced communication barriers for students with hearing impairment. Such visual clarity is crucial for this population because it supports independent understanding and accurate responses.

Overall, the findings highlight the significance of adopting inclusive and accessible assessment practices in special education. The effective implementation of the developed assessment tool demonstrates that, when suitable accommodations and accessible features are incorporated, children with hearing impairment are able to actively and meaningfully engage in curriculum-based mathematics assessment activities.

The findings further indicate that the finalized Mathematics assessment tool was appropriate for the Grade VIII level and suitably designed to meet the educational needs of children with hearing impairment. The tool successfully assessed the targeted mathematical competencies while demonstrating reliability, practicality, and suitability for evaluating learners from diverse educational backgrounds within inclusive classroom settings.

H 1: There is no significant difference in the performance scores of Grade- VIII students across different types of schools (government, private, aided).

The absence of testing for this proposed hypothesis indicates that there are many practical and contextual problems encountered typically in conducting educational research. Although the original intent of this research study was to compare the mathematical achievement of students from various types of school systems, the establishment of administrative boundaries as well as logistical constraints prevented the researcher from obtaining enough information to accurately represent the data from each classification of the school system in this study.

The researcher encountered many institutional regulations and administrative procedures that greatly restricted the time required to get permission from both government and assisted schools for the researcher to be able to complete a study. The researcher was therefore greatly hindered by several limitations including limitations placed on the ability to gain access to the schools due, in large part, to institutional and administrative regulations, which consequently impacted upon the amount of data the researcher could collect across many different educational venues.

Another challenge encountered by the researcher was the language barrier. Because of the high usage of Kannada as the primary medium of communication in many of the schools in which the data was collected, the researcher may have experienced difficulty with respect to communication and interaction with the subjects, consequently impacting on the feasibility of carrying out the assessment tool appropriately. Language-related challenges are extremely important issues for educational research because they may have a significant influence on rapport, clarity of directions, and overall administration of instruments.

Further, the timing of data collection coincided with the academic year-end period, including syllabus completion and annual examinations. During this period, schools generally prioritize academic preparation and examination activities, limiting opportunities for external research administration. Consequently, many schools were unable to allocate sufficient time for participation in the study.

Due to these constraints, the study was limited to private schools only. As a result, the findings of the present study cannot be generalized across all types of schools. The absence of data from government and aided schools restricted the possibility of conducting comparative statistical analysis regarding school-wise differences in mathematical performance.

The experience demonstrates the need for educational research to take into account administrative and contextual factors. Future studies could address the limitations of this study by providing multilingual support during administration of materials, including a longer collection of data, and through forming a collaborative agreement with schools well before the start of research. In addition, collecting data from more than one school location would provide an overall perspective for understanding the differences between student proficiency levels in math in different educational contexts.

Overall, this limitation did not influence the primary objectives related to the development and validation of the assessment tool; however, it restricted the scope of comparative analysis between different types of schools. Consequently, the hypothesis could not be adequately tested due to the lack of sufficient and representative data from the intended school categories.

RQ-2: To what extent does the assessment tool identify learning gaps in foundational mathematics (e.g., division, fractions, algebraic concepts)?

In this study, it was concluded that the developed mathematics assessment tool has effectively assessed the foundational math competencies of Grade-VIII students and determined their readiness to progress from Grade-VIII to Grade-IX. The tool also effectively identifies areas of strength and difficulty within different math domains.

The findings indicate that there is a need for additional instructional focus and reinforcement of understanding of mensuration, fractions, division, unit conversion and algebraic operation concepts, especially for students with hearing impairments, as these concepts represent the foundation for further advanced mathematical learning in later grades. As such, it is critical that students develop these skills in order to ensure a smooth academic progression into ninth grade and to facilitate their future success in ninth grade.

In addition, the study concluded that the developed mathematics assessment tool has practical educational use for identifying students' learning challenges in specific domains, assessing their foundational math competencies, and assisting in the instructional planning of educational services. Hence, it is a useful tool for teachers and educators to evaluate their students' mathematical performance and to provide appropriate remedial and supportive interventions for students with difficulties.

CHAPTER-6

SUMMARY AND CONCLUSION

6.1 Summary

Mathematics assessment forms an integral part of the teaching-learning process by providing insight into students' understanding and reasoning abilities, problem-solving capabilities, and overall achievement in mathematics. National and international educator frameworks agree (e.g., SDG-4; National Education Policy (NEP), 2020; Right to Education Act (RTE), 2009; National Curriculum Framework (NCF), 2005; CBSE assessment guidelines) that mathematics assessments must be fair, comprehensive, learner-centred, and inclusive in nature. There is little to no availability of a standardized mathematics assessment tool aligned with the Grade VIII curriculum and designed for typical developing and hearing-impaired students for use in inclusive educational settings. Therefore, this study was designed to develop and standardize a Grade-VIII Mathematics Assessment Tool for use in inclusive educational settings.

The primary goals of this study were to develop a curriculum-based Grade-VIII Mathematics Assessment Tool, establish validity and reliability, identify the benchmark performance ranges, and identify the appropriateness to assess the mathematics achievement of typical developing students, as well as deaf/hard of hearing students. Using a quantitative descriptive survey research design, this study included Grade-VIII students educated under NCERT, CBSE, and Karnataka State Board curricula. The study was completed in two separate phases.

To refine the assessment tool and examine the quality of the test items, a pilot study was conducted with 35 students in Grade VIII. The main study involved 109 typically developing students from three private schools, as well as 28 students with hearing impairments from a special school. The assessment was designed to measure three areas of learning: knowledge, comprehension, and application.

The assessment tool was designed to include the common content from the 13 chapters in mathematics used in the NCERT, CBSE, and Karnataka State Board curricula. To ensure adequate content area and cognitive domain representation, a blueprint was created. The first set of 89 test items was developed and sent for content validation by 12 experts (mathematics educators, teacher educators, and special educators). The items were altered to improve clarity, relevance, and appropriateness based on the responses of the experts. After pilot testing and item analysis, the unsuitable items were omitted. The final assessment consisted of 48 items (maximum score of 96 marks). The reliability of the tool (using Cronbach's alpha) was found to be 0.647; indicating the tool possesses acceptable internal consistency for the purpose of educational assessment.

The developed Grade-VIII mathematics assessment tool has been reported to have adequate validity, reliability, item difficulty, and discriminative power. This tool is able to distinguish between students who perform well and those who do not and is appropriate for use in school settings that include students with disabilities.

Assessment of the mathematics achievements of both typically developing students and those with hearing impairment showed that both younger and older children in both types of students are demonstrating adequate performance in the three domains of knowledge, understanding and applying. Students with hearing impairments achieved higher mean scores in both the knowledge and understanding domains, while both types of students scored similarly in the applying domain. In the applying domain, the results were variable, which suggests that children with hearing impairment differ in their ability to reason at higher levels or solve problems.

The results of the independent samples t-test showed that there are significant differences between both groups regarding total mathematics achievement. The results also showed that students with hearing loss had significantly higher total mathematics achievement than did typically developing students as measured across both total scores and percentage scores.

Students with hearing loss were able to perform math at a level that is equal or better than their typically developing peers when they received adequate instructional support, had access to visual learning opportunities, had assistance/accommodation provided through their classroom materials, and when they attended schools that provided a supportive educational environment.

Upper and lower benchmarks for many different levels of achievement were determined for all students using the Mean±1 SD method. The benchmarks for students with hearing loss were higher than those established for typically developing students, again reflecting the strong mathematics performance of these students. The assessment was found to be age-appropriate, accessible, and would allow for the assessment of Grade VIII students with hearing loss. The assessment tool has clear language, visual accessible content, and provides structured instructions to allow for the assessment of all students in an inclusive manner.

In this study, researchers examined specific difficulties experienced when trying to learn mathematics. Fractions, measurement, division, unit conversions and algebra were highlighted as areas that require targeted instruction and more academic support due to the conceptual challenges associated with them.

To conclude, the researchers developed and standardized a Grade VIII Mathematics Assessment Tool that is validated, reliable and appropriate to use when measuring mathematics achievement for both typically developing students and for students with hearing impairments. This tool will assist educators in identifying students' strengths and needs for future educational planning, as well as working toward implementing inclusive assessment practices within the school system.

6.2 Conclusion

6.2.1 Key Findings of the Study

The current study was undertaken to establish a Grade -VIII Mathematics Assessment Tool, based on the NCERT, CBSE and State board, and compare the mathematical ability of typically developing children versus children with a hearing impairment as represented by their score on this tool. Data analyses and interpretations generated the following results:

- A systematic procedure that included an item construction process, expert review, item analysis, and appropriate reliability estimates was utilized to develop and validate the Grade 8 Mathematics Assessment Tool.
- A review of the results indicated that the content validity of the tool was adequate; thus, the tool's evaluation criteria matched the NCERT curriculum's outlays for subject matter and objectives.
- The assessment instrument was valid for measuring students' knowledge, understanding, and application of mathematics to a stipulated degree.
- Most students in both groups performed at the expected grade level in mathematics.
- A statistically significant difference existed between the two groups' mathematics performance.
- Children with hearing impairment have, on average, scored higher than children who are typically developing. Contributing factors may be as a result of lower teacher-

student ratios; the teaching of visual instruction strategies; classes being revision-based prior to being tested; and having favourable conditions for testing.

- The findings of this research indicate that Curriculum Based Assessment tools can be used to effectively identify the student's strengths and weaknesses and provide the information for planning and implementing educational programs and appropriate interventions.

6.2.2 Limitations of the Study

Although the study met its objectives, several limitations should be considered when interpreting the findings and generalizing them to wider populations.

- Sample size was relatively small, which may limit the generalization of the results.
- The sample was drawn from selected schools only and may not represent all Grade VIII students across different educational settings.
- The study focused solely on Grade VIII Mathematics; therefore, findings cannot be generalized to other grades or subject areas.
- The developed tool has been found to have lower than acceptable coefficients of reliability, thereby indicating further refinement and/or development of the assessment tool is necessary.
- Other influencing factors (e.g. differing student/teacher ratios; differing methods of instruction; opportunities for visual learning; having undergone a current review prior to evaluation; timing of the evaluation) were not able to be controlled for and could possibly have impacted the results.
- Unequal representation of students across different school categories limited opportunities for more extensive comparative analyses.

6.2.3 Recommendations

Based on the study's finding and limitations, the following recommendations are proposed for educational practice and future result:

- Adopt the developed Grade VIII Mathematics Assessment Tool in classrooms and special education settings to assess students' mathematical achievement and identify specific learning needs.
- Develop similar curriculum-based assessment tools for other grades and subject areas to promote consistent, curriculum-aligned assessment practices.
- Promote inclusive and accessible assessment procedures to ensure meaningful participation by children with hearing impairment and other diverse learners.
- Use assessment results to inform individualized instruction, remedial programme, and targeted interventions.
- Conduct future studies with larger, more diverse samples to enhance generalization.
- Investigate mathematical performance across varied school settings and among students with different disabilities.
- Revise and re-validate the developed tool to improve its reliability and overall psychometric properties.
- Standardize the instrument on a larger sample and examine additional validity and reliability metrics to strengthen its applicability.
- Explore technology-based and digital assessment formats to increase accessibility, engagement, and efficiency in mathematics assessment.
- Replicate similar studies with other disability groups to evaluate the effectiveness of curriculum-based assessment tools in inclusive education.

The study underscores the importance of valid, inclusive assessment tools that accurately measures mathematical achievement and support evidence-based educational decision - making, especially for children with hearing impairment.

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Appendix -1

Grade Level Assessment Tool Mathematics Grade- VIII

GLAT-M(VIII)

SET-A

Time :3 Hours **Total Marks=96**

Choose the correct option:- **1×15=15**

1. Is 0 a rational number?

(a) Yes (b) No

(c) Sometimes (d) Only in integers

2. What is the general form of a linear equation in one variable?

(a) $ax + by = c$ (b) $ax + b = 0$

(c) $ax^2 + bx + c = 0$ (d) $x/y = k$

3. How many solutions does a linear equation in one variable have?

(a) No solution (b) One solution

(c) Two solutions (d) Infinite solutions

4. What is the name of a quadrilateral with all sides and all angles equal?

(a) Rectangle (b) Square

(c) Parallelogram (d) Kite

5. If one angle of a quadrilateral is 90° and the other three are equal, find each equal angle.

(a) 60° (b) 70°

(c) 80° (d) 90°

6. What is raw data?

(a) Data that is arranged in ascending order (b) Data that is summarized

(c) Unorganized and unprocessed (d) Data shown in a graph

7. Which digit never appears in the ones (units) place of a perfect square?

(a) 1 (b) 4

(c) 6 (d) 2

8. When the selling price of an article is more than its cost price, it is called:

(a) Loss (b) Discount

(c) Profit (d) Commission

9. The coordinates of the origin are:

(a) (1,1) (b) (0,1)

(c) (0,0) (d) (1,0)

10. More workers → Less days to finish work" represents which type of proportion?

(a) Direct proportion (b) Inverse proportion

(c) Compound proportion (d) Simple proportion

11. The coordinate form of a point is written as:

(a) x + y | (b) (x, y)

(c) x – y | (d) (xy)

12. In which quadrant are both x and y negative?

(a) First | (b) Second

(c) Third | (d) Fourth

13. The point (–4, 3) lies in which quadrant?

(a) First | (b) Second

(c) Third | (d) Fourth

14. Name the property of multiplication (32×53) ×710=32× (53×710).

(a) Commutative property | (b) Distributive property

(c) Associative property | (d) Identity property

15. Which of the following pairs best demonstrates the existence of an additive inverse in the set of integers?

(a) 7 and 1 | (b) –4 and 4

(c) 5 and –3 | (d) 0 and 1

Fill in the blanks :- **1×6=6**

16. The cube of all even numbers will always be…………...

17. 135.50% written as a number is ……………

18. 11: 5 expressed as a percentage is …………….

19. An example of a tri-nomial is …………….

20. Write the constant term in this expression: x^2+ 3x+2 is …………..

21. Which operations do not follow the commutative law for rational numbers?..................

Short Answer type questions (SA-1) **2×5=10**

22. Write the value of $(-3/5)^{-4}$.

23. Find the value of $(3^0+1^2+7^2)^3$.

24. Solve the equation : $\frac{7x}{5}=x-4$

25. Explain why a square is always a rectangle, but a rectangle is not always a square.

26. Find the number of sides of a regular polygon whose angle sum is 1260°.

SET-B

Short Answer type questions (SA-2) 2×8=16

27. The following data gives the number of children in 20 families:

1,1,2,3,2,3,4,5,1,5,4,1,2,4,2,2,1,3,3,2. Arrange the data in a frequency table.

28. Draw the histogram to present the following data:

Monthly income(rupees)	5000-5500	5500-6000	6000-6500	6500-7000	7000-7500
Number of workers	5	8	16	18	13

29. Check whether the given numbers are perfect cubes. (a).200 (b).343

30. A metallic cuboid of dimensions 4 cm × 6 cm × 9 cm is melted and reshaped into a cube. Find the side length of the cube.

31. The price of a scooter was ₹34,000 last year. This year, the price increased by 20%. What is the present price of the scooter?

32. The price of a TV is ₹13,000. A 12% sales tax is charged on it. How much money will Vinod have to pay to buy the TV?

33. Multiply the given expression (a+b)(2a-3b+c).

34. Find the curved surface area and total surface area of a right circular cylinder whose height and radius of the base are 20cm and 7cm, respectively.

Long Answer type questions (LA-1) **5×8=40**

35.Solve the equation for x : $\frac{3-5x}{7}-\frac{x}{4}=\frac{1}{2}+\frac{5-4x}{8}$

36. The ages of Anjali and Malti are in the ratio 3:4. Eight years later, the sum of their ages will be 44 years. What are their present ages?

37. The following frequency distribution table represents the marks scored by a group of students in a test:

Marks	0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36
Number of students	10	25	40	93	97	70	30	50	5

Read the table and answer the following questions.

(a)How many students have scored marks ≥ 24?

(b) What is the total number of students who took the test?

(c)What is the class mark of the class interval with frequency 25?

(d)How many students scored less than 20 marks?

(e)What percentage of students scored less than 16 marks?

38. The following data shows the expenditure of a person on different items during a month. Represents the data in a pie chart.

Item of expenditures	Rent	Education	Food	Clothing	Others
Amount	2700	1800	2400	1500	2400

39. There are 500 children in a school. For a P.T. drill, they have to stand in such a manner that the number of rows is equal to the number of columns. How many children would be left out in this arrangement?

Short Answer type questions (SA-3) **2×7=18**

40. The perimeter of one face of a cube is 20cm. Find the volume of the cube.

41. A godown is in the form of a cuboid of measures 60 m × 40 m × 30 m. How many cuboidal boxes can be stored in it if the volume of one box is 0.8 m^3?

42. $(-4)^{-3} \times (5)^{-3} \times (-5)^{-3}$

43. Find the value of m for which $5^m \div 5^{-3} = 5^5$

44. Use the Exponents to express small Numbers in Standard form.

Charge of an electron is 0.000,000,000,000,000,000,16 coulomb.

45. Evaluate the given expression $(1.23)^2 - (0.73)^2 \div (1.23+0.73)$.

46. A train is moving at a uniform speed of 75 km/hour.

(i) How far will it travel in 20 minutes?

(ii) Find the time required to cover a distance of 250 km.

Long Answer type questions (LA-2) 5×2=10

47. A road roller takes 750 complete revolutions to move once over to level a road. Find theareas of the road if the diameter of a road roller is 84 cm and the length is 1 m.

48. Draw a graph for the following

(i)

Side of the square (in cm)	2	3	3.5	5	6	7	8
Perimeter (in cm)	8	12	14	20	24	28	32

(ii)

Side of the square (in cm)	2	3	4	5	6	7	8
Area (in cm)	4	9	16	25	36	49	64

APPENDIX-2

Grade Level Assessment Tool Mathematics-Grade-VIII

GLAT-M(VIII)

Scoring Sheet

Name: Age:

Section -A	Marks per question	Obtained marks

I. Choose the correct answer $1\times15=15$

Q. No-1	0-1	
Q. No-2	0-1	
Q. No-3	0-1	
Q. No-4	0-1	
Q. No-5	0-1	
Q. No-6	0-1	
Q. No-7	0-1	
Q. No-8	0-1	
Q. No-9	0-1	
Q. No-10	0-1	
Q. No-11	0-1	
Q. No-12	0-1	
Q. No-13	0-1	
Q. No-14	0-1	
Q. No-15	0-1	
	Total =15	=

Fill in the blanks **$1\times6=6$**

Q. No-16	0-1	
Q. No-17	0-1	
Q. No-18	0-1	

Q. No-19	0-1	
Q. No-20	0-1	
Q. No-21	0-1	
	Total=6	=

Short answer type questions - 1 **2 ×5 = 10**

Q. No-22	0-2	
Q. No-23	0-2	
Q. No-24	0-2	
Q. No-25	0-2	
Q. No-26	0-2	
	Total=10	**Total**

Section -B	Marks per question	Obtained marks

Short answer type question-2 **2×8 =16**

Q. No-27	0-2	
Q. No-28	0-2	
Q. No-29	0-2	
Q. No-30	0-2	
Q. No-31	0-2	
Q. No-32	0-2	
Q. No-33	0-2	
Q. No-34	0-2	
	Total=16	**Total=**

Long answer type questions-1 **5×5 = 25**

Q. No-35	0-5	
Q. No-36	0-5	

Q. No-37	0-5	
Q. No-38	0-5	
Q. No-39	0-5	
	Total =25	**Total=**

Short answer type question-3 **2×7 =14**

Q. No-40	0-2	
Q. No-41	0-2	
Q. No-42	0-2	
Q. No-43	0-2	
Q. No-44	0-2	
Q. No-45	0-2	
Q. No-46	0-2	
	Total=14	**Total=**

Long answer type questions-2 **5×2 = 10**

Q. No-47	0-5	
Q. No-48	0-5	
	Total =10	**Total=**

Grand total=98	Obtained total scores =	Percentage=

Answer key

Section-A

Choose the correct answer

1. Is 0 a rational number?

A rational number is of the form p/q, where q ≠ 0. $0=\frac{0}{1}$

Since it can be written in the form p/q,

Answer: (a) Yes

2. General form of a linear equation in one variable

A linear equation in one variable has only one variable and a highest power of 1.

General form: $\boldsymbol{ax+b=0}$

Answer: (b) ax + b = 0

3. Number of solutions of a linear equation in one variable

A linear equation in one variable always has one unique solution.

Answer: (b) One solution

4. Quadrilateral with all sides and all angles equal

- Rectangle → angles equal, sides not all equal
- Square → all sides equal + all angles 90°

Answer: (b) Square

5. One angle = 90°, other three equal

Sum of angles of quadrilateral = 360°

Let each equal angle = x, $90° + x+x+x=360°$

$90+3x=360$

$3x=270$

$x=90°$

Answer: (d) 90°

6. Raw data

Raw data = Unorganized and unprocessed data.

Answer: (c)

7. Digit never appearing in unit place of perfect square

Perfect squares can end in: 0, 1, 4, 5, 6, 9

Digit 2 never appears.

Answer: (d) 2

8. Selling price > Cost price When SP > CP → Profit

Answer: (c) Profit

9. Coordinates of origin

Origin = (0, 0)

Answer: (c)

10. More workers → less days

Workers × Days = constant More workers → fewer days

This is Inverse proportion

Answer: (b)

11. Coordinate form of a point

Written as: (x, y)

Answer: (b)

12. Quadrant where x and y both negative

Third Quadrant

Answer: (c)

13. Point (–4, 3)

x negative, y positive → Second Quadrant

Answer: (b)

14. $(a \times b) \times c = a \times (b \times c)$

This is Associative Property of Multiplication

Answer: (c)

15. Additive inverse in integers

Additive inverse → sum = 0 $-4+4=0$

Answer:(b)

Fill in the blanks

16. Cube of even number

Even × even × even = even

Answer: Even

17. 135.50% as number

$\frac{135.50}{100}$ **=1.355**

18. 11: 5 as percentage

$\frac{11}{5} \times 100$ **=220%**

19. Example of trinomial

Three terms: x^2+3x+2

20. Constant term in x^2+5

Constant = term without a variable

Answer: 5

21. Operations not commutative in rational numbers

Subtraction and Division

Example **:5-3≠3-5, 6÷2≠2÷6**

Short Answer type questions-1

22. Using the law of exponents:

$a^{-n} = \frac{1}{a^n}$ $\left(-\frac{3}{5}\right)^{-4} = \left(-\frac{5}{3}\right)^{4}$

Since the power is even, the result is positive: $= \frac{5^4}{3^4} = \frac{625}{81}$

Answer: $\boxed{\frac{625}{81}}$

23. $\mathbf{(3^0+1^2+7^2)^3}$**.** $X^0 = 1$

$(1+1+49)^3$ $\Rightarrow (51)^3 = 132651$

Answer:132651

24.

5x-20 =7x

=> -20=2x

Answer: X= -10

25.

Parallelogram	Rectangle
Opposite sides are equal and parallel.	Opposite sides are equal and parallel.
Opposite angles are equal, but angles are not necessarily 90°.	All four angles are 90°.
Diagonals bisect each other but are not equal in general.	Diagonals bisect each other and are equal.
Adjacent sides are not necessarily equal.	Adjacent sides may be unequal, but all angles are right angles.

Conclusion:

Every rectangle is a parallelogram, but every parallelogram is not a rectangle because a rectangle must have all angles equal to 90°.

26.

The sum of interior angles of a polygon is given by: $(n-2)\times180^\circ(n - 2)$

Given: $(n-2)\times180^\circ=1260^\circ$

Now divide both sides by 180:

$n-2 = \frac{1260}{180}$ => $n-2=7$ => $n=7+2$ **$n=9$**

Therefore, the polygon has **9 sides**.

Section-B

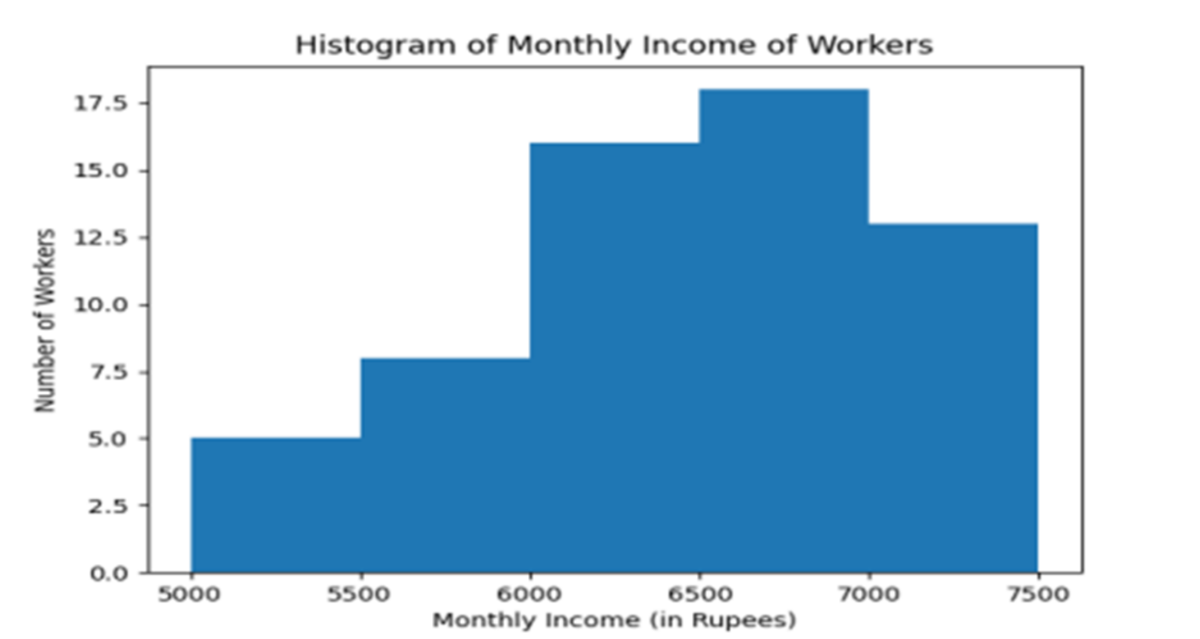
Short Answer type questions-2

27.

Number of Children	**Number of Families (Frequency)**
1	5
2	6
3	4
4	3
5.	2
Total	**20**

28.The histogram representing the monthly income distribution of workers has been drawn above. **Class width = 500**

The bars are continuous because the data is grouped in continuous intervals.



29.

(a) 200

tep 1: Prime factorization

$200=2\times2\times2\times5\times5$ $=2^3\times5^2$

Step 2: Check powers

Power of 2 = 3 (multiple of 3) Power of 5 = 2 (not a multiple of 3)

Since all powers are not multiples of 3, **200 is NOT a perfect cube.**

(b) 343

Step 1: Prime factorization $343=7\times7\times7$ $343=7^3$

Step 2: Check power Power of 7 = 3 (multiple of 3)

343 is a perfect cube.

Also, $^3\sqrt{343} = 7^3$

Final Answers: (a) 200 → Not a perfect cube (**b) 343** → Perfect cube **(Cube root = 7)**

30.

Find the volume of the cuboid

Volume of cuboid = l×b×h =>4×6×9 =216cm3

Let the side of the cube be a => Volume of cube = a^3

Since the metal is melted and reshaped, **volume remains same**: $a^3=216$

Find cube root a= 3√216 a =6

Because: $6^3=216$ **Side of the cube=6 cm**

31.Original price of scooter = ₹34,000

Increase = 20% $\frac{20}{100}$x3400 =6800

Present price = 34000+6800 =**40800₹**

32.Price of TV = ₹13,000

Sales tax = 12%

Step 1: Find 12% of ₹13,000 $\frac{12}{100}\times13000 = 1560$

Step 2: Find total amount to be paid

Total Amount=13,000+1,560 =14560₹

Vinod will have to pay ₹14,560.

33. Multiply:(a+b) (2a−3b+c)

Step 1: Distribute a Step 2: Distribute b

$a(2a-3b+c) = 2a^2-3ab+ac$ $b(2a-3b+c)=2ab-3b^2+bc$

Step 3: Add the terms

Final Answer: $\mathbf{2a^2-ab-3b^2+ac+bc}$

34.

Given: Radius (r)=7 cm Height(h)=20 cm

Curved Surface Area (CSA) Formula: CSA=2πrh

Substitute values: $=2\times\pi\times7\times20$ Using $\pi=\frac{22}{7}$

$=2\times\frac{22}{7}\times7\times20$ $=2\times22\times20 = 880\ \text{cm}^2$

Total Surface Area (TSA) Formula :**2πr(h +r)**

$F=2\times722\times7\times(20+7)$ Using $\pi=\frac{22}{7}$

$=2\times\frac{22}{7}\times7\times(20+7)$ $=2\times22\times27 = 1188\ \text{cm}^2$

Final Answers: Curved Surface Area = 880 cm² **Total Surface Area =** 1188 cm²

Long Answer type questions -1

35. $\frac{3-5x}{7}-\frac{x}{4}=\frac{1}{2}+\frac{5-4x}{8}$

Step 1: Take LCM of denominators

LCM of 7,4,2,8 =56

Multiply the whole equation by 56: => $56\times\frac{3-5x}{7}-56\times\frac{x}{4}=56\times\frac{1}{2}+56\times\frac{5-4x}{8}$

Simplify each term; $8(3-5x)-14x=28+7(5-4x)$

$=24-40x-14x=28=35-28x$ $\Rightarrow 24-54x=63-28x$

Step 3 Bringing like terms together

$24-63=-28X+54X$ $\Rightarrow -39=26X$

$X= -\frac{39}{26}$ $\mathbf{x=\frac{-3}{2}}$

36. Given:

Ratio of ages = **3: 4**

Step 1: Let present ages be Anjali = 3x, Malti = 4x

Step 2: After 8 years

Anjali's age = $3x + 8$ Malti's age = $4x + 8$

Sum after 8 years = 44

$(3x+8) +(4x+8)=44$ $\Rightarrow 3x+4x+16=44$ $=7x+16=44$

$\Rightarrow 7x=44-16$ $\Rightarrow 7x=28$ $\mathbf{x=4}$

present ages: Anjali **= 3×4=12years** Malti **= 4×4=16years**

37.A. How many students have scored marks ≥ 24?

Total = 30 + 50 + 5 = **85 students**

B. What is the total number of students who took the test?

10 + 25 + 40 + 93 + 97 + 70 + 30 + 50 + 5 = **420 students**

C. What is the class mark of the class interval with frequency 25?

Frequency 25 corresponds to class interval **4–8**.

Class mark formula: $\frac{\text{lower limit+Upper limits}}{2}$ => $\frac{4+8}{2}$ =6

Class mark = 6

D. How many students scored less than 20 marks?

Classes less than 20:

Total = 10 + 25 + 40 + 93 + 97 = **265 students**

E. What percentage of students scored less than 16 marks?

Total = 10 + 25 + 40 + 93 = **168 students** Total students = 420

Percentage= $\frac{168}{420}$ ×100 =40% **Percentage = 40%**

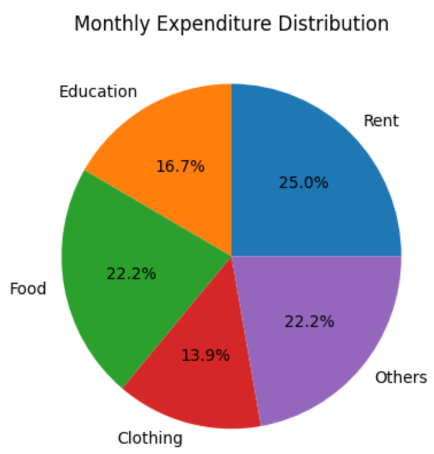
38. The pie chart represents the distribution of monthly expenditure.

Total Expenditure = 2700 + 1800 + 2400 + 1500 + 2400 = **₹10,800**

Rent: $\frac{2700}{10800}$×360=90∘ Education: $\frac{1800}{10800}$×360=60∘

Food: $\frac{2400}{10800}$×360=80∘ Clothing: $\frac{1500}{10800}$×360=50∘

Others: $\frac{2400}{10800}$×360=80∘



39.For a P.T. drill, the number of rows = number of columns.

So, children must stand in a **square formation**.

We need the greatest perfect square less than or equal to 500.

$22^2=484$ $23^2 = 529 > 500$

So, the maximum square arrangement possible is: $22×22=484$

Children left out: 500−484=16500 - 484 = 16500−484=16

Answer: 16 children would be left out.

Short Answer type questions-3

40.A face of a cube is a **square**.

Step 1: Find the side of the cube

Perimeter of square = 4×side

Given: 4a=20 => $a=\frac{20}{4}$ **a= 5cm**

Step 2: Find the volume of the cube

Volume=a^3 $v = 5^3 = 125cm^3$

Final Answer: Volume of the cube=125cm^3

41. Given:

Dimensions of godown (cuboid): 60m×40m×30m

Volume of one box = **0.8 m³**

Step 1: Find volume of the godown

Volume= l×b×h => $60×40×30 = 72{,}000m^3$

Step 2: Find number of boxes

Number of boxes = $\frac{Volume\ of\ godown}{Volume\ of\ one\ box}$ => $\frac{72000}{\mathbf{0.8}}$ =90,000

Number of boxes will be **90000 ₹**

42. $(-4)^{-3} \times (5)^{-3} \times (-5)^{-3}$

Step 1: Use the rule A-n= $\frac{1}{A^n}$

$(-4)^{-3}$ => $\frac{1}{(-4)3}$ => $\frac{1}{-64}$

$(5)^{-3}$ => $\frac{1}{(5)3}$ => $\frac{1}{125}$

$(-5)^{-3}$ => $\frac{1}{(-5)3}$ => $\frac{1}{-125}$

Step 2: Multiply $\frac{1}{-64} \times \frac{1}{125} \times \frac{1}{-125}$ $= \frac{1}{\mathbf{1,00,000}}$

43. Find the value of m for which $5^m \div 5^{-3} = 5^5$

Step 1: Use the law of exponents $5^x \div 5^y = 5^{x-y}$

$5^m \div 5^{-3} = 5^{m-(-3)}$ => 5^{m+3}

Step 2: Equate powers $5^{m+3} = 5^5$

Since bases are same, compare exponents: m+3=5 => m=5-3

m=2

43. Given:

Charge of an electron =0.00000000000000000016 coulomb

Step 1: Count decimal places

Move the decimal point to the right until one non-zero digit remains before the decimal.1.6

The decimal is moved **19 places** to the right.

Step 2: Write in standard form 1.6×10^{-19}

Final Answer: 1.6×10−19 coulomb

45. Solve $(1.23)^2-(0.73)^2 \div (1.23+0.73)$

Using formula :$(a)^2-(b)^2=(a+b)(a-b)$

$$\frac{(1.23+0.73)(1.23-0.73)}{(1.23+0.73)} \Rightarrow (1.23-0.73)$$

= 0.50

46. Given:

Speed of train = 75 km/hour

(i) Distance travelled in 20 minutes

Step 1: Convert minutes into hours 20 minutes= $\frac{20}{60}=\frac{1}{3}$ hour

Step 2: Use formula Distance=Speed×Time

$=75\times\frac{1}{3}=25$km =25 km

(ii) Time required to cover 250 km

Step 1: Use formula Time= $\frac{\text{Distance}}{\textit{speed}}$ $\Rightarrow\frac{250}{75}$ $=\frac{10}{3}$ **hours**

$3\frac{1}{3}$ => 3 hours 20 minutes

Final Answers: (1) 25 km (ii) 3 hours 20 minutes

Long Answer type questions (LA-2)

47.

Given:

Number of revolutions = **750** Diameter = **84 cm** Length = **1 m**

Convert everything into meters:

Diameter = 84 cm = **0.84 m**

Radius = $\frac{0.84}{2}$ = 0.42m Length = **1 m**

Step 1: Area covered in one revolution

In one revolution, the roller covers an area equal to its **curved surface area**.

Area in one revolution=Circumference Length $=2\pi rl$

$2\times\frac{22}{7}\times0.42\times1 \Rightarrow \frac{44\times 42}{7\times100} \Rightarrow \frac{264}{100}$

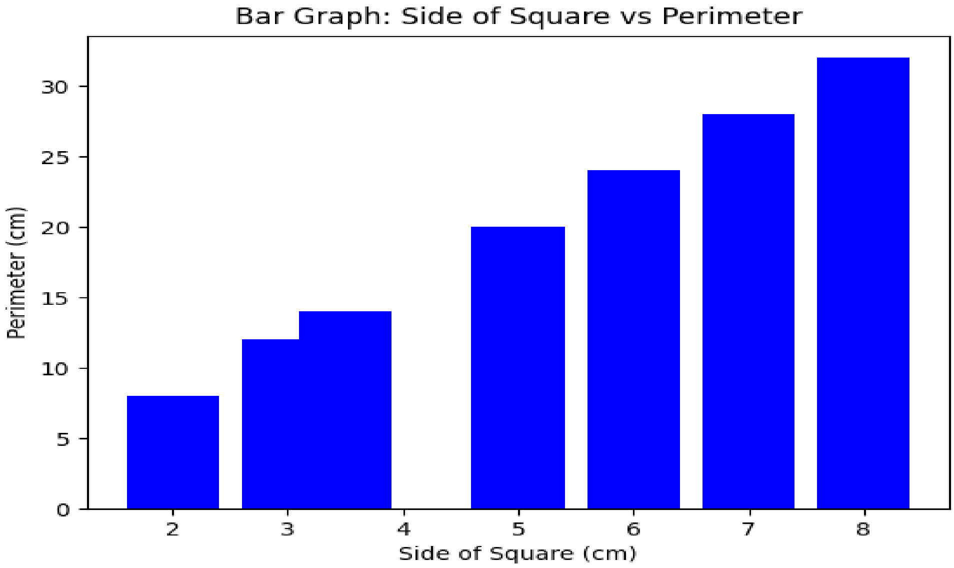
$=2.64m^2$

Step 2: Area covered in 750 revolutions

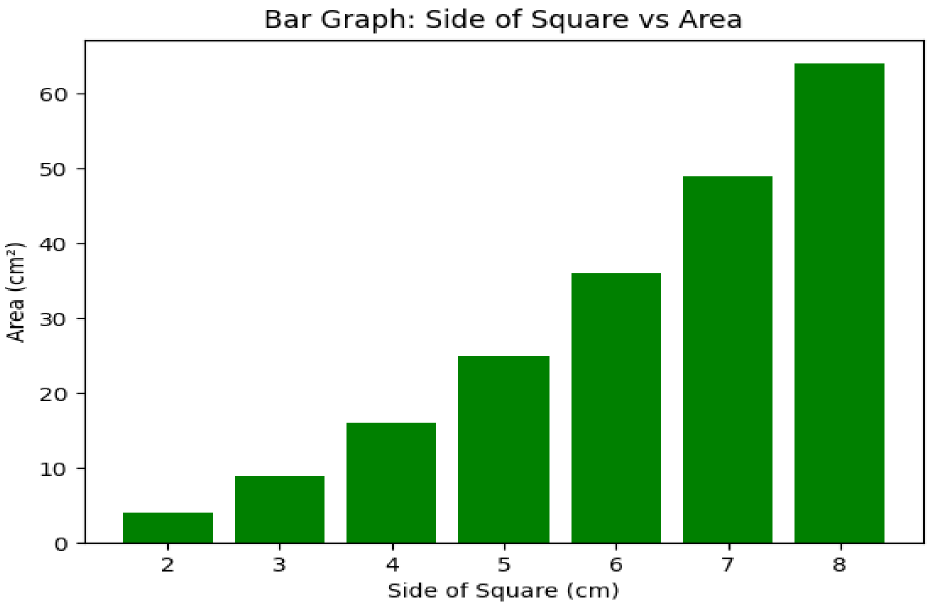
$=2.64\times750$

$=1980m^2$

48. (i)


Bar Graph: Side of Square vs Perimeter
Perimeter (cm)
0
5
10
15
20
25
30
2
3
4
5
6
7
8
Side of Square (cm)

(ii)


Bar Graph: Side of Square vs Area
Area (cm²)
0
10
20
30
40
50
60
2
3
4
5
6
7
8
Side of Square (cm)

Appendix-4

Rubrics for Tool

Rubrics for: 1 Mark questions

Criteria	Marks
Incorrect answer	0 mark
No answer / Blank	0 mark
Correct answer	1 mark
Total	1 mark

Rubric for 2-Mark Questions

Criteria	Marks
Wrong formula / no steps / irrelevant work	0 Mark
Formula + correct steps (even if final answer is wrong)	1 Mark
Correct values with+ correct final answer	1 Mark
Total Marks	2 Marks

Rubric for 5-Mark Questions

Criteria	Marks
Wrong formula / no steps / irrelevant work	0 Mark
Formula + correct steps (even if final answer is wrong)	2 Mark
Correct values with + correct Calculation	2 Mark
Correct Answer with Units	1 Marks
Total:	5 Marks

Rubric for 5-Mark Question: Plotting GRAPH

Criteria	Marks
Wrong formula / no steps / irrelevant work	0 Mark
Understanding X-Axis	1 Mark
Understanding Y-Axis	1 Mark
Plotting points on Graph paper neatly and appropriately	3 Marks
Total Marks	5 Marks

Appendix-5

Domain wise division of items

Sr.No	Level	Item Number	No.0f Item
1.	**Knowledge**	1, 2, 3, 4, 6,8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21,	19
2.	**Understanding**	5, 7,22, 23, 24,25, 27,29,33,35,37,42,43,44	14
3.	**Application**	26,28,30,31,32,34,36,38,39,40,41,45,46,47,48	15
	Total		**=48**

Appemdix-6

To

The Head of the Institution: Christ public School

Date: 23/01/2026

Subject: Request for Permission to Conduct Pilot Testing for M.Ed. Dissertation Research

Respected Sir/Madam,

I, Mr Vibhuti Kumar Jha, am pursuing M.Ed. (Special Education – Hearing Impairment) at the All India Institute of Speech and Hearing (AIISH), Mysuru. As part of my dissertation titled "Development of a Grade-Level Assessment Tool in Mathematics for Grade VIII Students," I seek permission to conduct pilot testing of the developed assessment tool in your institution.

The pilot testing aims to examine the clarity, appropriateness of language, difficulty level, and feasibility of the tool. It will be administered to a small sample of typically developing Grade VIII students during school hours at a time convenient to the institution.

I assure you that participation will be strictly for academic research purposes, and confidentiality and ethical guidelines will be strictly maintained.

I kindly request that you grant permission for this.

Thanking you for your kind cooperation.

Signature of Guide:

CHRIST PUBLIC SCHOOL

Yours sincerely,

Mr Vibhuti Kumar Jha

M.Ed. (Special Education – HI)

AIISH, Mysuru

Appemdix-7

ASSENT FORM FOR DATA COLLECTION

Title of the Study:
Development of a Grade-Level Assessment Tool in Mathematics for Grade VIII Students

Name of the Researcher:
Mr Vibhuti Kumar Jha
M.Ed.SPL Ed(HI)AIISH, Mysuru

Purpose of the Study:
This study is conducted for academic research as part of the M.Ed. dissertation.

Information for the Student

You are requested to take part in this study. The purpose of this study is to develop and try out a mathematics test for students of Class VIII.

If you agree to participate, you will be asked to answer some mathematics questions during school hours. This activity will not cause any harm or discomfort. Your participation will not affect your school marks or examinations.

Your participation is voluntary. You are free to say no or to stop participating at any time. All information collected from you will be kept confidential and used only for research purposes.

If you understand the above information and are willing to participate, please sign below to give your assent.

Student's Assent

I have understood the information given above. I agree to participate in this research study willingly.

Name of the Student: Sumith gabriel
Class & Section: VIII A1
Signature / Thumb Impression: Sumith gabriel
Date: 23/1/26

Researcher's Declaration

I have explained the purpose of the study to the student in simple language and assured confidentiality.

Signature of the Researcher: [signature]
Date: 23/01/26

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Photos during data collection