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RESEARCH ARTICLE

SPECIFIC DIFFICULTIES AND ERRORS PATTERNS EXHIBITED BY STUDENTS WITH MATHEMATICS LEARNING DISABILITY IN PRACTICAL GEOMETRY OF UPPER PRIMARY LEVEL

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Abstract

The present study examined the specific difficulties and error patterns exhibited by Upper Primary School (Grade VIII)Students with Mathematics Learning Disability (MLD) in Practical Geometry. A Mathematics Diagnostic Test in Practical Geometry was developed and administered to identify criterion-wise difficulties and errors in construction-based tasks. The analysis revealed that students experienced considerable difficulties in understanding construction and sequencing procedures correctly, using geometric instruments accurately, and maintaining precision in constructions. The errors committed reflected underlying conceptual and procedural difficulties. The findings emphasize the importance of diagnostic assessment in Practical Geometry and provide a sound basis for informed instructional planning and academic support for students with Mathematics Learning Disability.

Introduction:-

Mathematics Learning Disability (MLD) orSpecific Learning Disability in Mathematics refers to a specific neurodevelopmental disorder in which students exhibit persistent and significant difficulties in understanding and performing mathematical tasks, despite having average or above-average intelligence and receiving adequate instruction. These difficulties are not attributable to sensory impairments, emotional disturbances, or socio-cultural deprivation, but arise from deficits in underlying cognitive processes such as working memory, visual–spatial processing, logical reasoning, attention, and procedural sequencing.Students with MLD commonly experience problems in comprehending mathematical concepts, applying rules accurately, recalling procedures, and executing multi-step operations. In geometry, especially Practical Geometry**,** these difficulties manifest as an inability to visualize geometric relationships, follow construction steps sequentially, and maintain accuracy while using geometric instruments. Such errors are often repetitive rather than incidental. Supporting this view, Ramaa and Gowramma (1999) reported that high school students with learning disability committed consistent and patterned errors in geometry constructions, indicating weaknesses in procedural understanding and rule application. Further, Nair (2015) emphasized that geometry-related difficulties among students with learning disabilities are largely rooted in poor conceptual clarity and the absence of proper diagnostic identification of specific learning gaps.

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Thus, Mathematics Learning Disability significantly affects students' performance in Practical Geometry and necessitates systematic difficulty analysis and error analysis to inform effective instructional planning and remediation.

Need and Importance of the Study:-

Practical Geometry requires students to apply geometric concepts through accurate constructions, demanding precision, sequential thinking, and effective use of instruments. Students with Mathematics Learning Disability often struggle with these requirements, leading to persistent difficulties and repeated errors in geometry constructions. If such difficulties remain unidentified, they negatively affect students' overall achievement and confidence in mathematics.Previous studies have highlighted that students with learning disabilities exhibit difficulties and characteristic errors in geometry tasks. Ramaa and Gowramma (1999) emphasized that geometry-related errors among students with learning disability are not random but arise from specific procedural and conceptual weaknesses. Nair (2015) further pointed out that without proper diagnostic assessment, these learning difficulties often go unnoticed in regular classroom instruction.Despite these findings, there is a lack of focused diagnostic studies examining the specific difficulties and error patterns in Practical Geometry at the Grade VIII level. Identifying these difficulties is essential for planning appropriate instructional strategies and remedial support. Therefore, the present study is important as it provides a detailed diagnostic analysis of students' difficulties and errors in Practical Geometry, offering valuable insights for teachers, curriculum planners, and teacher educators to improve instructional practices for students with Mathematics Learning Disability.

Review Of Related Literature: -

Research in mathematics education has consistently shown that students with Mathematics Learning Disability experience persistent difficulties in geometry, particularly in construction-based tasks that demand sequential reasoning, spatial visualization, and precision. Practical Geometry requires learners to understand geometric relationships and execute step-wise procedures accurately, which often becomes challenging for students with learning difficulties.Studies conducted in the Indian context have provided important insights into the nature of these difficulties. Ramaa (1994) emphasized that students with learning disabilities often exhibit weak conceptual understanding and poor procedural control, leading to repeated errors in mathematical tasks. In a later study, Ramaa and Gowramma (1999) reported that high school students with learning disability committed errors in geometry constructions, indicating that such errors were characteristic of underlying procedural and conceptual weaknesses rather than careless mistakes. Their findings highlighted the importance of diagnosing specific error patterns to understand students' learning problems in geometry.

Emphasizing the role of diagnosis, Nair (2015) stated that criterion-based diagnostic assessment is essential for identifying specific learning difficulties in mathematics. According to Nair, conventional achievement tests fail to reveal detailed learning gaps, whereas diagnostic analysis enables the identification of precise difficulties related to concepts, procedures, and use of instruments, which are particularly relevant in Practical Geometry.From a methodological perspective, Garrett (1981) stressed that systematic analysis of students' responses is crucial for understanding learning difficulties and error patterns. His work provides the statistical foundation for analyzing item-wise performance and supports the use of diagnostic techniques in educational research.International studies also support the need for focused analysis of mathematical difficulties among students with learning disabilities. Fuchs and Fuchs (2001) observed that students with learning difficulties demonstrate consistent and predictable patterns of errors in mathematics, underscoring the importance of identifying specific areas of difficulty for instructional planning. Similarly, Witzel, Mercer, and Miller (2003) pointed out that difficulties in mathematics often arise from inadequate understanding of procedural steps, a concern that is highly relevant to construction-based geometry tasks.

A review of the existing literature thus reveals that, although several studies have examined mathematics learning difficulties, limited research has focused specifically on the diagnostic analysis of Practical Geometry at the Grade VIII level, particularly in terms of identifying specific difficulties and error patterns. This gap in research establishes the relevance of the present study, which aims to diagnose the difficulties and errors exhibited by Grade VIII students with Mathematics Learning Disability in Practical Geometry.

Review of Studies Related to Psychological Factors Associated with Mathematics Learning Disability Cogniti ve Processing Deficits:-

Research consistently identifies deficits in working memory, attention, and processing speed as central psychological factors associated with Mathematics Learning Disability (MLD). Learners with MLD struggle to retain intermediate steps, sustain attention during multi-step tasks, and process numerical and spatial information efficiently, resulting in frequent procedural errors (Geary, 1993, 2004; Swanson, 2006; Passolunghi, 2007). In practical geometry, these deficits limit the ability to remember construction sequences and coordinate spatial relationships accurately (Bull andJohnston, 1997; Gathercole andPickering, 2000).

Number Sense Impairment:-

Number sense impairment is widely recognized as a core psychological characteristic of MLD. Learners often show weak understanding of numerical magnitude, estimation, and proportional relationships, which restricts the development of mathematical concepts across domains (Butterworth, 1999, 2005; Dehaene, 2001, 2011; Geary, 2004). In geometry, such impairment adversely affects measurement, scaling, similarity, and coordinate geometry (Jordan et al., 2002; Mazzocco andThompson, 2005).

Executive Functioning Difficulties:-

Executive functioning deficits involving planning, inhibition, cognitive flexibility, and self-monitoring significantly contribute to MLD. These difficulties interfere with strategy selection, organization of solution steps, and error monitoring during mathematical tasks (Bull &Scerif, 2001; PassolunghiandSiegel, 2004; Swanson, 2006). In geometry, poor executive control results in incomplete constructions, incorrect sequencing, and faulty application of geometric rules (Geary, 2011; Mazzocco andKover, 2007).

Mathematical Anxiety:-

Mathematical anxiety has been shown to have a strong negative relationship with mathematics achievement. Anxiety consumes working memory resources, thereby reducing efficiency in problem solving and increasing avoidance behaviors among learners with MLD (Hembree, 1990; Ma, 1999; Ashcraft, 2002). In geometry, anxiety often leads to avoidance of visually complex tasks such as diagram interpretation and constructions (Ramirez &Beilock, 2011; Dowker, 2012).

Low Self-Esteem and Motivation:-

Repeated failure experiences in mathematics negatively influence learners' self-efficacy, academic self-concept, and motivation. Students with MLD often develop beliefs of low mathematical competence, leading to task avoidance and reduced persistence (Bandura, 1997; Chapman, 1988; Marsh andCraven, 2006). In geometry, low self-esteem discourages engagement with construction-based and spatially demanding tasks (Mazzocco, 2007).

Language and Symbol Processing Difficulties:-

Learners with MLD frequently experience difficulty understanding mathematical vocabulary, symbols, and verbal problem statements. These language-related weaknesses affect the correct interpretation of instructions and selection of appropriate operations (Jordan andHanich, 2000; Fuchs andFuchs, 2002; Swanson andBeebe-Frankenberger, 2004). In geometry, misinterpretation of definitions, theorems, and symbolic notations leads to conceptual misunderstandings (PassolunghiandPazzaglia, 2004).

Visual–Spatial Processing Deficits:-

Visual–spatial processing deficits are strongly associated with MLD, particularly in tasks involving shape recognition, spatial visualization, and transformations. Learners often struggle with interpreting geometric representations and spatial relationships (Kosc, 1974; Rourke, 1995; Geary, 1993). Research indicates that weaknesses in visuospatial working memory significantly predict poor performance in geometry and related mathematical tasks (Landerl et al., 2004; Mammarella et al., 2015).

Attention-Related Problems:-

Attention-related difficulties, including poor sustained attention and distractibility, are commonly observed among learners with MLD. These problems contribute to careless errors, incomplete solutions, and inconsistent performance in mathematical tasks (Barkley, 1997; Swanson, 2006). In geometry, attention deficits interfere with accurate drawing, measuring, and following step-by-step construction procedures (DuPaul andStoner, 2014; Mazzocco andRäsänen, 2013).

Emotional and Behavioral Factors:-

Emotional and behavioral factors often emerge as secondary consequences of persistent mathematical difficulty. Learners with MLD frequently experience frustration, avoidance, withdrawal, and learned helplessness, which reduce engagement and effective learning opportunities (McLeod, 1992; Gresham, 2002; Hallahan andKauffman, 2006). In geometry, such behaviors limit sustained participation in visually demanding and cognitively complex tasks (Wentzel, 1998; Mazzocco, 2007).

Objectives of the Study: -

1. To analyze the specific difficulties encountered by Grade VIII students with Mathematical Learning Disability while performing problems related to Practical Geometry.
2. To analyze the errors committed by Grade VIII students with Mathematical Learning Disability while performing problems related to Practical Geometry.

Research Questions: -

1. What specific difficulties are encountered by Grade VIII students with Mathematical Learning Disability while performing construction tasks related to Practical Geometry?
2. What kinds of errors are committed by Grade VIII students with Mathematical Learning Disability while solving problems related to Practical Geometry?

Methodology: -

The present studyis of diagnostic in nature and is designed to identify the specific difficulties and error patterns exhibited by Grade VIII students with Mathematics Learning Disability in Practical Geometry. The focus of the study was on examining criterion-wise difficulties and errors in construction-based geometry tasks to obtain an in-depth understanding of students' learning problems.

Sample:-

The sample for the present study was selected through a purposive sampling technique, combined with a multi-phase identification procedure, as the study specifically focused on students with Mathematical Learning Disability. This approach was essential to ensure that only those students who genuinely exhibited persistent mathematical difficulties were included in the final sample.Initially, permission was sought from ten schools to conduct the study. However, only eight upper primary CBSE schools granted approval. These schools included three Central Government institutions and five private schools, comprising a total of 13 sections at the Grade VIII level. The total student population from these schools was 509 students.The identification of students with Mathematical Learning Disability was carried out through a systematic screening process, involving clearly defined inclusionary and exclusionary criteria. The process was implemented in multiple stages to eliminate factors other than learning disability that could influence mathematics performance, such as age, attendance, sensory impairments, emotional problems, and lack of exposure.At each stage, students who did not meet the required criteria were eliminated, and only those who satisfied all conditions were retained. The details of this elimination and retention process are presented below.

Table 1: Number of Students Eliminated and Retained at Various Stages of Identification (N = 509)

Sl. No.	Reasons	Number Eliminated	Number Retained
1	Students with poor performance in mathematics	382	127
2	Age at or above 14 years	–	127
3	Without any serious emotional and behavioral problems	7	120
4	Not been absent to school frequently	6	114
5	Received extra help at home	15	99
6	Normal sensory functioning, visual tracking, and eye-hand coordination	10	89
7	Normal intellectual functioning	25	64
8	Poor and very poor performance (less than 2 years grade level in Mathematics)	32	32

The above table clearly shows that out of the initial 509 students, a total of 32 students were identified as having Mathematical Learning Disability after applying all screening criteria. From these 32 students, 22 participants were finally retained for the study based on feasibility considerations such as regular attendance, availability, and consistency in participation.These 22 identified students were then administered the Mathematics Diagnostic Test for Grade VIII Students in Practical Geometryto assess their difficulties and errors specifically in practical geometry. This formed the basis for diagnostic analysis.

Tools Used in the Study:-

The primary tool used in the study was a Mathematics Diagnostic Testfor Grade VIII Students in geometry, developed by the research scholar under the guidance of the supervisor to analyse difficulties and errors in mathematics, with specific focus on Geometry criterion-wise.

Mathematics Diagnostic Test for Grade VIII:-

The test was designed as a criterion-referenced diagnostic tool to assess students' conceptual and procedural understanding in selected areas of Grade VIII mathematics. The content was drawn strictly from the CBSE Grade VIII mathematics syllabus.

Development of the Mathematics Diagnostic Test for Grade VIII Students:-

The test consisted of items mapped to clearly defined criterion measures and sub-criterion measures. Each sub-skill was represented by more than one item, and items were arranged in increasing order of difficulty to facilitate accurate diagnosis.

Stage I: Content Validation:-

The Mathematics Diagnostic Test was content validated by five subject experts to ensure its relevance, clarity, and suitability for Grade VIII learners. The experts reviewed the items for content coverage, conceptual accuracy, grade appropriateness, and language clarity using a three-point rating scale: Essential, Useful but not essential, and Not necessary. The Scale Content Validity Index (S-CVI) obtained was 0.89, indicating strong content validity and high agreement among the experts. Based on their suggestions, minor revisions were made to improve wording, remove ambiguity, adjust difficulty levels, and eliminate overlapping items. Of the initial 200 items, 160 were retained as essential, 20 were revised and retained, and 20 were eliminated, resulting in a final set of 180 items for further analysis.

Stage II: Difficulty Index Analysis :-

The items retained after content validation were analysed using difficulty and discrimination indices based on the responses of 95 Grade VIII students. Items that were found to be too easy, too difficult, or having poor discriminating power were either revised or eliminated in accordance with accepted criteria. The analysis showed that the test items were well distributed across different levels of difficulty, ranging from very difficult to very easy. This balanced distribution indicates that the diagnostic test is appropriately constructed and suitable for identifying varying levels of student understanding and learning difficulties in mathematics.

Stage III: Discrimination Index Analysis:-

The Discrimination Index of the test items was determined using the standard procedure suggested by Garrett (1981) by comparing the performance of the top 27% and bottom 27% of Grade VIII students. This analysis assessed the ability of each item to distinguish between high and low achievers. The results indicated that most items exhibited good to excellent discrimination, while a small number of items showed marginal or fair discrimination and were revised accordingly. Overall, all items demonstrated adequate discriminating power, and therefore, all 158 items were retained for use in the final form of the diagnostic test.

Stage IV: Reliability:-

The reliability of the Mathematics Diagnostic Test was established using the split-half (odd–even) method and further corrected using the Spearman–Brown prophecy formula. The obtained reliability coefficient of 0.90 indicates very high internal consistency of the test. Thus, the diagnostic test was found to be highly reliable and suitable for assessing the mathematical learning difficulties of Grade VIII students.

Criterion Measures of Practical Geometry in the Final Test:-

The content area Practical Geometry was analysed using clearly defined criterion measures and sub-criterion measures to enable precise diagnosis of students' difficulties.

Table 5: Criterion Measures of Practical Geometry

Criterion Measure	Sub-Criterion Measure	Item	Score
CM–1: Quadrilateral (4 sides and1 diagonal)	(a) Drawing the given diagonal first Steps: Identify diagonal → Draw to scale Example: Draw PR in PQRS	Q.30 (a), Q.30 (b)	2
	(b) Locating vertices using arcs Steps: Use compass → Correct radius → Mark intersections	Q.30 (a), Q.30 (b)	4
	(c) Completing andlabelling Steps: Join vertices → Label neatly	Q.30 (a), Q.30 (b)	4
CM–2: Quadrilateral (3 sides and2 diagonals)	(a) Drawing the first diagonal accurately Steps: Identify diagonal → Draw to scale	Q.31 (a), Q.31 (b)	2
	(b) Locating vertices using given sides Steps: Draw arcs from diagonal endpoints	Q.31 (a), Q.31 (b)	4
	(c) Using second diagonal for verification Steps: Measure second diagonal → Verify intersection	Q.31 (a), Q.31 (b)	4
CM–3: Quadrilateral (2 adjacent sides and3 angles)	(a) Constructing angles accurately Major steps: Place protractor/compass → Construct angles	Q.32 (a), Q.32 (b)	4
	(b) Marking adjacent sides on rays Major steps: Measure length → Mark on rays	Q.32 (a), Q.32 (b)	4
	(c) Locating fourth vertex Major steps: Extend rays → Locate intersection	Q.32 (a), Q.32 (b)	2
CM–4: Quadrilateral (3 sides and2 included angles)	(a) Identifying included angles Steps: Identify common vertex → Choose correct angles	Q.33 (a), Q.33 (b)	2
	(b) Constructing angles at correct vertices Steps: Draw base → Construct angles	Q.33 (a), Q.33 (b)	4
	(c) Completing construction Steps: Extend sides → Join vertices	Q.33 (a), Q.33 (b)	4
CM–5: Square (one side given)	(a) Constructing perpendiculars Steps: Erect perpendiculars using compass	Q.34 (a), Q.34 (b)	2
	(b) Marking equal sides Steps: Measure side → Transfer length	Q.34 (a), Q.34 (b)	2
	(c) Neat completion andverification Steps: Join vertices → Verify	Q.34 (a), Q.34 (b)	4
CM–6: Rectangle (two adjacent sides)	(a) Constructing perpendicular at base Steps: Draw base → Construct perpendicular	Q.35 (a), Q.35 (b)	2
	(b) Drawing parallel sides Steps: Draw parallels → Complete shape	Q.35 (a), Q.35 (b)	2
	(c) Completing andverifying rectangle Steps: Join sides → Verify opposite sides	Q.35 (a), Q.35 (b)	4
	Total		**56**

Procedure of Data Collection:-

TheDiagnostic Test in geometry for Grade VIII Studentswas administered to the 22 identifiedStudentswith Mathematical Learning Disability under uniform conditions. Students' responses were scored using the predefined criterion measures and scoring scheme.

Based on the percentage of scores obtained in each criterion measure, students were classified as Masters (80% and above), Partial Achievers (above 0% and below 80%), and Non-Masters (0%). The diagnostic test data were subjected to difficulty analysis to analyze the specific difficulties encountered by Grade VIII students with Mathematics Learning Disability while performing construction tasks related to Practical Geometry, and to error analysis to analyze the types of errors committed by the students in solving Practical Geometry problems.

Analysis of the Specific Difficulties Encountered by Grade VIII Students with Mathematical Learning Disability while performing operations related to different Criterion Measures of Practical Geometry: -

The analysis of difficulties encountered by Grade VIII students with Mathematics Learning Disability in Practical Geometry was carried out through a systematic criterion-measure-wise and sub-criterion-measure-wiseanalysis. Each construction task was broken into essential sub-criterion measures, and students' performance at each step was examined. The number and percentage of students experiencing difficulty in each sub-criterion measure were calculated to determine the level of difficulty. The analysis focused only on identifying difficulties related to understanding construction steps, sequencing procedures, visualising geometric relationships, and using geometric instruments accurately. Observations of students' construction work were used to illustrate how these difficulties manifested. This approach helped identify the specific stages of Practical Geometry constructions where students faced maximum difficulty, providing a clear basis for focused instructional and remedial planning.

Analysis Difficulties encountered by Students in Practical Geometry:-

Table 1: Difficulties Encountered while Solving Problems of Criterion Measure:
CM–1: Quadrilateral (4 sides and1 diagonal)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Drawing the given diagonal first Steps: Identify diagonal → Draw to scale Example: Draw PR in PQRS	• Diagonal not drawn first – 14 (63.64%)	Several students began with a side instead of the given diagonal, causing later arcs not to intersect correctly and the construction to fail.
(b) Locating vertices using arcs Steps: Use compass → Correct radius → Mark intersections	• Incorrect arc radius – 12 (54.55%) • Arcs not intersecting – 10 (45.45%)	Students used approximate measurements or changed compass width mid-step, leading to misplaced vertices.
(c) Completing andlabelling Steps: Join vertices → Label neatly	• Sides left unjoined – 9 (40.91%) • Missing/incorrect labels – 8 (36.36%)	Constructions were often left incomplete, and vertex labels were omitted, indicating lack of awareness of evaluation criteria.

Table 2:Difficulties Encountered while Solving Problems of Criterion Measure:
CM–2: Quadrilateral (3 sides and2 diagonals)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Drawing the first diagonal accurately Steps: Identify diagonal → Draw to scale	• Diagonal drawn inaccurately – 13 (59.09%)	Inaccurate diagonal length resulted in incorrect arc intersections and distorted quadrilaterals.
(b) Locating vertices using given sides Steps: Draw arcs from diagonal endpoints	• Incorrect use of compass – 15 (68.18%)	Students failed to maintain constant radius while drawing arcs, showing weak instrument-handling skills.
(c) Using second diagonal for verification Steps: Measure second diagonal → Verify intersection	• Second diagonal ignored – 16 (72.73%)	Many students treated the second diagonal as optional and did not use it to confirm vertex positions.

Table 3: Difficulties Encountered while Solving Problems of Criterion Measure:
CM–3: Quadrilateral (2 adjacent sides and3 angles)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Constructing angles accurately Major steps: Place protractor/compass → Construct angles	• Inaccurate angle construction – 22 (100%)	Angles were either overestimated or underestimated, leading to rays that never intersected.
(b) Marking adjacent sides on rays Major steps: Measure length → Mark on rays	• Incorrect side marking – 18 (81.82%)	Students marked side lengths without aligning the scale properly, affecting vertex location.
(c) Locating fourth vertex Major steps: Extend rays → Locate intersection	• Rays failed to intersect – 22 (100%)	Due to earlier angle errors, rays diverged and no closed figure was obtained.

Table 4: Difficulties Encountered while Solving Problems of Criterion Measure:
CM–4: Quadrilateral (3 sides and2 included angles)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Identifying included angles Steps: Identify common vertex → Choose correct angles	• Included angles wrongly identified – 18 (81.82%)	Students confused included angles with non-adjacent angles, leading to incorrect base setup.
(b) Constructing angles at correct vertices Steps: Draw base → Construct angles	• Angles constructed at wrong vertices – 16 (72.73%)	Angles were drawn on incorrect sides of the base, preventing closure of the quadrilateral.
(c) Completing construction Steps: Extend sides → Join vertices	• Quadrilateral not closed – 22 (100%)	Final vertices failed to meet due to cumulative procedural errors.

Table 5: Difficulties Encountered while Solving Problems of Criterion Measure:
CM–5: Square (one side given)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Constructing perpendiculars Steps: Erect perpendiculars using compass	• Perpendiculars inaccurate – 20 (90.91%)	Students drew approximate right angles instead of using compass construction.
(b) Marking equal sides Steps: Measure side → Transfer length	• Unequal sides marked – 16 (72.73%)	Side lengths were transferred inconsistently, resulting in distorted squares.
(c) Neat completion andverification Steps: Join vertices → Verify	• Incomplete square – 12 (54.55%)	Some constructions lacked verification of right angles and equal sides.

Table 6: Difficulties Encountered while Solving Problems of Criterion Measure:
CM–6: Rectangle (two adjacent sides)

Sub-Criterion Measure	Specific Difficulties Exhibited (No. and%)	Elaborated Difficulty Instance (Observed in Students' Responses)
(a) Constructing perpendicular at base Steps: Draw base → Construct perpendicular	• Perpendicular inaccurate – 18 (81.82%)	Right angles were guessed rather than constructed, affecting parallelism.
(b) Drawing parallel sides Steps: Draw parallels →	• Parallels not maintained – 20 (90.91%)	Students failed to keep sides parallel, producing skewed figures.

Complete shape		
(c) Completing andverifying rectangle Steps: Join sides → Verify opposite sides	• Rectangle incomplete/distorted – 18 (81.82%)	Verification steps were ignored, resulting in inaccurate rectangles.

The difficulty analysis of Practical Geometry (Grade VIII) shows that each criterion measure involved multiple sub-skills, with difficulties compounding across steps. Partial Achievers attempted constructions but committed procedural errors, while most Non-Masters did not attempt the multi-step and angle-based constructions, indicating serious gaps in instrument handling, angle construction, and sequential execution.

Analysis of the errors committedby Grade VIII students with Mathematical Learning Disability while performing operations related to different Criterion Measures of Practical Geometry: -

The error analysis was conducted to identify the type and pattern of errors committed by students while solving problems related to Practical Geometry

Error Analysis in Practical Geometry – Grade VIII (N = 22)

Table 7: Errors Committed while Solving Problems of Criterion Measure:

CM–1: Constructing a quadrilateral (4 sides and 1 diagonal)

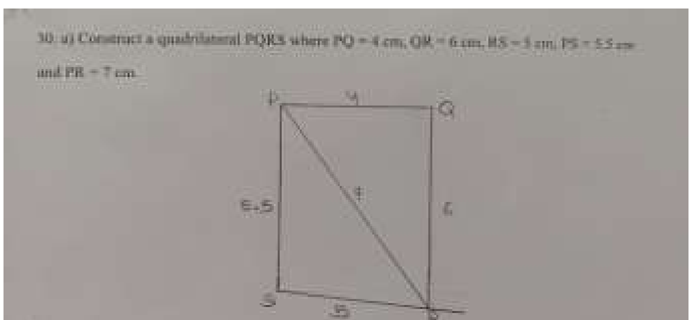
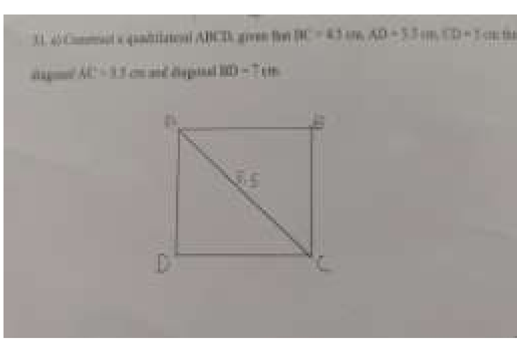
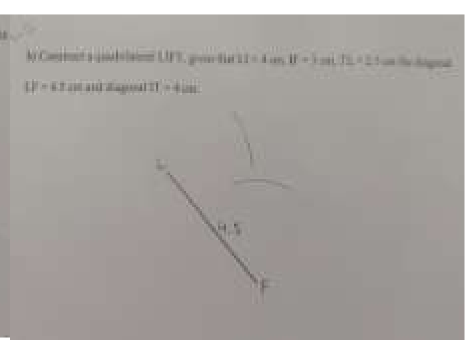
Task with Error Illustration	%&No. of Students Committing Error
Task: Construct a quadrilateral using four given sides and one diagonal.  **Error:** Students did not draw the given diagonal first resulting in incomplete or distorted figures.	**27.00 %** (6 out of 22)

Table 8: Errors Committed while Solving Problems of Criterion Measure:

CM–2: Constructing a quadrilateral (3 sides and 2 diagonals)

Task with Error Illustration	%&No. of Students Committing Error
Task: Construct a quadrilateral using three sides and two diagonals.  	**45.45%** (10 out of 22)

Error: Students were unable to use the second diagonal correctly for verification; arcs were drawn inaccurately, and most constructions were left incomplete.	

Table 9: Errors Committed while Solving Problems of Criterion Measure:
CM–3: Constructing a quadrilateral (2 adjacent sides and 3 angles)

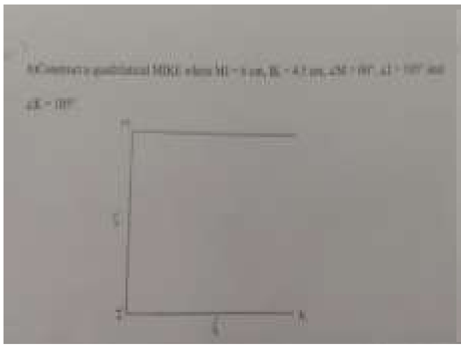
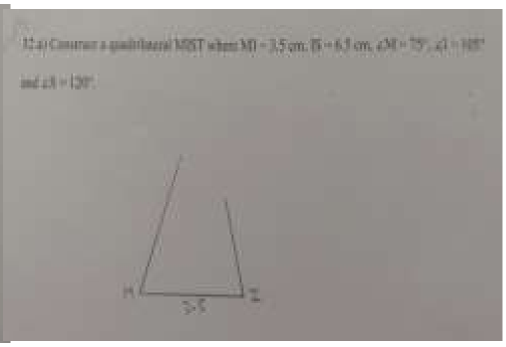
Task with Error Illustration	%&No. of Students Committing Error
Task: Construct a quadrilateral using two adjacent sides and three given angles.   **Error:** Students failed to construct angles accurately using compass/protractor methods and could not locate the fourth vertex through intersection of rays.	**54.55 %** (12 out of 22)

Table 10: Errors Committed while Solving Problems of Criterion Measure:
CM–4: Constructing a quadrilateral (3 sides and 2 included angles)

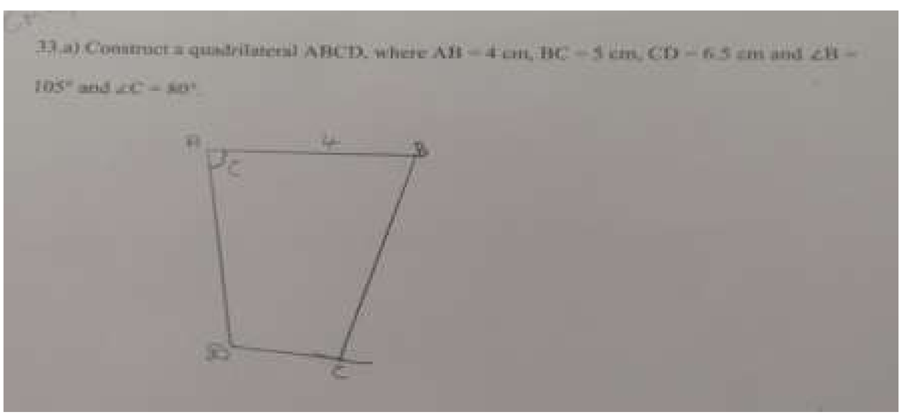
Task with Error Illustration	% andNo. of Students Committing Error
Task: Construct a quadrilateral using three sides and two included angles.  **Error:** Students were unable to identify included angles correctly; angle construction was inaccurate, leading to non-intersecting rays or incorrect shapes.	**59.09%** (22 out of 22)

Table 11: Errors Committed while Solving Problems of Criterion Measure:
CM–5: Constructing a square (one side given)

Task with Error Illustration	% andNo. of Students Committing Error

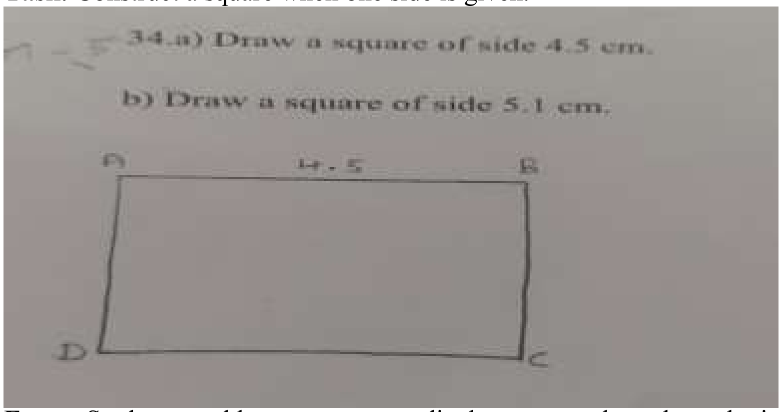
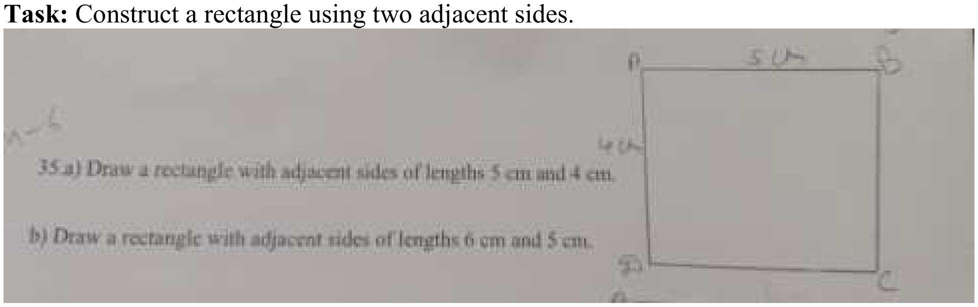
Task: Construct a square when one side is given.  **Error:** Students could not erect perpendiculars accurately at the endpoints of the given side or failed to mark equal side lengths; many left the item unattempted.	**31.82%** (7 out of 22)

Table 12: Errors Committed while Solving Problems of Criterion Measure:
CM–6: Constructing a rectangle (two adjacent sides given)

Task with Error Illustration	% andNo. of Students Committing Error
Task: Construct a rectangle using two adjacent sides.  **Error:** Students failed to draw perpendiculars or parallel lines correctly and could not complete the rectangle, indicating weak instrument-handling skills.	**68.18%** (15 out of 22)

The error analysis of Practical Geometry (Grade VIII) reveals that errors were largely observed among Partial Achievers, while most Non-Masters left construction-based items unattempted, especially in angle-based constructions (CM–3 and CM–4). This indicates severe difficulty in instrument handling, angle construction, and step-wise execution.

Major Findings and Discussion: -

1. Grade VIII students with Mathematics Learning Disability exhibited considerable difficulties in Practical Geometry, particularly in understanding and executing step-wise construction procedures. The present study clearly indicates that students with Mathematics Learning Disability (MLD) experience major difficulty in following the sequential steps involved in Practical Geometry constructions. Geometry constructions demand ordered reasoning, recall of rules, and systematic execution, all of which pose challenges for students with MLD. This finding is in agreement with Ramaa and Gowramma (1999), who reported that students with learning disability show poor procedural understanding in geometry, resulting in repeated failure in construction tasks. Geary (2004) also emphasized that procedural deficits and difficulty in managing multi-step tasks are core characteristics of mathematical learning disability, particularly in rule-based areas such as geometry.

2. Difficulties were prominently observed in constructing quadrilaterals using given conditions, where students struggled with identifying correct construction steps and sequencing them logically. The study found that constructions involving quadrilaterals under given conditions posed greater difficulty than simpler constructions.

Students were often unable to interpret the given data correctly and translate it into an appropriate construction plan. This supports the findings of Nair (2015), who stated that geometry difficulties often arise due to poor conceptual clarity and inability to relate given conditions to construction procedures. Similarly, Clements and Battista (1992) observed that learners with weak spatial reasoning struggle to integrate multiple conditions such as sides, angles, and diagonals, leading to breakdowns in complex geometric constructions.

3. A significant number of students showed improper use of geometric instruments, including inaccurate use of the compass and ruler, leading to incorrect constructions. Improper handling of geometric instruments emerged as a major difficulty among students with MLD. Many students failed to maintain a constant compass radius or draw accurate line segments using a ruler. This finding aligns with the work of Hegarty and Kozhevnikov (1999), who highlighted visual–spatial and motor coordination difficulties among students with learning disabilities. Ramaa (2000) also reported that poor instrument-handling skills significantly contribute to failure in Practical Geometry, particularly in tasks requiring precision and accuracy.

4. Error analysis revealed that the errors committed by the students were recurring, indicating underlying procedural and conceptual weaknesses rather than random mistakes.The errors observed in the present study were repetitive and patterned, suggesting stable misconceptions and procedural weaknesses. This finding strongly supports Ramaa and Gowramma (1999), who noted that errors in geometry among students with learning disabilities are systematic in nature and reflect faulty rule application. Ashlock (2010) also emphasized that recurring errors in mathematics are indicative of deep-seated misconceptions rather than careless mistakes, highlighting the need for diagnostic assessment and targeted remediation.

5. Common errors included incorrect drawing of base lines or diagonals, failure to locate vertices accurately using arcs, and incomplete or incorrect joining of sides.The frequent occurrence of these errors indicates students' difficulty in understanding the functional role of each construction step. Similar observations were made by Battista (2007), who found that students with poor spatial structuring skills struggle to visualise intersections and closure of figures. NCTM (2000) also emphasized that lack of conceptual understanding of construction principles leads to incomplete and incorrect geometric constructions.

6. Students also exhibited difficulty in maintaining precision and neatness, such as inaccurate measurements, improper labeling of vertices, and incomplete verification of constructions.The difficulty in maintaining precision and neatness reflects weaknesses in attention, monitoring, and self-regulation among students with MLD. This finding is consistent with Swanson and Jerman (2006), who reported that students with learning disabilities often have deficits in working memory and attentional control, leading to omission of verification steps. Ramaa (2002) similarly observed that students with learning disabilities tend to neglect labeling and checking, even when they are aware of construction procedures.

7. Criterion-wise analysis showed variation in performance, with higher concentration of difficulties and errors in tasks involving multiple conditions compared to simpler constructions such as squares and rectangles.The study revealed that task complexity significantly influenced students' performance. Constructions involving multiple given conditions placed higher cognitive demands, resulting in greater difficulty and error rates. This finding corroborates Geary, Hoard, and Hamson (1999), who noted that increased task complexity intensifies cognitive load for students with MLD. Nair (2015) also reported that constructions with multiple constraints require higher levels of conceptual integration and procedural control, which are particularly challenging for students with mathematics learning disability.

Educational Implications: -

The findings of the present study have several specific educational implications for teaching Practical Geometry to Grade VIII students with Mathematics Learning Disability (MLD). These implications are derived from the observed performance patterns and are intended to improve instructional planning and learner outcomes.First, since students exhibited significant difficulty in understanding and executing step-wise construction procedures, geometry instruction should explicitly emphasise**s**ystematic step-by-step teaching. Teachers need to model each construction step slowly and sequentially, verbalising the reasoning behind every action. Providing written step lists, flowcharts, or visual construction maps can help students internalise the procedural sequence involved in Practical Geometry.

Second, the pronounced difficulty observed in constructing quadrilaterals with given conditions indicates the need for focused instruction on interpreting given data. Teachers should train students to analyse the given conditions before beginning construction by identifying known elements such as sides, angles, and diagonals, and planning the strategy in advance. Guided practice in converting verbal or symbolic information into a clear construction plan can minimise procedural confusion.Third, improper use of geometric instruments highlights the necessity for systematic training in instrument-handling skills. Repeated and supervised practice in using the compass, ruler, and protractor should be provided, with special attention to maintaining constant radius, accurate measurement, steady hand movement, and correct alignment. Remedial sessions may include isolated drills in drawing straight lines, arcs, and circles before integrating these skills into complete constructions.

In addition, it was observed that a few students drew completely distorted figures — lines were not straight, circles were irregular, and overall presentation reflected poor motor control and unclear handwriting. Such patterns may indicate possible fine motor coordination difficulties or motor-related learning issues or mathematics phobia rather than purely conceptual mathematical problems. These students may require further diagnostic assessment by specialists to determine whether an underlying motor disability or developmental coordination difficulty or mathematics phobia is present. Early identification and referral for appropriate support services can help address these challenges effectively.Fourth, the recurrence of similar errors across constructions suggests the need for diagnostic and corrective teaching. Instead of merely pointing out mistakes, teachers should analyse error patterns, identify underlying misconceptions, and provide targeted re-teaching with corrective feedback.

Fifth, as many difficulties were associated with baseline or diagonal construction, vertex location using arcs, and completion of figures, instruction should emphasise the functional purpose of each construction step. Explaining why a step is required and how it influences the next stage will strengthen conceptual understanding alongside procedural competence.Sixth, difficulty in maintaining precision, neatness, proper labeling, and verification indicates the need to explicitly teach checking and verification strategies. Teachers may introduce structured checklists covering labeling, measurement accuracy, property verification (equal sides, right angles, parallel lines), and overall neatness as integral parts of assessment.Finally, variation in performance across criterion measures, particularly greater difficulty in tasks involving multiple conditions, suggests that instruction should follow a graded progression of complexity. Students should master simpler constructions before progressing to more complex quadrilaterals. Scaffolded instruction, with gradual increase in task demands, can help manage cognitive load and improve success rates among students with MLD.Overall, these implications highlight the importance of structured, diagnostic, remedial-oriented, and multidisciplinary approaches in teaching Practical Geometry. Instruction should be carefully adapted to the specific learning and possible motor-related difficulties identified among students, rather than relying solely on generalized classroom teaching methods.

Conclusion:-

The present study revealed that Grade VIII students with Mathematics Learning Disability experience substantial difficulties in Practical Geometry, particularly in understanding construction conditions, sequencing steps, using geometric instruments accurately, and maintaining precision. These difficulties were more pronounced in constructions involving multiple given conditions. The findings highlight the need for structured, step-wise, and diagnostic-based instructional approaches in teaching Practical Geometry. By identifying specific difficulty areas through criterion- and sub-criterion-measure-wise analysis, the study provides a clear basis for targeted remedial instruction, thereby contributing meaningfully to improving geometry learning among students with Mathematics Learning Disability.

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