

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

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.

Key words: -

Mathematics Learning Disability (MLD), Dyscalculia, Specific Learning Disability In Mathematics, Neurodevelopmental Disorder, Mathematical Anxiety, Cognitive Processing Deficits, Executive Functioning Difficulties, Motor Disability, Visual-Spatial Processing Deficits, Emotional and Behavioral Factors, Visual-Spatial Processing Deficits, Language and Symbol Processing Difficulties

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3 Introduction: -

4 Mathematics Learning Disability (MLD) or Specific Learning Disability in Mathematics refers to a specific
5 neurodevelopmental disorder in which students exhibit persistent and significant difficulties in understanding and
6 performing mathematical tasks, despite having average or above-average intelligence and receiving adequate
7 instruction. These difficulties are not attributable to sensory impairments, emotional disturbances, or socio-cultural
8 deprivation, but arise from deficits in underlying cognitive processes such as working memory, visual-spatial
9 processing, logical reasoning, attention, and procedural sequencing.

10 Students with MLD commonly experience problems in comprehending mathematical concepts, applying rules
11 accurately, recalling procedures, and executing multi-step operations. In geometry, especially **Practical Geometry**,
12 these difficulties manifest as an inability to visualize geometric relationships, follow construction steps sequentially,
13 and maintain accuracy while using geometric instruments. Such errors are often repetitive rather than incidental.
14 Supporting this view, **Ramaa and Gowramma (1999)** reported that high school students with learning disability
15 committed consistent and patterned errors in geometry constructions, indicating weaknesses in procedural
16 understanding and rule application. Further, **Nair (2015)** emphasized that geometry-related difficulties among
17 students with learning disabilities are largely rooted in poor conceptual clarity and the absence of proper diagnostic
18 identification of specific learning gaps.

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

22 **Need and Importance of the Study**

23 Practical Geometry requires students to apply geometric concepts through accurate constructions, demanding
24 precision, sequential thinking, and effective use of instruments. Students with Mathematics Learning Disability
25 often struggle with these requirements, leading to persistent difficulties and repeated errors in geometry
26 constructions. If such difficulties remain unidentified, they negatively affect students' overall achievement and
27 confidence in mathematics.

28 Previous studies have highlighted that students with learning disabilities exhibit difficulties and characteristic errors
29 in geometry tasks. **Ramaa and Gowramma (1999)** emphasized that geometry-related errors among students with
30 learning disability are not random but arise from specific procedural and conceptual weaknesses. **Nair (2015)**
31 further pointed out that without proper diagnostic assessment, these learning difficulties often go unnoticed in
32 regular classroom instruction.

33 Despite these findings, there is a lack of focused diagnostic studies examining the specific difficulties and error
34 patterns in Practical Geometry at the Grade VIII level. Identifying these difficulties is essential for planning
35 appropriate instructional strategies and remedial support. Therefore, the present study is important as it provides a
36 detailed diagnostic analysis of students' difficulties and errors in Practical Geometry, offering valuable insights for
37 teachers, curriculum planners, and teacher educators to improve instructional practices for students with
38 Mathematics Learning Disability.

39 **Review Of Related Literature: -**

40 Research in mathematics education has consistently shown that students with Mathematics Learning Disability
41 experience persistent difficulties in geometry, particularly in construction-based tasks that demand sequential
42 reasoning, spatial visualization, and precision. Practical Geometry requires learners to understand geometric
43 relationships and execute step-wise procedures accurately, which often becomes challenging for students with
44 learning difficulties.

45 Studies conducted in the Indian context have provided important insights into the nature of these difficulties. **Ramaa**
46 **(1994)** emphasized that students with learning disabilities often exhibit weak conceptual understanding and poor
47 procedural control, leading to repeated errors in mathematical tasks. In a later study, **Ramaa and Gowramma**
48 **(1999)** reported that high school students with learning disability committed errors in geometry constructions,
49 indicating that such errors were characteristic of underlying procedural and conceptual weaknesses rather than
50 careless mistakes. Their findings highlighted the importance of diagnosing specific error patterns to understand
51 students' learning problems in geometry.

52 Emphasizing the role of diagnosis, **Nair (2015)** stated that criterion-based diagnostic assessment is essential for
53 identifying specific learning difficulties in mathematics. According to Nair, conventional achievement tests fail to
54 reveal detailed learning gaps, whereas diagnostic analysis enables the identification of precise difficulties related to
55 concepts, procedures, and use of instruments, which are particularly relevant in Practical Geometry.

56 From a methodological perspective, **Garrett (1981)** stressed that systematic analysis of students' responses is
57 crucial for understanding learning difficulties and error patterns. His work provides the statistical foundation for
58 analyzing item-wise performance and supports the use of diagnostic techniques in educational research.

59 International studies also support the need for focused analysis of mathematical difficulties among students with
60 learning disabilities. **Fuchs and Fuchs (2001)** observed that students with learning difficulties demonstrate
61 consistent and predictable patterns of errors in mathematics, underscoring the importance of identifying specific
62 areas of difficulty for instructional planning. Similarly, **Witzel, Mercer, and Miller (2003)** pointed out that
63 difficulties in mathematics often arise from inadequate understanding of procedural steps, a concern that is highly
64 relevant to construction-based geometry tasks.

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

70 **Review of Studies Related to Psychological Factors Associated with Mathematics Learning Disability**

71 **Cognitive Processing Deficits**

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

78 **Number Sense Impairment**

79 Number sense impairment is widely recognized as a core psychological characteristic of MLD. Learners often show
80 weak understanding of numerical magnitude, estimation, and proportional relationships, which restricts the
81 development of mathematical concepts across domains (Butterworth, 1999, 2005; Dehaene, 2001, 2011; Geary,
82 2004). In geometry, such impairment adversely affects measurement, scaling, similarity, and coordinate geometry
83 (Jordan et al., 2002; Mazzocco & Thompson, 2005).

84 **Executive Functioning Difficulties**

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

90 **Mathematical Anxiety**

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

96 **Low Self-Esteem and Motivation**

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

105

106 **Language and Symbol Processing Difficulties**

107 Learners with MLD frequently experience difficulty understanding mathematical vocabulary, symbols, and verbal
108 problem statements. These language-related weaknesses affect the correct interpretation of instructions and selection
109 of appropriate operations (Jordan & Hanich, 2000; Fuchs & Fuchs, 2002; Swanson & Beebe-Frankenberger, 2004).
110 In geometry, misinterpretation of definitions, theorems, and symbolic notations leads to conceptual
111 misunderstandings (Passolunghi & Pazzaglia, 2004).

112
113 **Visual-Spatial Processing Deficits**

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

119
120 **Attention-Related Problems**

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

126
127 **Emotional and Behavioral Factors**

128 Emotional and behavioral factors often emerge as secondary consequences of persistent mathematical difficulty.
129 Learners with MLD frequently experience frustration, avoidance, withdrawal, and learned helplessness, which
130 reduce engagement and effective learning opportunities (McLeod, 1992; Gresham, 2002; Hallahan & Kauffman,
131 2006). In geometry, such behaviors limit sustained participation in visually demanding and cognitively complex
132 tasks (Wentzel, 1998; Mazzocco, 2007).

133
134 **Objectives of the Study: -**

- 135 1. To analyze the specific difficulties encountered by Grade VIII students with Mathematical Learning
136 Disability while performing problems related to Practical Geometry.
137 2. To analyze the errors committed by Grade VIII students with Mathematical Learning Disability while
138 performing problems related to Practical Geometry.
139

140 **Research Questions: -**

- 141 1. What specific difficulties are encountered by Grade VIII students with Mathematical Learning Disability
142 while performing construction tasks related to Practical Geometry?
143 2. What kinds of errors are committed by Grade VIII students with Mathematical Learning Disability while
144 solving problems related to Practical Geometry?
145

146 **Methodology: -**

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

151
152 **Sample**

153 The sample for the present study was selected through a purposive sampling technique, combined with a multi-phase
154 identification procedure, as the study specifically focused on students with Mathematical Learning Disability. This

155 approach was essential to ensure that only those students who genuinely exhibited persistent mathematical
156 difficulties were included in the final sample.

157 Initially, permission was sought from ten schools to conduct the study. However, only eight upper primary CBSE
158 schools granted approval. These schools included three Central Government institutions and five private schools,
159 comprising a total of 13 sections at the Grade VIII level. The total student population from these schools was 509
160 students.

161 The identification of students with Mathematical Learning Disability was carried out through a systematic screening
162 process, involving clearly defined inclusionary and exclusionary criteria. The process was implemented in multiple
163 stages to eliminate factors other than learning disability that could influence mathematics performance, such as age,
164 attendance, sensory impairments, emotional problems, and lack of exposure.

165 At each stage, students who did not meet the required criteria were eliminated, and only those who satisfied all
166 conditions were retained. The details of this elimination and retention process are presented below.

167 **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

168 The above table clearly shows that out of the initial 509 students, a total of 32 students were identified as having
169 Mathematical Learning Disability after applying all screening criteria. From these 32 students, 22 participants were
170 finally retained for the study based on feasibility considerations such as regular attendance, availability, and
171 consistency in participation.

172 These 22 identified students were then administered the Mathematics Diagnostic Test for Grade VIII Students in
173 Practical Geometry to assess their difficulties and errors specifically in practical geometry. This formed the basis for
174 diagnostic analysis.

175 **Tools Used in the Study**

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

180 **Mathematics Diagnostic Test for Grade VIII**

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

184

185 **Development of the Mathematics Diagnostic Test for Grade VIII Students**

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

189
 190 **Stage I: Content Validation**

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

199 **Stage II: Difficulty Index Analysis**

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

206
 207 **Stage III: Discrimination Index Analysis**

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

214
 215 **Stage IV: Reliability**

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

220
 221 **Criterion Measures of Practical Geometry in the Final Test**

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

224
 225 **Table 5: Criterion Measures of Practical Geometry**

Criterion Measure	Sub-Criterion Measure	Item	Score
CM–1: Quadrilateral (4 sides & 1 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 & labelling Steps: Join vertices → Label neatly	Q.30 (a), Q.30 (b)	4

CM-2: Quadrilateral (3 sides & 2 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 & 3 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 & 2 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 & verification 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 & verifying rectangle Steps: Join sides → Verify opposite sides	Q.35 (a), Q.35 (b)	4
	Total		56

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Procedure of Data Collection

The Diagnostic Test in geometry for Grade VIII Students was administered to the 22 identified Students with 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: -

243 The analysis of difficulties encountered by Grade VIII students with Mathematics Learning Disability in Practical
 244 Geometry was carried out through a systematic criterion-measure-wise and sub-criterion-measure-wise analysis.
 245 Each construction task was broken into essential sub-criterion measures, and students' performance at each step was
 246 examined. The number and percentage of students experiencing difficulty in each sub-criterion measure were
 247 calculated to determine the level of difficulty. The analysis focused only on identifying difficulties related to
 248 understanding construction steps, sequencing procedures, visualising geometric relationships, and using geometric
 249 instruments accurately. Observations of students' construction work were used to illustrate how these difficulties
 250 manifested. This approach helped identify the specific stages of Practical Geometry constructions where students
 251 faced maximum difficulty, providing a clear basis for focused instructional and remedial planning.
 252

253 **Analysis Difficulties encountered by Students in Practical Geometry**

254 **Table 1: Difficulties Encountered while Solving Problems of Criterion Measure:**

255 **CM-1: Quadrilateral (4 sides & 1 diagonal)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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 & labelling 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.

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257 **Table 2: Difficulties Encountered while Solving Problems of Criterion Measure:**

258 **CM-2: Quadrilateral (3 sides & 2 diagonals)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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.

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260 **Table 3: Difficulties Encountered while Solving Problems of Criterion Measure:**

261 **CM-3: Quadrilateral (2 adjacent sides & 3 angles)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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.

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263 **Table 4: Difficulties Encountered while Solving Problems of Criterion Measure:**

264 **CM-4: Quadrilateral (3 sides & 2 included angles)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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.

265

266 **Table 5: Difficulties Encountered while Solving Problems of Criterion Measure:**

267 **CM-5: Square (one side given)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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 & verification Steps: Join vertices → Verify	• Incomplete square – 12 (54.55%)	Some constructions lacked verification of right angles and equal sides.

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269 **Table 6: Difficulties Encountered while Solving Problems of Criterion Measure:**

270 **CM-6: Rectangle (two adjacent sides)**

Sub-Criterion Measure	Specific Difficulties Exhibited (No. & %)	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 → Complete shape	• Parallels not maintained – 20 (90.91%)	Students failed to keep sides parallel, producing skewed figures.
(c) Completing & verifying rectangle Steps: Join sides → Verify opposite sides	• Rectangle incomplete/distorted – 18 (81.82%)	Verification steps were ignored, resulting in inaccurate rectangles.

271

272 The difficulty analysis of Practical Geometry (Grade VIII) shows that each criterion measure involved multiple sub-

273 skills, with difficulties compounding across steps. Partial Achievers attempted constructions but committed

274 procedural errors, while most Non-Masters did not attempt the multi-step and angle-based constructions, indicating

275 serious gaps in instrument handling, angle construction, and sequential execution.

276

277 **Analysis of the errors committed by Grade VIII students with Mathematical Learning**

278 **Disability while performing operations related to different Criterion Measures of Practical**

279 **Geometry: -**

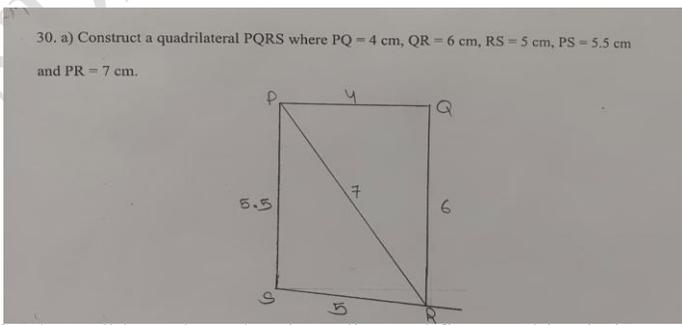
280 The error analysis was conducted to identify the type and pattern of errors committed by students while solving

281 problems related to Practical Geometry

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

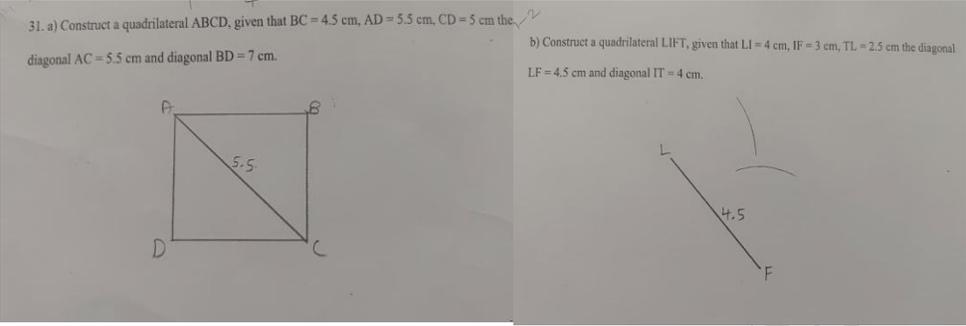
283 **Table 7: Errors Committed while Solving Problems of Criterion Measure:**

284 **CM-1: Constructing a quadrilateral (4 sides and 1 diagonal)**

Task with Error Illustration	% & No. of Students Committing Error
<p>Task: Construct a quadrilateral using four given sides and one diagonal.</p>  <p>30. a) Construct a quadrilateral PQRS where PQ = 4 cm, QR = 6 cm, RS = 5 cm, PS = 5.5 cm and PR = 7 cm.</p> <p>Error: Students did not draw the given diagonal first resulting in incomplete or distorted figures.</p>	<p>27.00 % (6 out of 22)</p>

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

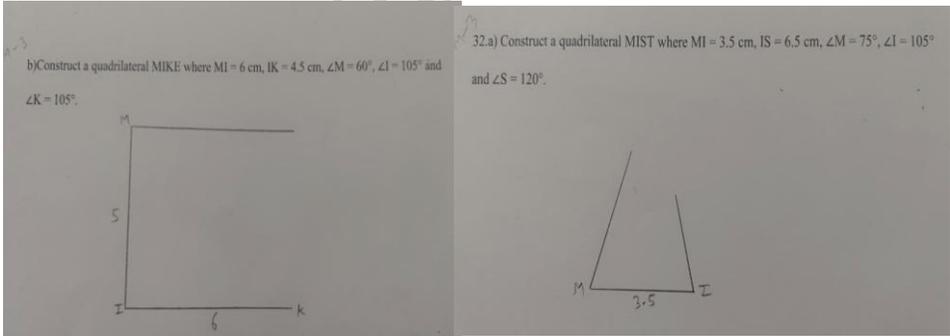
287 **CM-2: Constructing a quadrilateral (3 sides and 2 diagonals)**

Task with Error Illustration	%&No. of Students Committing Error
<p>Task: Construct a quadrilateral using three sides and two diagonals.</p>  <p>31. a) Construct a quadrilateral ABCD, given that BC = 4.5 cm, AD = 5.5 cm, CD = 5 cm the diagonal AC = 5.5 cm and diagonal BD = 7 cm.</p> <p>b) Construct a quadrilateral LIFT, given that LI = 4 cm, IF = 3 cm, TL = 2.5 cm the diagonal LF = 4.5 cm and diagonal IT = 4 cm.</p> <p>Error: Students were unable to use the second diagonal correctly for verification; arcs were drawn inaccurately, and most constructions were left incomplete.</p>	<p>45.45% (10 out of 22)</p>

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289 **Table 9: Errors Committed while Solving Problems of Criterion Measure:**

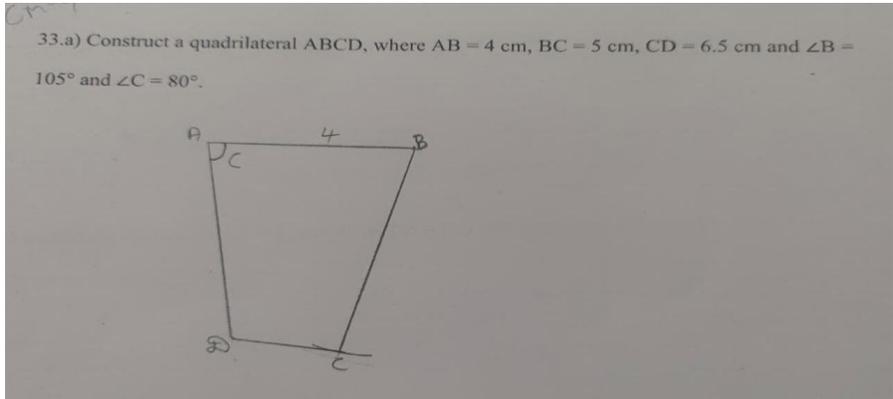
290 **CM-3: Constructing a quadrilateral (2 adjacent sides and 3 angles)**

Task with Error Illustration	%&No. of Students Committing Error
<p>Task: Construct a quadrilateral using two adjacent sides and three given angles.</p>  <p>b) Construct a quadrilateral MIKE where MI = 6 cm, IK = 4.5 cm, $\angle M = 60^\circ$, $\angle I = 105^\circ$ and $\angle K = 105^\circ$.</p> <p>32.a) Construct a quadrilateral MIST where MI = 3.5 cm, IS = 6.5 cm, $\angle M = 75^\circ$, $\angle I = 105^\circ$ and $\angle S = 120^\circ$.</p> <p>Error: Students failed to construct angles accurately using compass/protractor methods and could not locate the fourth vertex through intersection of rays.</p>	<p>54.55 % (12 out of 22)</p>

291

292 **Table 10: Errors Committed while Solving Problems of Criterion Measure:**

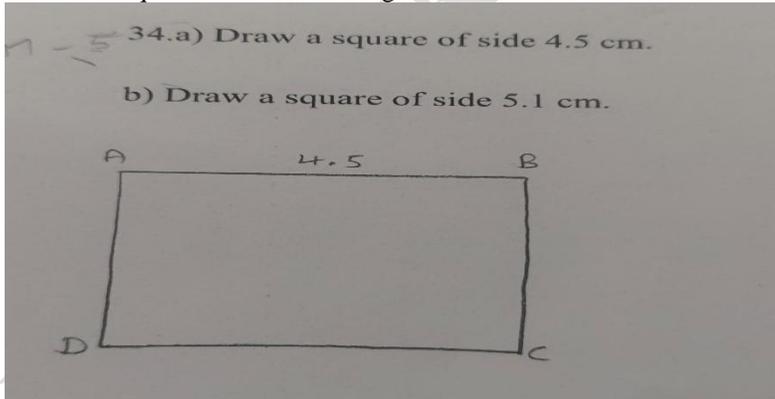
293 **CM-4: Constructing a quadrilateral (3 sides and 2 included angles)**

Task with Error Illustration	% & No. of Students Committing Error
<p>Task: Construct a quadrilateral using three sides and two included angles.</p>  <p>Error: Students were unable to identify included angles correctly; angle construction was inaccurate, leading to non-intersecting rays or incorrect shapes.</p>	<p>59.09% (22 out of 22)</p>

294

295 **Table 11: Errors Committed while Solving Problems of Criterion Measure:**

296 **CM-5: Constructing a square (one side given)**

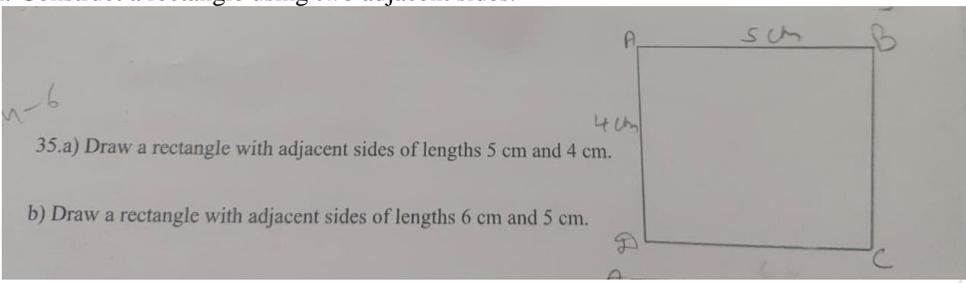
Task with Error Illustration	% & No. of Students Committing Error
<p>Task: Construct a square when one side is given.</p>  <p>Error: Students could not erect perpendiculars accurately at the endpoints of the given side or failed to mark equal side lengths; many left the item unattempted.</p>	<p>31.82% (7 out of 22)</p>

297

298 **Table 12: Errors Committed while Solving Problems of Criterion Measure:**

299 **CM-6: Constructing a rectangle (two adjacent sides given)**

Task with Error Illustration	% & No. of Students Committing
------------------------------	--------------------------------

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

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

304

305 **Major Findings and Discussion: -**

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

315 2. Difficulties were prominently observed in constructing quadrilaterals using given conditions, where students
316 struggled with identifying correct construction steps and sequencing them logically. The study found that
317 constructions involving quadrilaterals under given conditions posed greater difficulty than simpler constructions.
318 Students were often unable to interpret the given data correctly and translate it into an appropriate construction plan.
319 This supports the findings of Nair (2015), who stated that geometry difficulties often arise due to poor conceptual
320 clarity and inability to relate given conditions to construction procedures. Similarly, Clements and Battista (1992)
321 observed that learners with weak spatial reasoning struggle to integrate multiple conditions such as sides, angles,
322 and diagonals, leading to breakdowns in complex geometric constructions.

323 3. A significant number of students showed improper use of geometric instruments, including inaccurate use of the
324 compass and ruler, leading to incorrect constructions. Improper handling of geometric instruments emerged as a
325 major difficulty among students with MLD. Many students failed to maintain a constant compass radius or draw
326 accurate line segments using a ruler. This finding aligns with the work of Hegarty and Kozhevnikov (1999), who
327 highlighted visual-spatial and motor coordination difficulties among students with learning disabilities. Ramaa
328 (2000) also reported that poor instrument-handling skills significantly contribute to failure in Practical Geometry,
329 particularly in tasks requiring precision and accuracy.

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

337 5. Common errors included incorrect drawing of base lines or diagonals, failure to locate vertices accurately using
338 arcs, and incomplete or incorrect joining of sides. The frequent occurrence of these errors indicates students'
339 difficulty in understanding the functional role of each construction step. Similar observations were made by Battista
340 (2007), who found that students with poor spatial structuring skills struggle to visualise intersections and closure of
341 figures. NCTM (2000) also emphasized that lack of conceptual understanding of construction principles leads to
342 incomplete and incorrect geometric constructions.

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

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

359

360

361 **Educational Implications: -**

362 The findings of the present study have several specific educational implications for teaching Practical Geometry to
363 Grade VIII students with **Mathematics Learning Disability (MLD)**. These implications are derived from the
364 observed performance patterns and are intended to improve instructional planning and learner outcomes.

365
366 First, since students exhibited significant difficulty in understanding and executing step-wise construction
367 procedures, geometry instruction should explicitly emphasise **systematic step-by-step teaching**. Teachers need to
368 model each construction step slowly and sequentially, verbalising the reasoning behind every action. Providing
369 written step lists, flowcharts, or visual construction maps can help students internalise the procedural sequence
370 involved in Practical Geometry.

371
372 Second, the pronounced difficulty observed in constructing quadrilaterals with given conditions indicates the need
373 for focused instruction on **interpreting given data**. Teachers should train students to analyse the given conditions
374 before beginning construction by identifying known elements such as sides, angles, and diagonals, and planning the
375 strategy in advance. Guided practice in converting verbal or symbolic information into a clear construction plan can
376 minimise procedural confusion.

377
378 Third, improper use of geometric instruments highlights the necessity for **systematic training in instrument-**
379 **handling skills**. Repeated and supervised practice in using the compass, ruler, and protractor should be provided,

380 with special attention to maintaining constant radius, accurate measurement, steady hand movement, and correct
381 alignment. Remedial sessions may include isolated drills in drawing straight lines, arcs, and circles before
382 integrating these skills into complete constructions.

383
384 In addition, it was observed that a few students drew completely distorted figures — lines were not straight, circles
385 were irregular, and overall presentation reflected poor motor control and unclear handwriting. Such patterns may
386 indicate possible **fine motor coordination difficulties or motor-related learning issues or mathematics phobia**
387 rather than purely conceptual mathematical problems. These students may require further diagnostic assessment by
388 specialists to determine whether an underlying motor disability or developmental coordination difficulty or
389 mathematics phobia is present. Early identification and referral for appropriate support services can help address
390 these challenges effectively.

391
392 Fourth, the recurrence of similar errors across constructions suggests the need for **diagnostic and corrective**
393 **teaching**. Instead of merely pointing out mistakes, teachers should analyse error patterns, identify underlying
394 misconceptions, and provide targeted re-teaching with corrective feedback.

395
396 Fifth, as many difficulties were associated with baseline or diagonal construction, vertex location using arcs, and
397 completion of figures, instruction should emphasise the **functional purpose of each construction step**. Explaining
398 why a step is required and how it influences the next stage will strengthen conceptual understanding alongside
399 procedural competence.

400
401 Sixth, difficulty in maintaining precision, neatness, proper labeling, and verification indicates the need to explicitly
402 teach **checking and verification strategies**. Teachers may introduce structured checklists covering labeling,
403 measurement accuracy, property verification (equal sides, right angles, parallel lines), and overall neatness as
404 integral parts of assessment.

405
406 Finally, variation in performance across criterion measures, particularly greater difficulty in tasks involving multiple
407 conditions, suggests that instruction should follow a **graded progression of complexity**. Students should master
408 simpler constructions before progressing to more complex quadrilaterals. Scaffolded instruction, with gradual
409 increase in task demands, can help manage cognitive load and improve success rates among students with MLD.

410
411 Overall, these implications highlight the importance of structured, diagnostic, remedial-oriented, and
412 multidisciplinary approaches in teaching Practical Geometry. Instruction should be carefully adapted to the specific
413 learning and possible motor-related difficulties identified among students, rather than relying solely on generalized
414 classroom teaching methods.

415
416
417 **Conclusion: -**

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

426
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