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1 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:** - 1 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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1 2 Introduction: - 3 1 **Mathematics Learning Disability (MLD)** or Specific Learning Disability in Mathematics refers to a specific 4 neurodevelopmental disorder in which students exhibit persistent and significant difficulties in understanding and 5 performing mathematical tasks, despite having average or above-average intelligence and receiving adequate 6 instruction. These difficulties are not attributable to sensory impairments, emotional disturbances, or socio-cultural 7 deprivation, but arise from deficits in underlying cognitive processes such as working memory, visual–spatial 8 processing, logical reasoning, attention, and procedural sequencing. 9 Students with MLD commonly experience problems in comprehending mathematical concepts, applying rules 10

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

2 Thus, Mathematics Learning Disability significantly affects students' performance in Practical Geometry and 19 necessitates systematic difficulty analysis and error analysis to inform effective instructional planning and 20 remediation. 21 Need and Importance of the Study 22 Practical Geometry requires students to apply geometric concepts through accurate constructions, demanding 23 precision, sequential thinking, and effective use of instruments. Students with Mathematics Learning Disability 24 often struggle with these requirements, leading to persistent difficulties and repeated errors in geometry 25 constructions. If such difficulties remain unidentified, they negatively affect students' overall achievement and 26 confidence in mathematics. 27 Previous studies have highlighted that 4 students with learning disabilities exhibit difficulties and characteristic errors 28 in geometry tasks. Ramaa and Gowramma (1999) emphasized that geometry-related errors among students with 29 learning disability are not random but arise from specific procedural and conceptual weaknesses. Nair (2015) 30 further pointed out that without proper diagnostic assessment, these learning difficulties often go unnoticed in 31 regular classroom instruction. 32 Despite these findings, there is a lack of focused diagnostic studies examining the specific difficulties and error 33 patterns in Practical Geometry at the Grade VIII level. Identifying these difficulties is essential for planning 34 appropriate

instructional strategies and remedial support. Therefore, the present study is important as it provides a 35 detailed diagnostic analysis of students' difficulties and errors in Practical Geometry, offering valuable insights for 36 teachers, curriculum planners, and teacher educators to improve instructional practices for students with 37 Mathematics Learning Disability. 38 Review Of Related Literature: - 39 Research in mathematics education has consistently shown that 3 students with Mathematics Learning Disability 40 experience persistent difficulties in geometry, particularly in construction-based tasks that demand sequential 41 reasoning, spatial visualization, and precision. Practical Geometry requires learners to understand geometric 42 relationships and execute step-wise procedures accurately, which often becomes challenging for students with 43 learning difficulties. 44 Studies conducted in the Indian context have provided important insights into the nature of these difficulties. Ramaa 45 (1994) emphasized that 4 students with learning disabilities often exhibit weak conceptual understanding and poor 46 procedural control, leading to repeated errors in mathematical tasks. In a later study, Ramaa and Gowramma 47 (1999) reported that high school students with learning disability committed errors in geometry constructions, 48 indicating that such errors were characteristic of underlying procedural and conceptual weaknesses rather than 49 careless mistakes. Their findings highlighted the importance of diagnosing specific error patterns to understand 50 students' learning problems in geometry. 51 Emphasizing the role of diagnosis, Nair (2015) stated that criterion-based diagnostic assessment is essential for 52 identifying 3 specific learning difficulties in mathematics. According to Nair, conventional achievement tests fail to 53 reveal detailed learning gaps, whereas diagnostic analysis enables the identification of precise difficulties related to 54 concepts, procedures, and use of instruments, which are particularly relevant in Practical Geometry. 55 From a methodological perspective, Garrett (1981) stressed that systematic analysis of students' responses is 56 crucial for understanding learning difficulties and error patterns. His work provides the statistical foundation for 57 analyzing item-wise performance and supports the use of diagnostic techniques in educational research. 58

3 International studies also support the need for focused analysis of mathematical difficulties among students with 59 learning disabilities. Fuchs and Fuchs (2001) observed that students with learning difficulties demonstrate 60 consistent and predictable patterns of errors in mathematics, underscoring the importance of identifying specific 61 areas of difficulty for instructional planning. Similarly, Witzel, Mercer, and Miller (2003) pointed out that 62 difficulties in mathematics often arise from inadequate understanding of procedural steps, a concern that is highly 63 relevant to construction-based geometry tasks. 64 A review of the existing literature thus reveals that, although several studies have examined mathematics learning 65 difficulties, limited research has focused specifically on the diagnostic analysis of Practical Geometry at the 66 Grade VIII level, particularly in terms of identifying specific difficulties and error patterns. This gap in research 67 establishes the relevance of the present study, which aims to diagnose the difficulties and errors exhibited by Grade 68 VIII students with **1 Mathematics Learning Disability in** Practical Geometry. 69 Review of Studies Related to Psychological Factors Associated with Mathematics Learning Disability 70 Cognitive Processing Deficits 71 Research consistently identifies deficits in working memory, attention, and processing speed as central 72 psychological factors associated with **1 Mathematics Learning Disability (MLD)**. Learners with MLD struggle to 73 retain intermediate steps, sustain attention during multi-step tasks, and process numerical and spatial information 74 efficiently, resulting in frequent procedural errors (Geary, 1993, 2004; Swanson, 2006; Passolunghi, 2007). In 75 practical geometry, these deficits limit the ability to remember construction sequences and coordinate spatial 76 relationships accurately (Bull & Johnston, 1997; Gathercole & Pickering, 2000). 77 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 85 Executive Functioning Difficulties 86 Executive functioning deficits involving planning, inhibition, cognitive flexibility, and self-monitoring significantly 87 contribute to MLD. These difficulties interfere with strategy selection, organization of solution steps, and error 88 monitoring during mathematical tasks (Bull & Scerif, 2001; Passolunghi & Siegel, 2004; Swanson, 2006). In 89 geometry, poor executive control results in incomplete constructions, incorrect sequencing, and faulty application of 90 geometric rules (Geary, 2011; Mazzocco & Kover, 2007). 91 92 Mathematical Anxiety 93 Mathematical anxiety has been shown to have a strong negative relationship with mathematics achievement. 94 Anxiety consumes working memory resources, thereby reducing efficiency in problem solving and increasing 95 avoidance behaviors among learners with MLD (Hembree, 1990; Ma, 1999; Ashcraft, 2002). In geometry, anxiety 96 often leads to avoidance of visually complex tasks such as diagram interpretation and constructions (Ramirez 97 & Beilock, 2011; Dowker, 2012). 98 99 Low Self-Esteem and Motivation 100 Repeated failure experiences in mathematics negatively influence learners' self-efficacy, academic self-concept, and 101 motivation. Students with MLD often develop beliefs of low mathematical competence, leading to task avoidance 102 and reduced persistence (Bandura, 1997; Chapman, 1988; Marsh & Craven, 2006). In geometry, low self-esteem 103 discourages engagement with construction-based and spatially demanding tasks (Mazzocco, 2007). 104 105

4 Language and Symbol Processing Difficulties 106 Learners with MLD frequently experience difficulty understanding mathematical vocabulary, symbols, and verbal 107 problem statements. These language-related weaknesses affect the correct interpretation of instructions and selection 108 of appropriate operations (Jordan & Hanich, 2000; Fuchs & Fuchs, 2002; Swanson & Beebe-Frankenberger, 2004). 109 In geometry, misinterpretation of definitions, theorems, and symbolic notations leads to conceptual 110 misunderstandings (Passolunghi & Pazzaglia, 2004). 111 112 Visual–Spatial Processing

Deficits 113 Visual–spatial processing deficits are strongly associated with MLD, particularly in tasks involving shape 114 recognition, spatial visualization, and transformations. Learners often struggle with interpreting geometric 115 representations and spatial relationships (Kosc, 1974; Rourke, 1995; Geary, 1993). Research indicates that 116 weaknesses in visuospatial working memory significantly predict poor performance in geometry and related 117 mathematical tasks (Landerl et al., 2004; Mammarella et al., 2015). 118 119 Attention-Related Problems 120 Attention-related difficulties, including poor sustained attention and distractibility, are commonly observed among 121 learners with MLD. These problems contribute to careless errors, incomplete solutions, and inconsistent 122 performance in mathematical tasks (Barkley, 1997; Swanson, 2006). In geometry, attention deficits interfere with 123 accurate drawing, measuring, and following step-by-step construction procedures (DuPaul & Stoner, 2014; 124 Mazzocco & Räsänen, 2013). 125 126 Emotional and Behavioral Factors 127 Emotional and behavioral factors often emerge as secondary consequences of persistent mathematical difficulty. 128 Learners with MLD frequently experience frustration, avoidance, withdrawal, and learned helplessness, which 129 reduce engagement and effective learning opportunities (McLeod, 1992; Gresham, 2002; Hallahan & Kauffman, 130 2006). In geometry, such behaviors limit sustained participation in visually demanding and cognitively complex 131 tasks (Wentzel, 1998; Mazzocco, 2007). 132 133 Objectives of the Study: - 134 1. To analyze the specific difficulties encountered by Grade VIII students with Mathematical Learning 135 Disability while performing problems related to Practical Geometry. 136 2. To analyze the errors committed by Grade VIII students with Mathematical Learning Disability while 137 performing problems related to Practical Geometry. 138 139 Research Questions: - 140 1. What specific difficulties are encountered by Grade VIII students with Mathematical Learning Disability 141 while performing construction tasks related to Practical Geometry? 142 2. What kinds of errors are committed by Grade VIII students with Mathematical Learning Disability while 143 solving problems related to Practical Geometry? 144 145 Methodology: - 146 The present study is of diagnostic in nature and is designed to identify

the specific difficulties and error patterns 147 exhibited by Grade VIII students with **1** **Mathematics Learning Disability in** Practical Geometry. The focus of the 148 study was on examining criterion-wise difficulties and errors in construction-based geometry tasks to obtain an in149 depth understanding of students' learning problems. 150 151 Sample 152 The sample for the present study was selected through a purposive sampling technique, combined with a multi-phase 153 identification procedure, as the study specifically focused on students with Mathematical Learning Disability. This 154

5 approach was essential to ensure that only those students who genuinely exhibited persistent mathematical 155 difficulties were included in the final sample. 156 Initially, permission was sought from ten schools to conduct the study. However, only eight upper primary CBSE 157 schools granted approval. These schools included three Central Government institutions and five private schools, 158 comprising a total of 13 sections at the Grade VIII level. The total student population from these schools was 509 159 students. 160 The identification of **2** **students with Mathematical Learning** Disability was carried out through a systematic screening 161 process, involving clearly defined inclusionary and exclusionary criteria. The process was implemented in multiple 162 stages to eliminate factors other than learning disability that could influence mathematics performance, such as age, 163 attendance, sensory impairments, emotional problems, and lack of exposure. 164 At each stage, students who **2** **did not meet the** required criteria were eliminated, and only those who satisfied all 165 conditions were retained. The details of this elimination and retention process are presented below. 166 Table 1: Number of Students Eliminated and Retained at Various Stages of Identification (N = 509) 167

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
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 168 Mathematical Learning Disability after applying all screening criteria. From these 32 students, 22 participants were 169 finally retained for the study based on feasibility considerations such as regular attendance, availability, and 170 consistency in participation. 171 These 22 identified students were then administered the Mathematics Diagnostic Test for Grade VIII Students in 172 Practical Geometry to assess their difficulties and errors specifically in practical geometry. This formed the basis for 173 diagnostic analysis. 174 Tools Used in the Study 175 The primary tool used in the study was a Mathematics Diagnostic Test for Grade VIII Students in geometry, 176 developed by the research scholar under the guidance of the supervisor to analyse difficulties and errors in 177 mathematics, with specific focus on Geometry criterion-wise. 178 179 Mathematics Diagnostic Test for Grade VIII 180 The test was designed as a criterion-referenced diagnostic tool to assess students' conceptual and procedural 181 understanding in selected areas of Grade VIII mathematics. The content was drawn strictly from the CBSE Grade 182 VIII mathematics syllabus. 183 184 Development of the Mathematics Diagnostic Test for Grade VIII Students 185

6 The test consisted of items mapped to clearly defined criterion measures and sub-criterion measures. Each sub-skill 186 was represented by more than one item, and items were arranged in increasing order of difficulty to facilitate 187 accurate diagnosis. 188 189 Stage I: Content Validation 190 The Mathematics Diagnostic Test was content validated by five subject experts to ensure its relevance, clarity, and 191 suitability for Grade VIII learners. The experts reviewed the items for content coverage, conceptual accuracy, grade 192 appropriateness, and language clarity using a three-point rating scale: Essential, Useful but not essential, and Not 193 necessary. The Scale Content Validity Index (S-CVI) obtained was 0.89, indicating strong content validity and high 194 agreement among the experts. Based on their suggestions, minor revisions were made to improve wording,

remove 195 ambiguity, adjust difficulty levels, and eliminate overlapping items. Of the initial 200 items, 160 were retained as 196 essential, 20 were revised and retained, and 20 were eliminated, resulting in a final set of 180 items for further 197 analysis. 198 Stage II:

Difficulty Index Analysis 199 The items retained after content validation were analysed

5

using difficulty and discrimination indices based on the 200 responses of 95 Grade VIII students. Items that were found to be too easy, too difficult, or having poor 201

discriminating power were either revised or eliminated in accordance with accepted criteria.

The analysis showed 202 that the test items were well distributed across different levels of difficulty, ranging from very difficult to very easy. 203 This balanced distribution indicates

that the diagnostic test is appropriately constructed and suitable for identifying 204 varying

levels of student understanding and learning difficulties in mathematics. 205 206 Stage III:

Discrimination Index Analysis 207 The Discrimination Index of the test items was

determined using the standard procedure suggested by Garrett (1981) 208 by comparing

the performance of the top 27% and bottom 27% of Grade VIII students. This analysis

assessed the 209 ability of each item to distinguish between high and low achievers. The

results indicated that most items exhibited 210 good to excellent discrimination, while a

small number of items showed marginal or fair discrimination and were 211 revised

accordingly. Overall, all items demonstrated adequate discriminating power, and therefore,

all 158 items 212 were retained for use in the final form of the diagnostic test. 213 214

Stage IV: Reliability 215 The reliability of the Mathematics Diagnostic Test was established

using the split-half (odd–even) method and 216 further corrected using the

Spearman–Brown prophecy formula. The obtained reliability coefficient of 0.90 indicates

217 very high internal consistency of the test. Thus, the diagnostic test was found to be

highly reliable and suitable for 218 assessing the mathematical learning difficulties of

Grade VIII students. 219 220 Criterion Measures of Practical Geometry in the Final Test

221 The content area Practical Geometry was analysed using clearly defined criterion

measures and sub-criterion 222 measures to enable precise diagnosis of students'

difficulties. 223 224 Table 5: Criterion Measures of Practical Geometry 225 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

7 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 56 226

Procedure of Data Collection 227 The Diagnostic Test in geometry for Grade VIII

Students was administered to the 22 identified Students with 228 Mathematical Learning

Disability under uniform conditions. Students' responses were scored using the predefined 229 criterion measures and scoring scheme. 230 231 Based on the percentage of scores obtained in each criterion measure, students were classified as Masters (80% and 232 above), Partial Achievers (above 0% and below 80%), and Non-Masters (0%). The diagnostic test data were 233 subjected to difficulty analysis to analyze the specific difficulties encountered by Grade VIII students with 234 Mathematics Learning Disability while performing construction tasks related to Practical Geometry, and to error 235 analysis to analyze the types of errors committed by the students in solving Practical Geometry problems. 236 237 238 Analysis of the Specific Difficulties Encountered by Grade VIII Students with 239 Mathematical Learning Disability while performing operations related to different 240 Criterion Measures of Practical Geometry: - 241 242

8 The analysis of difficulties encountered by Grade VIII students with **1 Mathematics Learning Disability in** Practical 243 Geometry was carried out through a systematic criterion-measure-wise and sub-criterion-measure-wise analysis. 244 Each construction task was broken into essential sub-criterion measures, and students' performance at each step was 245 examined. The number and percentage of students experiencing difficulty in each sub-criterion measure were 246 calculated to determine the level of difficulty. The analysis focused only on identifying difficulties related to 247 understanding construction steps, sequencing procedures, visualising geometric relationships, and using geometric 248 instruments accurately. Observations of students' construction work were used to illustrate how these difficulties 249 manifested. This approach helped identify the specific stages of Practical Geometry constructions where students 250 faced maximum difficulty, providing a clear basis for focused instructional and remedial planning. 251 252 Analysis Difficulties encountered by Students in Practical Geometry 253 Table 1: Difficulties Encountered while Solving Problems of Criterion Measure: 254 CM-1: Quadrilateral (4 sides & 1 diagonal) 255 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. 256

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

CM–2: Quadrilateral (3 sides & 2 diagonals) 258 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. 259

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

CM–3: Quadrilateral (2 adjacent sides & 3 angles) 261 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. 262 Table 4: Difficulties Encountered while Solving Problems of Criterion Measure: 263 CM–4: Quadrilateral (3 sides & 2 included angles) 264 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 nonadjacent 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 Table 5: Difficulties Encountered while Solving Problems of Criterion Measure: 266 CM–5: Square (one side given) 267 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. 268 Table 6: Difficulties Encountered while Solving Problems of Criterion Measure: 269

10 CM–6: Rectangle (two adjacent sides) 270 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 The difficulty analysis of Practical Geometry (Grade VIII) shows that each criterion measure involved multiple sub272 skills, with difficulties compounding across steps. Partial Achievers attempted constructions but committed 273 procedural errors, while most Non-Masters did not attempt the multi-step and angle-based constructions, indicating 274 serious gaps in instrument handling, angle construction, and sequential execution. 275 276 Analysis of the errors committed by Grade VIII 2 students with Mathematical Learning 277 Disability while performing operations related to different Criterion Measures of Practical 278 Geometry: - 279 The error analysis was conducted to identify the type and pattern of errors committed by students while solving 280 problems related to Practical Geometry 281 Error Analysis in Practical Geometry – Grade VIII (N = 22) 282 Table 7: Errors Committed while Solving Problems of Criterion Measure: 283 CM–1: Constructing a quadrilateral (4 sides and 1 diagonal) 284 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) 285

11 Table 8: Errors Committed while Solving Problems of Criterion Measure: 286 CM–2: Constructing a quadrilateral (3 sides and 2 diagonals) 287 Task with Error Illustration %&No. of Students Committing Error Task: Construct a quadrilateral using three sides and two diagonals. Error: Students were unable to use the second diagonal correctly for verification; arcs were drawn inaccurately, and most constructions were left

incomplete. 45.45% (10 out of 22) 288 Table 9: Errors Committed while Solving Problems of Criterion Measure: 289 CM–3: Constructing a quadrilateral (2 adjacent sides and 3 angles) 290 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) 291 Table 10: Errors Committed while Solving Problems of Criterion Measure: 292 CM–4: Constructing a quadrilateral (3 sides and 2 included angles) 293

12 Task with Error Illustration % & No. 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) 294 Table 11: Errors Committed while Solving Problems of Criterion Measure: 295 CM–5: Constructing a square (one side given) 296 Task with Error Illustration % & No. 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) 297 Table 12: Errors Committed while Solving Problems of Criterion Measure: 298 CM–6: Constructing a rectangle (two adjacent sides given) 299 Task with Error Illustration % & No. of Students Committing

13 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 300 Achievers, while most Non-Masters left construction-based items unattempted, especially in angle-based 301 constructions (CM–3 and CM–4). This indicates severe

difficulty in instrument handling, angle construction, and 302 step-wise execution. 303 304
Major Findings and Discussion: - 305 1. Grade VIII ³ students with Mathematics Learning
Disability exhibited considerable difficulties in Practical 306 Geometry, particularly in
understanding and executing step-wise construction procedures. The present study clearly
307 indicates that students with ¹ Mathematics Learning Disability (MLD) experience
major difficulty in following the 308 sequential steps involved in Practical Geometry
constructions. Geometry constructions demand ordered reasoning, 309 recall of rules, and
systematic execution, all of which pose challenges ² for students with MLD. This finding
is in 310 agreement with Ramaa and Gowramma (1999), who reported that students with
learning disability show poor 311 procedural understanding in geometry, resulting in
repeated failure in construction tasks. Geary (2004) also 312 emphasized that procedural
deficits and difficulty in managing multi-step tasks are core characteristics of 313
mathematical learning disability, particularly in rule-based areas such as geometry. 314 2.
Difficulties were prominently observed in constructing quadrilaterals using given conditions,
where students 315 struggled with identifying correct construction steps and sequencing
them logically. The study found that 316 constructions involving quadrilaterals under given
conditions posed greater difficulty than simpler constructions. 317 Students were often
unable to interpret the given data correctly and translate it into an appropriate construction
plan. 318 This supports the findings of Nair (2015), who stated that geometry difficulties
often arise due to poor conceptual 319 clarity and inability to relate given conditions to
construction procedures. Similarly, Clements and Battista (1992) 320 observed that
learners with weak spatial reasoning struggle to integrate multiple conditions such as
sides, angles, 321 and diagonals, leading to breakdowns in complex geometric
constructions. 322 3. A significant number of students showed improper use of geometric
instruments, including inaccurate use of the 323 compass and ruler, leading to incorrect
constructions. Improper handling of geometric instruments emerged as a 324 major
difficulty among students with MLD. Many students failed to maintain a constant compass
radius or draw 325 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 348 aware of construction procedures. 349 350 7. Criterion-wise analysis showed variation in performance, with higher concentration of difficulties and errors in 351 tasks involving multiple conditions compared to simpler constructions such as squares and rectangles. The study 352 revealed that task complexity significantly influenced students' performance. Constructions involving multiple 353 given conditions placed higher cognitive demands, resulting in greater difficulty and error rates. This finding 354 corroborates Geary, Hoard, and Hamson (1999), who noted that increased task complexity intensifies cognitive load 355 2 for students with MLD. Nair (2015) also reported that constructions with multiple constraints require higher levels 356 of conceptual integration and procedural control, which are particularly challenging for students with mathematics 357 learning disability.

358 359 360 Educational Implications: - 361 The findings of the present study have several specific educational implications for teaching Practical Geometry to 362 Grade VIII students with 1 Mathematics Learning Disability (MLD). These implications are derived from the 363 observed performance patterns and are intended to improve instructional planning and learner outcomes. 364 365 First, since students exhibited significant difficulty in understanding and executing step-wise construction 366 procedures, geometry instruction should explicitly emphasisesystematic step-by-step teaching. Teachers need to 367 model each construction step slowly and sequentially, verbalising the reasoning behind every action. Providing 368 written step lists, flowcharts, or visual construction maps can help students internalise the procedural sequence 369 involved in Practical Geometry. 370 371 Second, the pronounced difficulty observed in constructing quadrilaterals with given conditions indicates the need 372 for focused instruction on interpreting given data. Teachers should train students to analyse the given conditions 373 before beginning construction by identifying known elements such as sides, angles, and diagonals, and planning the 374 strategy in advance. Guided practice in converting verbal or symbolic information into a clear construction plan can 375 minimise procedural confusion. 376 377 Third, improper use of geometric instruments highlights the necessity

for systematic training in instrument³⁷⁸ handling skills. Repeated and supervised practice in using the compass, ruler, and protractor should be provided, ³⁷⁹

¹⁵ with special attention to maintaining constant radius, accurate measurement, steady hand movement, and correct ³⁸⁰ alignment. Remedial sessions may include isolated drills in drawing straight lines, arcs, and circles before ³⁸¹ integrating these skills into complete constructions. ³⁸² ³⁸³ In addition, it was observed that a few students drew completely distorted figures — lines were not straight, circles ³⁸⁴ were irregular, and overall presentation reflected poor motor control and unclear handwriting. Such patterns may ³⁸⁵ indicate possible fine motor coordination difficulties or motor-related learning issues or mathematics phobia ³⁸⁶ rather than purely conceptual mathematical problems. These students may require further diagnostic assessment by ³⁸⁷ specialists to determine whether an underlying motor disability or developmental coordination difficulty or ³⁸⁸ mathematics phobia is present. Early identification and referral for appropriate support services can help address ³⁸⁹ these challenges effectively. ³⁹⁰ ³⁹¹ Fourth, the recurrence of similar errors across constructions suggests the need for diagnostic and corrective ³⁹² teaching. Instead of merely pointing out mistakes, teachers should analyse error patterns, identify underlying ³⁹³ misconceptions, and provide targeted re-teaching with corrective feedback. ³⁹⁴ ³⁹⁵ Fifth, as many difficulties were associated with baseline or diagonal construction, vertex location using arcs, and ³⁹⁶ completion of figures, instruction should emphasise the functional purpose of each construction step. Explaining ³⁹⁷ why a step is required and how it influences the next stage will strengthen conceptual understanding alongside ³⁹⁸ procedural competence. ³⁹⁹ ⁴⁰⁰ Sixth, difficulty in maintaining precision, neatness, proper labeling, and verification indicates the need to explicitly ⁴⁰¹ teach checking and verification strategies. Teachers may introduce structured checklists covering labeling, ⁴⁰² measurement accuracy, property verification (equal sides, right angles, parallel lines), and overall neatness as ⁴⁰³ integral parts of assessment. ⁴⁰⁴ ⁴⁰⁵ Finally, variation in performance across criterion measures, particularly greater

difficulty in tasks involving multiple 406 conditions, suggests that instruction should follow a graded progression of complexity. Students should master 407 simpler constructions before progressing to more complex quadrilaterals. Scaffolded instruction, with gradual 408 increase in task demands, can help manage cognitive load and improve success rates among students with MLD. 409 410 Overall, these implications highlight the importance of structured, diagnostic, remedial-oriented, and 411 multidisciplinary approaches in teaching Practical Geometry. Instruction should be carefully adapted to the specific 412 learning and possible motor-related difficulties identified among students, rather than relying solely on generalized 413 classroom teaching methods. 414 415 416 Conclusion: - 417 The present study revealed that Grade VIII 3 students with Mathematics Learning Disability experience substantial 418 difficulties in Practical Geometry, particularly in understanding construction conditions, sequencing steps, using 419 geometric instruments accurately, and maintaining precision. These difficulties were more pronounced in 420 constructions involving multiple given conditions. The findings highlight the need for structured, step-wise, and 421 diagnostic-based instructional approaches in teaching Practical Geometry. By identifying specific difficulty areas 422 through criterion- and sub-criterion-measure-wise analysis, the study provides a clear basis for targeted remedial 423 instruction, thereby contributing meaningfully to improving geometry learning among students with Mathematics 424 Learning Disability. 425 426 References: - 427 428 Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Cognition*, 85(2), 181– 429 185. [https://doi.org/10.1016/S0010-0277\(02\)00196-1](https://doi.org/10.1016/S0010-0277(02)00196-1) 430 Ashlock, R. B. (2010). *Error patterns in computation* (10th ed.). Pearson Education. 431

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