# DIAGNOSTIC TESTING IN MATHEMATICS- A LITERATURE REVIEW

## ABSTRACT

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Diagnostic Testing helps to provide remedy for learning difficulties that are unresolved by the standard corrective prescriptions of formative evaluation. The results from diagnostic testing assist institutions to devise approaches to adjust the Mathematics teaching and curriculum to the needs of the students and also to inform subject specialists' expectations of their student mathematical abilities (LTSN, 2003). The purpose of this paper is to bring together the findings from a review of a significant part of the available literature associated with development and effectiveness of Diagnostic Test in Mathematics. The findings indicate that diagnostic assessment is a powerful tool to identify the learning deficiencies of students in mathematics.

The Engineering Council of United Kingdom recommended to all universities that those students embarking on Mathematics based degree courses should have a diagnostic test at the entry level (Engineering Council, 2000). Moreover, National Curriculum Framework (2005) suggested that teachers require specific training in diagnostic testing that can be of assistance in remediation efforts. Schonell (1957) pointed out that the purpose of a diagnostic test is to discover as fully as possible what pupil knows and what he does not know. Skinner (1962) remarked that Diagnostics Tests are constructed to provide a pattern or detailed analysis of individual performance in various skills and abilities. The results from diagnostic testing assist institutions to devise approaches to adjust the Mathematics teaching and curriculum to the needs of the students and also to inform subject specialists' expectations of their student mathematical abilities (LTSN, 2003). Diagnostic assessment is a means by which a teacher and a learner

iteratively and mutually agree to collaborate in monitoring a learner's conceptions and in deciding upon subsequent remediation (Muwanga-Zake, 2006).

## Identification of Learning Deficiencies

The review related to development and use of diagnostic testing in mathematics reveal that diagnostic tests in mathematics are really valuable instruments to identify causes of backwardness, patterns of disabilities among slow learners, causes of underachievement, level of difficulties and learning deficiencies of learners in any particular area/s of mathematics. Diagnostic Assessment is a concise tool for classroom teachers and special educators to use in differentiating instruction and monitoring student progress. A summary of the diagnostic tests in different topics of mathematics to identify the difficulties faced by the students of class V to class VIII, developed and used by various researchers is given in the Table 1.

Author	Year	Name of Test	Findings
Rastogi	1983	Diagnostic Test of	Poor command over the basic Arithmetic Skills
		basic Arithmetic Skills	
Dutta	1986	Congruency of Triangles	Identification of thirty-three major patterns of disabilities
			among slow learners in Geometry
Chel	1990	Diagnostic Test of Underachievement of Middle School Examination	<ol> <li>Difficulties faced by students included concept gaps, confusion in understanding Mathematical language, stereotype way of presenting contents and lack of openness in teaching.</li> <li>Mistakes by students and teacher trainees in Mathematisation of verbal problems, interpretations of Mathematical results and learning new topics in Mathematics.</li> </ol>

**Table 1 :** A summary of the diagnostic tests in different topics of mathematics to identify the difficulties faced by the students of class V to class VIII

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			3. Underachievement was caused due to lack of understanding of the Mathematical concepts at the earlier stage, and the abstract nature of Mathematics.
Mulla	1997	Battery for Diagnostic Tests (Fractions)	<ol> <li>Learners from standard V found the definitions of Fraction, Decimal Fraction and Equivalent Fraction difficult</li> <li>More than 90% of learners from standard V could not add or subtract Fractions with like denominators and could not solve word problems based on it.</li> <li>In addition to (2), the learners from standard VI faced the difficulties in Recurring decimal; operations- addition and subtraction of decimal fractions and multiplication and division of two decimal Fractions.</li> <li>Learners from standard VII and VIII had learning deficiencies in Decimal Fraction and Mixed Fraction; operation- addition and subtraction of two Fractions with like denominators and unlike denominators, multiplication and division of Fractions and decimal Fractions; Application of word problems on percentage.</li> <li>The learners of standard VIII had learning deficiencies in mixed operations involving three Fractions and four Fractions.</li> </ol>
Wright, Stanger, Stafford, and Martland	2006	1. Student Numeracy Assessment Progressions (SNAP) 2. Learning Framework in Number (LFIN)	Teachers gained awareness of the many facets of early numeracy.
Sharma and Devi	2012	Diagnostic Test	Level of difficulty was different in different topics and difficulty level was maximum in topics of 'Understanding Quadrilateral and Mensuration'.
Lee and Robinson	2004	Paired Question Style Diagnostic Test	Several students were identified as in need of extra support that included setting up of individual action plans for some and offering help through drop-in sessions in the Mathematics Learning Support Centre for others.

# Standardized Diagnostic Tests in Mathematics

Diagnostic tests are essentially power tests that begin with very simple items and then progress in difficulty. The development of good diagnostic tests depends upon two major assumptions: (1) the ability to analyze skills or knowledge into component subskills, and (2) the ability to develop test items that will validly measure these subskills. A number of researchers prepared and standardized diagnostic tests in mathematics covering different branches or topics. A description obtained from the review of literature associated with construction and standardization of diagnostic testing in mathematics is given in the Table 2.

Author	Year	Name of Test	Reliability, Validity and Percentile Norms
Bhattacharya	1986	1. One Diagnostic Test in Linear Equation in one Unknown 2.Three Diagnostic Tests in knowledge of solving, understanding, and application of the same	Reliable and valid
Bhardwaj	1987	Diagnostic Test in Mathematics (consisting of three branches namely Arithmetic, Algebra and Geometry)	<ol> <li>Reliability established through the Test-retest Method had a Reliability Coefficient ranging from 0.81 to 0.91 for each of the three areas and the whole test</li> <li>Intrinsic Validity of the test for all the three areas and the whole test ranged from 0.90 to 0.95.</li> <li>Validation of the test against students' marks in Mathematics in the public examination gave a value of 0.83.</li> <li>Percentile norms were established and the scores were categorized in five-fold categories ranging from very good to very poor</li> </ol>
Busamma	1995	Diagnostic Test in Exponents and Powers (DTEP)	Percentile norms were formulated
Alam	2010	Mathematics Diagnostic Test for class – I	Highly reliable and valid

Table 2 : A description of construction and standardization of diagnostic testing in mathematics

#### **Remedial Teaching**

Many researchers assert that use of diagnostic testing in mathematics followed by appropriate adopted F.J. Schonell's Diagnostic Arithmetic Tests followed by remedial teaching and reported that the Remedial Teaching had significantly improved the Achievement in Arithmetic. The finding was supported by Dutta (1990) when he used a diagnostic test to diagnose the problems in reasoning faced by students in learning Geometry. After diagnosing the problems, he adopted a teaching strategy involving use of audio-visual materials. He asserted that learning through Audio-visual Materials caused more prolonged retention than through Conventional Method.

## International Assessments

Diagnostic testing can also be used as a means to compare the students at international level. Dogan and Tatsuoka (2008) studied how a Diagnostic Testing Model can be used to make detailed comparisons between student populations participating in international assessments. He concluded that Turkish students were weak in algebra and probability/statistics. They also demonstrated poor profiles in skills such as applying rules in algebra, approximation/ estimation, solving open-ended problems, recognizing patterns and relationships, and quantitative reading.Similarily, Im and Park (2010) compared the US and Korean students' Mathematics skills using a Cognitive Diagnostic Testing Method.. The results showed substantial differences between the US and Korean students' performance in problem restructuring and reasoning, measurement, and geometry. The most helpful instructional strategy for both Korean and US students was encouraging students' independent problem solving. Reviewing, reteaching, and clarifying content were especially effective for the US students.

### Improvement in Students' Future Performance

Many studies have been conducted to study the effectivenessof various diagnostic testing systems. The studies argue that use of diagnostic assessment improves the scores of students in mathematics tests. It is evident as Betts, Hahn, &Zau (2011) studied the effect of the Mathematics Diagnostic Testing Project (MDTP) testing on students' Mathematics Achievement and concluded that the mandatory MDTP testing boosts scores on the California Standards Test's Mathematics Test enough to move students up several percentile points. This argument was supported by James (2012) who pointed out that the formative test with feedback and remediation group performed better than the other groups without feedback and remediation. Konstantopoulos, Miller, Ploeg, Li and Traynor (2011) studied the impact of Indiana's System of Diagnostic Assessments on

# Mathematics Achievement. The investigator found that across all grades (K to 8) the treatment effect was positive. ICT and Diagnostic Testing in Mathematics

In the present digital age, the use of ICT is necessary for quality education. If it is used there is enough scope for the learner to dynamically interact with the content to construct their own meaning. Such efforts can be made in the field of testing, to diagnose the strengths and weaknesses of students in a particular subject and then providing remedies. Appleby (2000) reported the use of Diagnostic Testing, using the computer-based test DIAGNOSYS. He concluded that consistent testing could give useful information to individuals and for groups, but that both prediction of subsequent success and selection of groups for remediation must proceed with caution. Muwanga-Zake (2006) studied the Diagnostic value of Computer Assisted Assessment (CAA) in the process of teaching and learning and reported that learners improved due to self-assessment and descriptive feedback which enabled them to diagnose and remedy mistakes themselves, through dialogue with or without assistance from the teachers. Wang, Jiao, Young, Brooks and Olson (2008) compared Computer-Based and Paper-and-Pencil Testing in K-12 Reading Assessments. They observed that in recent years, Computer-Based Testing (CBT) has grown in popularity and will likely to become the primary mode for delivering tests in the future. Ahmad, Al-Mashari and Al-Lawati (2010) developed a Computer Based Diagnostic tool that generated a diagnostic report alongwith remedial advices to be utilized by the instructor to enhance process of the learning in cases when the learner experiences severe learning difficulties.

#### Conclusion

The aim of this paper was to provide information on the use of diagnostic testing in mathematics. The findings of this study indicate that diagnostic assessment is a powerful tool to identify the learning deficiencies of students in mathematics. It is also evident that if students are provided with appropriate remedial teaching or teaching strategies are changed on the basis of diagnosis made, the likelihood of their improvement in scores increases. Therefore, it is advisable for the schools to implement diagnostic evaluation in mathematics. It will, certainly, remove the negative reinforcers, like, fear, tension, anxiety etc. from the students. School authorities should organize special training programmes for teachers in diagnostic evaluation, especially, in computer based diagnostic evaluation.

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