

CONSTRUCTION OF THREE TIER CONCEPT ACHIEVEMENT TEST (TTCAT) IN MATHEMATICS

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Abstract

This paper includes the construction of Three Tier Concept Achievement Test (TTCAT) in Mathematics. The Three Tier Concept Achievement Test (TTCAT) is a criterion referenced test which is helpful to assess errors and misconceptions in mathematics learning prevalent among secondary school students. The first tier of an item on the test presents an ordinary multiple choice or alternate response questions, the second tier presents a set of reasons for the response given to the first tier, and the third tier questions if examinees are confident for their responses to the first two tiers. In the light of review of related literature and the discussions with the experts in the field, the scale was constructed for the students of IX class of C.B.S.E affiliated schools. It was observed that 38% of items fall in knowledge domain, 24% comprehension domain, 13% in application domain, 11% in analysis domain, 7% in synthesis domain and 7% in evaluation domain. The final draft of Three Tier Concept Achievement Test (TTCAT) in Mathematics was prepared on the basis of item response and content validity. The reliability of Three Tier Concept Achievement Test (TTCAT) was accomplished by Rational Equivalence or Kuder Richardson Method. The reliability of the Three Tier Concept Achievement Test (TTCAT) was estimated as 0.77.

Key Words: Construction, Achievement Test, and Three Tier

Introduction

It is a well known fact that despite the best efforts made by teachers, students fail to grasp fundamental ideas. Students give right responses by using correctly memorized words. When questioned more closely these students fail to explain the underlying concepts (Mestre, 1999). Errors may be due to mistakes, false negatives, lack of knowledge and misconceptions among students (Eryilmaz and Surmeli, 2002;

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Pesman, 2005 and Kutuluay, 2005). All the errors are not misconceptions. Misconceptions refer to intuitive ideas that students have constructed for themselves as a result of experience with their physical environment, popularly known as students' conceptions, children's science alternative conceptions or alternative frameworks (Gilbert and Watts, 1983) and as private concepts, naive theories and half truths (Mestre, 1987) and as naive conceptions or naive knowledge (Reiner, Slotta, Chi and Resnick, 2000) and as commonsense beliefs (Hestenes, Well and Swackmer, 1992).

An array of tools has been used by the researchers to identify and diagnose the misconceptions among the student's viz. questionnaires (Orhun, 1983; Wax and Stavy, 1987; Schoon, 1989; Chang, 1999; Sindhu and Sharma, 2004), Concept mapping (Ross, 1989; Cakir and Crawford, 2001), Interviews (Piburn et al., 1988; Chang, 1999), two tier diagnostic tests (Treagust, 1988; Lai, 2007; Chandrasegaran, Treagust and Mocerino, 2008) and three-tier diagnostic tests (Kutluay, 2005; Haki, 2005; Pesman, 2005; Turker, 2005; Ozlem, 2007; Baweja, 2008; Bala, 2011; Kaur 2011).

The present study was carried out with the following objective:

To develop Three Tier Concept Achievement Test (TTCAT) which is helpful to assess and measure the errors and misconceptions in mathematics learning among secondary school students.

The Three Tier Concept Achievement Test (TTCAT) consist of Three Tiers viz. multiple choice items and alternate response items in the first tier, reasoning part in second tier and confidence scale in the third tier. To develop Three Tier Concept Achievement Test (TTCAT) the content was selected from the mathematics text book of grade IX prescribed by the central board of school education.

Development of Three Tier Concept Achievement Test (TTCAT) In Mathematics

(A) Preparation of Preliminary Draft

I) Writing Instructional Objectives

Instructional objectives serves as a guide for students, act as a basis for selection of instructional material, procedure and to determine appropriate way to evaluate the learning of students. It is also called performance or behavioral objectives. The course content of class IX dealing with the concepts of number system, polynomials and Linear equations in two variables were content analyzed to prepare instruction objectives which deal with determination of achievement of students. Instructional objectives were formulated by keeping in view Conciseness, Specificity, Measurable, Realistic, Describe expected behavior of the items.

II) Classification of Instruction Objectives in Terms of Bloom's Taxonomy

Benjamin Bloom classified educational objectives in three domains i.e. cognitive domain, Affective domain and psychomotor domain. The Cognitive domain elucidates the intellectual and mental skills and is

further grouped into six broad categories viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. So the instructional objectives covering the content area in three chapters of Mathematics test book of IX class prescribed by the NCERT were classified in terms of Bloom taxonomy. It was observed 33% of items fall in knowledge domain, 23% comprehension domain, 13% in application domain, 11% in analysis domain, 9% in synthesis domain and 11% in evaluation domain.

III) Preparation of Preliminary Draft of Three Tier Concept Achievement Test (TTCAT)

On the basis of content area, the Instructional Objectives covering this content area in totality and the list of misconceptions obtained on literature review, Three Tier Concept Achievement Test (TTCAT) was prepared with First-tier consisting of 55 multiple choice items with one answer and three distracters and alternate response, Second Tier consisting of reasoning part and Third-Tier consisting of five point confidence scale ranging from confident to not at all confident given after each question.

(B) Scoring of Preliminary Draft

Each item was scored on three points viz. One mark is given to every right response and zero mark for every wrong response on items of Tier I ; One mark is given to every right reason and zero mark for every wrong reason on items of Tier II ; One mark is given if the student is confident for the responses given in the first and second tiers and zero if the student is not confident for the responses given in the first and second tier.

(C) Students' response analysis

The test was administered to 50 students of Pine Grove Public School, Bassi Pathana, Fatehgarh Sahib. Before administration of the test, rapport was established with the students. General instructions were given to the students to attempt the test. Every precaution was taken to ensure normal conditions during administration of the test.

After preliminary try out, problems faced by the students were noted down and given due consideration at the time of revision of first draft. Discussions were held with the students and the mathematics teachers on the basis of their performance.

In the light of the views of mathematics teacher and discussion with the students, the Three Tier Concept Achievement Test (TTCAT) was reviewed. As a result ten irrelevant and ambiguous items were eliminated, five items were modified with slight changes and three items were improved by modifying distracters.

Judgmental approach was used for item analysis. Item Analysis involves examination of the characteristics of test items which is an imperative aspect of

test analysis. The purpose of item analysis is fixing marks of current class providing diagnostic information of students; the content validation of TTCAT was done in following manner.

1. **Subject Expert Advice-** The test book of IX class as prescribed by the NCERT, the instructional objectives and the Three Tier Concept Achievement Test with 55 items were given to the subject expert to sought their advice on the validity of the test items in relation to instructional objectives
2. **Language Expert-** The test items were also given to the Language experts to seek their advice on the conciseness, appropriateness and relevance of the test items in linguistic terms.

(D) Final Draft Of the Test

Final draft of the Three Tier Concept Achievement Test (TTCAT) was prepared on the basis of response analysis. The final draft of the test comes out with 45 items with Three Tiers viz. multiple choice items and alternate response items in the first tier, reasoning part in second tier and confidence scale in the third tier.

Specification In Terms Of Objectives and Content

Content	Knowledge No of initial items - No. final items	Comprehension No of initial items - No. final items	Application No of initial items - No. final items	Analysis No of initial items - No. final items	Synthesis No of initial items - No. final items	Evaluation No of initial items - No. final items	Total No of initial items - No. final items
Number System	5-0 = 5	4-0 = 4	3-0 = 3	2-0 = 2	2-1 = 1	2-1 = 1	18-2 = 16
Polynomials	5-1 = 4	5-0 = 5	2-1 = 1	2-0 = 2	2-1 = 1	2-1 = 1	18-3 = 15
Linear Equations in two variables	8-0 = 8	4-2 = 2	3-1 = 2	1-0 = 1	1-0 = 1	2-1 = 1	19-4 = 14
Total	18-1 = 17	13-2 = 11	8-2 = 6	5-0 = 5	5-2 = 3	6-3 = 3	55-10 = 45
Percentage	38%	24%	13%	11%	7%	7%	100%

(E) Reliability of the Test

Rational Equivalence or Kuder Richardson Method Formulas are used for estimating the internal consistency of the test. This method is used to measure inter-item consistency of the homogeneous test in which items should be scored either 1 or 0, that is all correct answers should be scored as +1 and all incorrect

answers should be scored as zero.

The test was administered to the students, who were not included in the population. Rational Equivalence or Kuder Richardson reliability coefficient was estimated for the test as 0.77.

(F) Time Limit Of the Test

When the preliminary draft was administered to the students the time taken by each student was noted to have the estimate of the time required for the completion of the test. Time taken when the preliminary draft was administered to the students the time taken by each student was noted to have the estimate of the time required for the completion of the test. Time taken by the students to complete the test is fifty minutes, fifty five minutes, sixty minutes, and sixty five minutes. Maximum students took sixty minutes. Hence the time limit for the completion of the TTCAT was set as sixty minutes.

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