



CONSTRUCTION AND STANDARDIZATION OF AN ACHIEVEMENT TEST IN PHYSICAL SCIENCE

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Abstract: In the present study a standardized achievement test was constructed to measure achievement in physical science of class IX students. The initial draft of the test consisted of 74 items from 4 chapters in Physical Science of class IX which were as follows “Matter in our Surroundings” and “Is Matter Around us Pure” from Chemistry and “Motion” and “Forces and Laws of Motion” from Physics. For item analysis, the difficulty value and discrimination power of each item was calculated and items that have difficulty value of less than 0.15 and more than 0.85 were eliminated and the final form of the test consist of 40 items. The reliability of test was calculated by method of Cronbach’s Alpha and found to be 0.91. Validity of the test was determined by using content validity method.

Keywords: Achievement Test, construction, reliability, validity, physical science.

INTRODUCTION

Physical science is the branch of natural sciences which deals with non-living things. It includes physics which is the study of matter and its motion through space and time and chemistry which is the study of structure, composition and properties of matter. In the field of school education, the school administrators and teachers plays a very important role in improving student’s learning and achievement. Latest methods of teaching and evaluation techniques are necessary to meet the need of the fast growing society. Achievement test is used to measure knowledge or skills of learners developed in a particular grade level or after receiving training or instructions for definite period of time. It is measured in test scores where high scores indicate mastery in learning and low scores indicate poor learning. Bhagat and Baliya (2016) developed achievement test in science for class VIII for J&K Board of school education. It was intended to measure knowledge based on something learned. Sharma & Sarita (2018) constructed standardized achievement test in science for class VII students. This test consisted of 80 items of multiple choice type. The reliability was calculated by Test-retest method and its value was found to be 0.84 and validity was established by content validity method. Balta and Eryilmaz (2020)

developed modern physics achievement test for high school students.. This test consisted of 23 items of which 5 were true-false type, 6 matching type and 12 MCQ. Reliability was found to be 0.75 and content validity was found out.

Construction and Standardization of Physical Science Achievement Test

Achievement test was constructed in accordance with cognitive domain of Bloom's Taxonomy. The objectives of teaching include Remembering, Understanding, Applying and High order thinking skills for learning physical science at secondary level. Before constructing achievement test, researcher reviewed the literature related to achievement test in physical science and after thorough investigation a need was felt for construction of achievement test in physical science for class IX students according to CBSE syllabus. The Science textbook for class IX, Pradeep's Science (Part I) for Physics and Pradeep's Science (Part II) for Chemistry were used for framing items of the test. Four important units of physical science were identified and questions were carefully framed from these units. On this basis initial draft of the test was prepared which consisted of 74 items which are in the form of multiple choice questions. This draft was assessed by subject experts who judge the worth of each item included in the test. After suggestions from subject experts the revised version of initial draft consisted of 60 items.

According to (Singh,2006) the following general steps are used for test construction which are as follows:

1. Test Planning
2. Item Writing
3. Try-out of the test
4. Item Analysis
5. Reliability
6. Validity

1. Planning of the test: It is the first step for test construction. In this step, researcher clearly specifies the objectives of the test. Researcher selects the nature of content or items to be included, instructions to be imparted, sampling method, pre try-out and final try-out of the test, length and time-limit for the test, statistical methods to be used etc.

In this test researcher opted physical science subject of IX standard under CBSE syllabus for preparation of test. Multiple choice type questions were prepared where each item had 4 options. A blueprint of the test was prepared in view the content area and objectives of learning as per Bloom's Taxonomy of educational objectives.

2. Item Writing: It is very crucial step in test preparation. It requires a lot of hard work and intelligence on part of item writer to develop test items. Items should not be too easy or difficult, should not promote guesswork, should be easy to read and no ambiguity should be their regarding its meaning for both item writer as well as students who takes the test.

The initial draft of the test consisted of 74 items from two units of physics and two units of chemistry of class IX . Each item of the test was of multiple choice type with four different options and only one option was correct answer. This draft was presented to subject experts for evaluation and based on their suggestions some of the items were modified and some were deleted. The revised draft consisted of 60 items.

Table 1: Distribution of weightage to Objective of learning as per Bloom's Taxonomy of educational objectives in Initial draft of Test.

S.No	Objectives of Learning	Number of Items	Percentage
1	Remembering	14	23
2	Understanding	24	40
3	Applying	12	20
4	HOTS	10	17
	Total	60	100

Table 2: Distribution of weightage to Content area of Physical Science in Initial draft of Test.

S.No	Objectives of Learning	Number of Items	Percentage
1	Matter in our Surroundings	15	25
2	Is Matter Around Us Pure	15	25
3	Motion	15	25
4	Forces and Laws of Motion	15	25
	Total	60	100

Size and type of test: Initial draft of achievement test consisted of 60 items which are of multiple choice type items. The number of items in initial draft is more in number than the desired number of items in the final draft because it is difficult to prepare all good items in first attempt.

Preparation of Blueprint:

Table 3: Blue Print for Initial draft of Achievement Test in Physical Science

Content	Remembering	Understanding	Applying	HOTS	Total
Matter in our Surroundings	2	9	2	2	15
Is Matter Around Us Pure	4	9	1	1	15
Motion	4	5	2	4	15
Forces and Laws of Motion	4	1	7	3	15
Total	14	24	12	10	60

Table 4: Distribution of question in each objective of learning in Initial draft of Test.

Remembering	1,6,11,16,21,26,31,32,38,39,46,47,54,55
Understanding	2,3,7,8,12,13,17,18,22,23,27,28,33,34,35,40,41,42,48,49,50,56,57,58
Applying	4,9,14,19,24,29,36,43,44,51,52,59
HOTS	5,10,15,20,25,30,37,45,53,60

3. Try- out of the test : Initially the test was administered on 40 students through random sampling method from secondary schools of Aligarh district. This is done to check any difficulty in language or any other issue regarding construction of test. No time limit is set and the time taken by students to complete the test is noted down.

Final Try-out: The test was administered on 100 students out of which 64 were boys and 36 were girls randomly selected from secondary schools of Aligarh district. Written instructions were given on the top of the test and the time limit for the test was one hour. Oral instructions were also given before the commencement of the test.

Scoring: The scoring key is prepared in advance by the researcher , where each correct item is given one mark and wrong answer is given a zero mark. There is no negative marking for any wrong answer.

4. Item Analysis: It is the procedure by which validity of each item in the test is found out. It tells us which item should be included in the test and which one should be modified or eliminated from the test. This procedure involves the following steps:

Difficulty Value: It can be defined as the percentage of students who answered the item correctly. Its value can vary from 0% to 100% and higher the value , easier is the item. The items which are answered correctly by 0% or 100% students have no differentiating significance. The optimum difficulty value is 50% for maximum discrimination between high and low achievers. Generally items of moderate difficulty values are preferred. In this test items which were answered correctly by 85% of students were considered easy and those items which were answered incorrectly by 85% were considered to be difficult . Therefore, items having difficulty value of less than 0.15 (Very Difficult items) and more than 0.85 (Very Easy items) were eliminated.

Difficulty value of the item can be calculated by following formula:

$$P = \frac{R}{N}$$

Where,

P = Difficulty Value

R = Number of students who answered the items correctly

N = Total number of students

Table : Distribution of Difficulty value of Items for Initial draft of the test.

Level of Difficulty	Item Number	Total
High (< 0.15)	4,5,10,16,17,18,38,57,59	9
Medium (0.15 – 0.85)	1,2,3,4,6,7,8,9,11,12,13,14,15,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,58,60	51
Low (> 0.85)	-	0

Discrimination Power: It is the ability of the item to separate the superior from the inferior on the basis of their scores in the entire test. The range of discrimination index is from -1 to +1. The common method to calculate discrimination index is the use of correlation techniques. In this test Pearson Product Moment Correlation Technique was used to calculate the correlation between total score and the individual item score of all respondents. Items having correlation coefficient values of less than 0.35 were discarded.

Table : Distribution of Discrimination Power of Items for Initial draft of the test.

Discrimination Power	Item Number	Total
< 0.35	1,4,5,8,10,16,17,18,20,23,24,25,28,34,35,38,42,46,57,59	20
0.35 and above	2,3,6,7,9,11,12,13,14,15,19,21,22,26,27,29,30,31,32,33,36,37,39,40,41,43,44,45,47,48,49,50,51,52,53,54,55,56,58,60	40

The 20 items have been discarded from the initial draft of the test .

Table 6 : List of Items discarded from the initial draft of the test.

Discarded Item Numbers	Item
1, 4, 5, 8, 10, 16, 17, 18, 20, 23, 24, 25, 28, 34, 35, 38, 42, 46, 57, 59	

Final Draft of Achievement Test: The final draft of test was prepared on the basis of Item Analysis and it consisted of 40 items.

Table 7 : Distribution of weightage to Objective of learning as per Bloom's Taxonomy of educational objectives in final draft of Achievement Test.

S.No	Objectives of learning	Number of Items	Percentage
1	Remembering	10	25
2	Understanding	15	37.5
3	Applying	9	22.5
4	HOTS	6	15
	Total	40	100

Table 8 : Distribution of Weightage to Content in final draft of Achievement Test.

S.No	Objectives of learning	Number of Items	Percentage
1	Matter in our Surroundings	9	22.5
2	Is Matter Around Us Pure	11	27.5
3	Motion	10	25
4	Forces and Laws of Motion	10	25
	Total	40	100

Table 9 : Blue Print for final draft of Achievement Test

Content	Remembering	Understanding	Applying	HOTS	Total
Matter in our Surroundings	2	5	1	1	9
Is Matter Around Us Pure	2	7	1	1	11
Motion	4	2	2	2	10
Forces and Laws of Motion	2	1	5	2	10
Total	10	15	9	6	40

Table 10 : Distribution of question in each objective of learning in final draft of Test.

Remembering	1, 2, 9, 10, 17, 18, 25, 26, 31, 36
Understanding	3, 4, 5, 11, 12, 13, 19, 20, 21, 27, 28, 32, 33, 37, 38
Applying	6, 7, 14, 15, 22, 23, 29, 34, 39
HOTS	8, 16, 24, 30, 35, 40

Standardization of Achievement Test: The final form of Achievement test consist of 40 items. The test was standardized by establishing reliability and validity of the test.

5. Reliability: It is very important property of any test. It tells us about the accuracy of measurement of any test. If a test is reliable then it should give consistent results both at present as well as with time. There are various methods which can be used to calculate reliability of any test

and these are as follows Test-Retest, Internal Consistency, Kuder-Richardson Formula etc. In this test reliability was calculated by using scores of 100 students on 40 item of the test by using method of Cronbach's Alpha and give the value of $\alpha = 0.91$. This shows that the test was very reliable.

6. Validity: It tells us about the purpose for which test is prepared. It checks whether the test is fulfilling the purpose for which it is made. It should measure what it intends to measure. There are various methods to calculate validity of the test and they are content validity criterion-validity, predictive validity, concurrent validity etc. In this test it is calculated by using content validity method. Items of the test were checked by 5 experienced science teachers and only those items were included in the final test which were recommended by the experts.

CONCLUSION

The physical science achievement test has a significant degree of reliability and validity calculated on the representative samples of secondary school students of class IX in Aligarh district of Uttar Pradesh, India. This test can be used by teachers to assess the achievement of students in physical science when content area of IX class from these 4 units are covered.

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