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# Construction and Validation of an Instrument to Measure the Attitude towards Science

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## ABSTRACT

*The work reported here is an effort to construct and validate an instrument to measure the students' attitude towards science. This work is likely to be a predictor of students' emotional attachment to science and is expected to help to classify or enroll students in science for higher grades. 150 students of 6th grade (of age 10 ½ -12 ½ years) were randomly selected from the male schools of Federal Area Islamabad (Nilore) and the Provincial area of Punjab (district Jhelum and Gujrat). The construct was broken down into eight domains (Reflectivity, Critical observation, Rationality, Objectivity, Productivity, Appreciation, Curiosity and Courage). Forty statements were developed which related to the study of science and the students were asked to respond to these statements on a five point Likert scale. To accept or reject the statements, t-test was used. For this purpose, the research considered the frequency distribution of scores based upon the responses to all students. The value of't' for each statement was calculated and compared with the table value. The statement having t-value greater than t-table were retained while others were removed from the instrument. Finally, 25 statements were retained in the instrument. This final attitude questionnaire was administered to the sample and all the statements were evaluated. The marks for each student were added up to give a total score. The highest scores is said to indicate the most positive attitude. This research makes it*

**Key Words:** Spearman Brown formula; Likert scale; Semantic differential; Thurston scale; Guttmann scale

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*possible to locate the uninteresting contents in the science textbooks for elementary classes. The outcome suggests some ways by which science curriculum planners and text- book writers can produce material in science, which will prove interesting and attractive for elementary level students. This study may also be helpful for teachers to modify their teaching strategies, by relating the cognitive objectives with affective.*

## INTRODUCTION

In a general analysis of the situation in schools in Pakistan, science is compulsory subject at elementary level. The statistical data entries and passes at elementary examination show that science is the 2nd most popular subject after Social studies. Although the results of grade 4 students in the subjects tested (Urdu, Mathematics, Social studies, Science) were not encouraging nonetheless the students pass percentage showed their interest in science.

According to the results presented by National Evaluation and Assessment System (NEAS), examination statistics 2006, the average score of grade 4 students are below the scaled average score of 500. It means that the average marks of the individuals were less than 50% of the possible marks in the subjects of Urdu, Science, Mathematics and Pakistan studies.

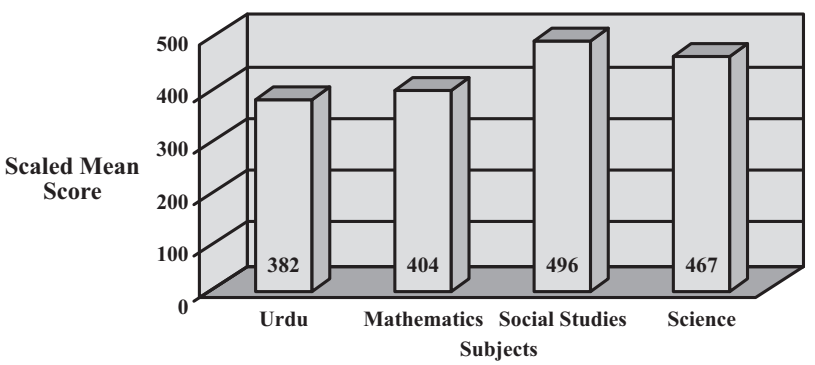
### Main Findings of NEAS Grade 4 National Assessments 2006

Results for the 2006 National Assessments show that the average scores of grade 4 students are below the scaled average score of 500. This means that the average mark obtained by all students is less than 50% of the possible marks in each of the four subjects tested (Urdu, Mathematics, Science and Social Studies).

In the Language test 24% of students scored greater than the scaled mean score of 500. In the Mathematics test only 19% of students scored greater than the mean score of 500 while in Science 33% of students scored greater than the set mean of 500.

In the Social Studies test, 43% of students got a score of more than the set mean of 500. The scaled mean score of all students tested in Social Studies was close to the set mean of 500.

**Figure: 1** **Scaled Mean Score of Grade 4 Students**



In the view of Reid and Skryabina (2002, p.69) “attitude towards science classes have been found to be the best predictors of students' intentions to enroll in science classes.”

The main objective of this study was to develop an instrument to measure the students' attitude towards science, to classify students in secondary schooling and at higher grade (arts group, science group, computer science group) and to gain insight into the factors (curriculum, teaching strategies, classroom environment) which were making science popular at school, college and the university.

In this study, a process was highlighted to construct and validate an instrument to measure the attitude towards science.

## LITERATURE REVIEW

In the view of Shah (2004), A person's mental-attitude are his/her coherent ways of anticipating, evaluating and responding to people, ideas, objects and situations.

In the view of (Dunham, 1974), attitudes affect behaviour, influencing what the learner selects from the environment, how they will react to teachers, the materials being used and the other students. This selection and the processing of the input of information, which follow it, are strongly influenced by the instructor's expectations, attitudes and concepts. Gupta (2004) presented the views of Thurstone that attitude is the degree of positive or negative effect associated with some psychological object. Object here is 'science' as a discipline. Attitude towards science indicates feeling of an individual or a group concerning science like faith in scientific method, value of science, opinion about scientists, opinion held about science related social issues, etc. An attitude must have a target. We have an attitude directed towards something or someone. Attitudes are highly complex and can affect learning extensively. In the view of Shah (2004), attitudes have three-part structure consisting of:

(1) a cognitive component, that is, beliefs about an object, a person or a situation.
(2) an attitude has an affective or feeling component and
(3) there is a response-potential or an action-tendency component.

All aspects of learning science can contribute to attitudes towards science and to the learning of integrated science. There will be the cognitive aspects: what the learner knows and experiences. There will be affective aspects: does the learner like experience of the learning, the subject itself and the instructor. There will also be the action component in the sense of what the learner actually does (and this will include practical work) and how the learner might apply the learned material.

### Why Attitudes Important?

In the view of Ernest (1994), surveys of attitudes about courses, subjects and school in general can be a first step. Reid (2003, p.33), states " attitudes are important to us because they cannot be neatly separated from study. It is a relatively quick series of steps for a student with difficulty a topic to move from that to a belief that they cannot succeed in that topic, that it is beyond them totally and they, therefore, will no longer attempt to learn in that area. A bad experience has led to a perception, which has led to an evaluation and further learning is

effectively blocked." In general, attitudes in life allow us to:

a) Make sense of ourselves;
b) Make sense of the world around us;
c) Make sense of relationships;

It is necessary to inculcate in our students the intellectual sense of the world around them that is the very nature of the subject matter of the physical sciences (and other sciences) of course it helps them to contribute to the understanding of the world if they can also make sense of themselves and others.

Johnson (1979, p.500), " the purpose of assessing students' attitudes is to use information to modify and improve instructional programs. Attitude should have no effect on students' grades, and teacher should not be evaluated on the basis of whether or not their students have positive attitudes. But components of instructional program such as teaching strategies and curriculum materials can be modified on the basis of the students' attitudes they promoted."

According to (Reid, 2002, pp. 68) "if attitudes lead to behaviour, then we aim to measure behaviour and then deduce what the attitude might be. A simple example is to look at the numbers who choose to study physical sciences. In schools in most countries, physics is not seen as popular and this negative attitude for many is easily observed in their behaviour, they choose not to continue with physics studies and in England and Wales, A Level entries have fallen."

**Theoretical Framework**

It was around 1929 when a researcher called Likert who has given his name to a technique, which is widely used today, made the first serious attempt. Now several kinds of scales are found in literature. Gay (1987, p.146) states that there are four basic types of scales used to measure attitude;

**(1) Likert scale** (ask an individual to respond to a series of statements by indicating whether he/she is strongly agree (SA), Agree (A), is undecided (U), disagree (D), or strongly disagree (DA) with each statement).

**(2) Semantic differential scale** (ask an individual to give a qualitative rating to the subject of the attitude on a number of bipolar adjective such as good-bad, fair-unfair, friendly-unfriendly etc. Semantic differential scales usually have 5 to 7 intervals with a neutral attitude being assigned a score value 0).

**(3) Thurston scale** (ask an individual to select from a list of statements that represent different points of view those with which he or she agrees. Each item has an associated point value between 1 and 11; point values for each item are determined by averaging the values of the items assigned by a number of "judges").

**(4) Guttmann scale** (ask the individuals to agree or disagree with a number of statements. It attempts to determine whether an attitude is uni-dimensional, i.e. it produces a cumulative scale. In a cumulative, an individual who agrees with a given statement also agrees with all related preceding statements).

According to Earnest (1994, p.299) " Teachers constructing tests of attitudes and

perceptions have a choice between asking open-ended questions and constructing questionnaires that can be scored objectively. Open-ended formats can range from direct questions ("Describe a school situation in which you felt particularly good") to sentence completion items ("I feel good in school when ….."). Open-ended questions have the advantage of eliciting perceptions that might not be anticipated in advance.

An alternative to open-ended questionnaires is a closed response format with limited response options. Closed response questionnaires present a series of statements to which students answer yes or no or indicate their level of agreement on a five-point scale ranging from strongly agree to strongly disagree. Such five-point response scales are referred to as **Likert scale**, after R. A. Likert who originated this format in 1929 and coupled it with item analysis procedures for retaining effective items from a larger pool.

At the elementary level, a three-point scale agree, uncertain, and disagree is more common. A typical stem for a closed format questionnaires would be "I feel good when my teacher stands near me". Closed format questionnaires have a major advantage in the ease with which large amounts of data can be collected, scored, analyzed and summarized."

**Research Methods**

The present study aimed at the construction and validation of an instrument to measure the attitude of the 6th grade students towards science. 150 students of 6th grade (of age 10 ½ - 12 ½ years) were randomly selected from the secondary schools of Federal Area Islamabad (Nilore) and the Provincial area of Punjab (District Jhelum and District Gujrat).

**Table 1: Sex wise / Area wise, Sample Distribution**

| | Federal area Islamabad | Provincial area District Jhelum | Provincial area District Gujrat | Total |
|---|---|---|---|---|
| **Boys** | 25 | 25 | 25 | 75 |
| **Girls** | 25 | 25 | 25 | 75 |
| **Total** | 50 | 50 | 50 | 150 |

**Validity of Attitude Scale**

After defining the construct it was broken down into eight domains (Reflectivity, Critical observation, Rationality, Objectivity, Productivity, Appreciation, Curiosity and Courage). Forty statements were developed which relate to the study of science and the students were asked to respond to these statements on a five point Likert scale.

The statements were modified on the basis of previous questionnaires. Validity was checked by seeking opinions of a group of three science teachers from the elementary schools of district Jhelum. An interview is a powerful tool to gain insights into students' attitudes. The researchers used this technique (interview) with sample students to gain further insights into the results which have been obtained from the questionnaires.

**Selection of Statements**

T-test was used to reject or accept the statements. For this purpose, the frequency distribution of score based upon the responses to all students was considered. The researchers then took 33% of the subject (50 in this case) with the highest total score and 33% of the subjects (50 in this case) with the lowest total scores with the assumption that these two groups provide the criterion groups in term of which to evaluate the statements. By using this formula

$$t = \frac{X_h - X_l}{\sqrt{\frac{S_h^2 + S_l^2}{n\,(n-1)}}}$$

The value of each statement was calculated and compared with the table value of't' at 0.05 level with degree of freedom (df) 148. The statement was accepted if the calculated value of 't' for that particular statement was greater or equal than the table value otherwise it was rejected and excluded from the instrument. The calculation for one positive statement is given below:

**Table 2:**

**The calculation of t for evaluating the difference in the mean response to an attitude statement by High and Low achiever. (N= 150, for a favourable statement).**

| Response Categories | High achievers | | | | Low achievers | | | |
|---|---|---|---|---|---|---|---|---|
| | X | f | fx | $fx^2$ | X | f | fx | $fx^2$ |
| SA | 5 | 30 | 150 | 750 | 5 | 15 | 75 | 375 |
| A | 4 | 10 | 40 | 160 | 4 | 10 | 40 | 160 |
| U | 3 | 10 | 30 | 90 | 3 | 5 | 15 | 45 |
| D | 2 | - | - | - | 2 | 15 | 30 | 60 |
| SD | 1 | - | - | - | 1 | 5 | 5 | 5 |
| $\Sigma$ | | 50<br>N | 220<br>$\Sigma fx$ | 1000<br>$\Sigma fx^2$ | | 50<br>N | 165<br>$\Sigma fx$ | 645<br>$\Sigma fx^2$ |

From the above table we get the empirical value of t = 3.3

As the t-calculated is greater than the t-table (i.e. 2.01), therefore this statement was retained in the attitude scale.

By applying the procedure, the researcher found the values of 't' for every statement and then arranged in rank order. Then 25 statements were selected with highest t- value for the instrument, which is shown in the Appendix.

**Reliability of the Instrument**

After the selection of statements, the instrument was divided into two parts i.e. scores achieved by the students in the favourable statements (positive) and unfavourable statements (negative). With the help of these two sets of scores, the reliability of the instrument was calculated by

using split - half method. First, the correlation co-efficient (r) was measured, which gave the internal consistency of the instrument. Then by using the Spearman Brown formula, the reliability of the instrument was calculated (i.e. 0.77).

**Findings and Results**

The literature reflects that a few people adopt science as a subject in their higher studies. In Pakistan, the traditional teaching strategies (rote memorization of facts) are still used in the public schools instead of developing the conceptual understanding of the concepts and ultimately not appealing to the students.

**Table 3:**

**Comparison of mean scores of students achieved in the attitude scale (Boys Vs Girls)**

| Sample | N | Mean Socre |
|---|---|---|
| Boys | 75 | 102.5 |
| Girls | 75 | 97.00 |

It is indicated from the table-3 that at elementary level, the boys have more positive attitude towards science than girls, which shows the girls have less interest in science as compare to boys. A clearer picture is shown below in the form of bar diagram.

**Comparison of mean scores of students achieved in the attitude scale (Boys Vs Girls)**


**Table 4:**

**Comparison of mean scores of students achieved in the attitude scale (Federal Vs Provincial Area)**

| Sample | N | Mean Socre |
|---|---|---|
| Federal Area Islamabad | 50 | 107.02 |
| Provincial Area | 100 | 89.06 |

The table-4 indicates high positive attitude towards science in favour of students of Federal Area. Comparatively less positive attitude towards science in the provincial area indicates some barriers, which create hindrance for the development of positive attitude among the

provincial area students. Barriers may include parents and society's impact. Kumar (1995) states that the personal examples of the teachers and environment of the class help to develop the positive attitude towards a subject / object. Low participation and their low positive attitude towards science are greatly affected by the teacher attitude.

From the above discussion, it is concluded that the curriculum planners determine the area where there are difficulties, especially for girls and for provincial area students. The results also help the teacher to review their teaching strategies and make the content more meaningful to the learners.

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## APPENDIX

**Distribution of Statements According to Subscales**

**A. CRITICAL OBSERVATION**
Statement Number: 12

**B. RATIONALITY**
Statement Number: 5. 15, 16, 19

**C. OBJECTIVITY (IMPARTIALITY)**
Statement Number: 11, 17, 22

**D. REFLECTIVITY** (A reflective person is one who have a slow conceptual tempo and thus tackles learning tasks by categorization the information in methodical, thoughtfulway. 6, 7,13, 2 ,24

**E. PRODUCTIVITY**
Statement Number: 1, 2, 3, 14, 21

**F. APPRECIATION**
Statement Number: 4, 9, 18, 20

**G. CURIOSITY**
Statement Number: 10, 25

**H. COURAGE**
Statement Number: 8

**INSTRUCTIONS:** Indicate by a check (✓) your degree of agreement in each statement on five-point scale. These are as under:-

5. **Strongly Agree (SA)**
4. **Agree (A)**
3. **Undecided (U)**
2. **Disagree (D)**
1. **Strongly Disagree (SD)**

| S. No. | Statements | SA | A | U | D | SD |
|---|---|---|---|---|---|---|
| 1 | Knowing science will help me to earn a living. | | | | | |
| 2 | Science is important to me in my life's work. | | | | | |
| 3 | I will use science in many ways when I am an adult. | | | | | |
| 4 | Scientific knowledge has aesthetic value because the scientist seeks for truth and truth is beauty. | | | | | |
| 5 | Science has made our life very difficult. | | | | | |
| 6 | Science help me to save from superstitions and un-reasoning. | | | | | |
| 7 | The work of the scientist is not systematic. | | | | | |
| 8 | The work in the science lab is very dangerous that's why I feel fear. | | | | | |
| 9 | Science will increase my habits of creative thinking. | | | | | |
| 10 | Scientific knowledge will help me in understanding natural phenomena. | | | | | |
| 11 | I have no need of planning in the playground. | | | | | |
| 12 | Scientific knowledge will develop the sense of observation. | | | | | |
| 13 | Before entering into the science lab I need no preparation. | | | | | |
| 14 | Science practical work has no utility in my everyday life. | | | | | |
| 15 | I don't like science because it is tentative. | | | | | |
| 16 | Instead of scientific programmes on T.V. I would like to watch fairy tales like Ainak Wala Jin etc. | | | | | |
| 17 | Knowledge once I accepted will not subject to change. | | | | | |
| 18 | We should not criticize the work of others. | | | | | |
| 19 | Traditional beliefs should be preferred even harmful. | | | | | |
| 20 | Science is the best friend of the human being. | | | | | |
| 21 | The development and prosperity of a country mostly depends on scientific advancements. | | | | | |
| 22 | The knowledge gain through personal experiences is more reliable than the scientific knowledge. | | | | | |
| 23 | In our daily work we should have to plan our activities. | | | | | |
| 24 | We should not plan our future because future will take care of itself. | | | | | |
| 25 | Listening to new ideas is a very interesting and pleasing activity. | | | | | |