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RESEARCH ARTICLE

Development of Standardized Scientific Temper Tool

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ABSTRACT

The prime aim of the present paper was to develop a standardized tool to measure scientific temper. For this purpose, the investigators organized three workshops with experts in the field of science and social sciences and the tool is developed in three phases. In the first phase, the term scientific temper had been operationally defined and four dimensions, i.e. spirit of enquiry, rational thinking, cause and effect relationship and scientific information were finalized to measure the scientific temper among people. This scientific temper tool was developed in the form of a questionnaire. The items related to above four dimensions were collected and shuffled well to prepare initial draft of the schedule. Thus the initial draft contained 70 items in it. The questionnaire was prepared in three parts, designated as FORM A, FORM B and FORM C. In the FORM A responses were recorded on Likert-scale while in FORM B questions were kept open-ended and the responses in FORM C, which constituted the core of Scientific Temper Questionnaire (STQ), were categorized into three options, from scientific to superstitious. It should be noted that all the three parts contianed identical indicators.

In the second phase, the initial draft of STQ was administered on a sample of 120 students in order to determine the discriminative value and popularity value of each item for the purpose of item analysis. The reliability was established through Kuder Richardson formula and content and concurrent validity were also established. In order to develop norms raw scores were converted into Z-scores and Stanine scores.

KEYWORDS: Scientific Temper, Standardization of the Tool, Survey, Reliability, Validity.

Introduction

Inquisitiveness is a fundamental trait of human beings. From times immemorial man has tried to comprehend the world in which he finds himself. The knowledge gained through observation of natural occurrences like apparent movement of sun, moon and other 'heavenly' bodies, storms and lightning, eclipses and meteorites, growth and properties of plants, etc., was gradually systematized and classified, and the process of identifying casual relationships was initiated. The roots of modern science and scientific method can be traced in the early attempts to relate cause and effect on full moon nights the waves in the sea were always higher than on moonless nights, eating certain plants always induced intoxication, stones thrown at a certain angle of inclination traversed the largest horizontal distance, etc. Another crucial step was identification of patterns in observation, Full moon nights and moonless nights occurred at regular periods, there was noticeable periodicity and repeated observation of such patterns and causal relationships led to induction of generalizations or theories, many of which were often raised to the status of 'laws of science' once the deductions from these theories were experimentally verified repeatedly. This in essence is the process by which even modern scientists progressively understand the nature better, thus enabling us to harness its potentials for the welfare of humanity (Dhar, 2000).

The Concept of Scientific Temper

Scientific temper is a way of life - an individual and social process of thinking and acting - which uses a scientific method, which may include questioning, observing physical reality, testing, hypothesizing, analysing, and communicating (not necessarily in that order). Scientific temper describes an attitude which involves the application of logic. Discussion, argument and analysis are vital parts of scientific temper. Elements of fairness, equality and democracy are built into it. Jawaharlal Nehru was the first to use the phrase in 1946. *'Scientific temper may be defined as a temperament which connotes a type of frame or disposition of mind which is free from superstition, prejudice, rigidness, obscurantism, close-mindedness, irrationality, un-innovativeness, subjectivity and other parochial tendencies.'*

Scientific Temper: The Need of Hour

In our country, where a large section of the society is still caught in the quagmire of superstitions and obscurantist practices, inculcating scientific temper among the citizens is of paramount importance for development of the nation.

In view of the unique importance of science education the National Curriculum Frame Work for school education 2005, recommended that pedagogy of learning sciences should be designed to address the aims of learning science, that is to learn the facts and principles of science and it's applications, consistent with the stage of cognitive development. It also recommended to imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment and to cultivate scientific temper, objectivity, critical thinking and freedom from fear and prejudice among students.

NCF, 2005 is not the only document that has given directions for developing scientific temper among the students, but several commissions and committees on education have recommended for inculcating scientific temper, developing the spirit of inquiry and focusing on learning by doing through activity based science teaching in school curriculum which can play a great role in developing scientific temper.

However, despite these efforts, scientific temper did not permeate in society to make any perceptible impact on the national psyche. As Narlikar opined, 'Today we live in a free India that is feeling its way towards economic prosperity. Yet we are still a long way from achieving that scientific outlook which Nehru considered so essential for our future wellbeing' (Narlikar, 2003). If one were to pick out three or four most important reasons for the country's backwardness or failure in many areas, the lack of scientific temper would be one of them (Bhargava and Chakrabarti, 2010). Nehru's dream about the spread of scientific temper in the country has remained largely unrealised, in spite of significant growth in science and technology in India (Mahanti, 2013).

Though our country claims development in various spheres like atomic energy, space and telecommunication, technological excellence, it is a matter of regret that still there is lack of scientific temper in public in general and students in particular.

Significance of Developing Standardized Scientific Temper Tool

The spirit of enquiry and the acceptance of the right to question and be questioned are fundamental in scientific temper. It considers knowledge as open ended and ever evolving. Scientific Temper is incompatible with theological and metaphysical beliefs. While science is universal, religions and their dogmas are divisive. Scientific Temper cannot flourish in a grossly in-egalitarian society where 50 per cent of the population lives below the poverty line and almost 70 per cent of our people, especially women, are functionally illiterate. Social justice, widespread education and unrestricted communication are pre-requisites for the spread of Scientific Temper and, therefore, optimizing the results of science and technology. The government of India is continuously striving for fostering scientific temper among our citizens. It is running many programmes to communicate Science and Technology to masses, stimulate scientific and technological temper and coordinate and orchestrate such efforts throughout the country. But ironically, so far there is no standardized tool through which we can measure the scientific temper of our citizens. If we develop a standardized scientific temper tool, we would not only be able to measure the scientific temper but we could also ensure the efficacy of the programmes which are being run throughout the country in order to foster scientific temper among our citizens.

Objective

The main aim of the present attempt is to develop a standardized scientific temper tool through which scientific temper could be measured among people.

Procedure of Developing Standardized Scientific Temper Tool: Research Design

The present project is aimed to develop standardized scientific temper tool. The research design for this purpose has been discussed as follows.

Population for the purpose of the present study, target population comprises all the people who are above 12 years of age and are residing in Rohilkhand Region (in northern part of India).

Sample and Sampling Technique Sample for the present study was selected through two stage random sampling technique. At the first stage, 05 cities were selected randomly out of 08 cities situated in Rohilkhand Region. At second stage a total sample of 500 respondents was selected randomly from all sampled cities giving proper representation to sex, age, educational background, residential background.

Construction of Scientific Temper Tool ('STQ')

The procedure of development of scientific temper tool and its construction is as follows –

Structural Approach

Operational Definition of the term 'Scientific Temper': the term Scientific Temper has been operationalised as-

"Scientific temper is an attribute in which individuals interact with the world in rational terms and are guided by empirical evidence in their actions. They tend to have a open-mind in considering the issues." As corollary of above conceptualization, Scientific temperament connotes a type of frame or disposition of mind which is free from superstition, prejudice, rigidness, obscurantism, conformity, close-mindedness, irrationality, un-innovativeness, subjectivity and other parochial tendencies.

In order to measure scientific temper in operationalized terms, the following dimensions were decided to be included in the scientific temper tool.

1. Scientific Literacy/Information
2. Rational Thinking
3. Spirit of Enquiry
4. Cause-Effect Relationship

After determining the definition and dimension of scientific temper, the tool has been constructed in three phases which are discussed in detail as follows-

Phase I

Construction of Items

On the basis of informal discussions with senior scientists, experts in the field of social sciences, survey of concerned literature and

other related already available tools, initially, a schedule based on 70 items were constructed.

Item Analysis

The adequacy of a test depends on the care with which the items of the test have been chosen. It is therefore necessary to analysis each item in order to retain only those which suit the purpose and rationale of the device being constructed. To find out the suitability of an item two indices were calculated (Best, 1977).

1. Item discriminating value
2. Popularity value

Item Selection: Item selection was accomplished in two phases. In the first phase an item was selected if its discriminating value was more than 1.97, which is significant at.05 level of confidence. On the basis of above ground 4 items were significant at.05 level, and rest were significant at.01 level. In this step, 5 items were not found significant at both level of confidence, so 5 items were rejected. In the second phase these items whose popularity value was below 0.40 and less than 3.60 were be retained. But the values of all the items were more than 0.40 and less than 3.60. Therefore, all the 50 items were retained according to these norms also.

Table 1 — Inter-correlations matrix among dimensions

DIMESIONS	Rational Thinking	Scientific Information	Spirit Of Enquiry	Cause Effect Relationship
Rational Thinking	1.00	.67	.71	.78
Scientific Information	.67	1.00	.58	.69
Spirit Of Enquiry	.71	.58	1.00	.76
Cause Effect Relationship	.78	.69	.76	1.00

Phase II

Final Draft of ‘STQ’: In the final format of STQ the instructions were printed on the cover page. There was no time limit for the test. However, it required approximately 15-20 minutes for the completion. The dimension wise distribution of item is given in Table 2.

Table 2 — Dimension wise distribution of items in final form of 'STQ'

Sl. No.	Scientific Temper Dimensions	Item Number	Positive	Negative	Total No. of Items
1	Rational Thinking	1,2,4,5,7,14,15,18, 23,24,25,27, 28,29,34, 36, 40,41,43,45,48, 49,50	1,2,4,7,14, 15,18,2324, 27,28,29, 40,43, 48,50	5,25,34, 36,41,45, 49	23
2.	Spirit To Inquire	8,10,11,13,22, 42,47	8,10,11,13, 42,47,	22	07
3.	Scientific Information	3,19,26,32,35, 38,44,46	3,32,35,44,46	19,26,38	08
4.	Cause-Effect Relationship	6,12,16,17,18, 20,21,30,31, 33,37,39	6,12,16,18, 20,2131, 33,37,39	17,30	12
Total		50	37	13	50

STQ: The Instructions

STQ contains the 50 items. The 'STQ' is prepared in the form of questionnaire in which the respondent has to tick one option out of three options. The options/response is categorized in three forms *i.e*., 'Scientific', 'Less Scientific', 'Superstitious wrong notion'.

Scoring & Interpretation

The scoring of each item of STQ will range from 0 to 2. If the respondent ticks the option which is purely scientific then he will be accorded highest 2 marks on each item,if he ticks the option which is less scientific then he will be accorded 1 mark and if he ticks the option which is superstitious/prejudice/wrong notion etc., then no marks (0) will be given to him. Thus maximum marks on STQ would be 100. Hence the higher score STQ will indicate higher scientific temper while lower score will indicate lower scientific temper. Thus the responses so obtained will be helpful to understand and interpret the exact status of scientific temper of the respondents.

Field Try Out

In order to standardize this questionnaire, the final draft has been administered on 500 sample people. After administration, the reliability and validity of the questionnaire has been established and norms have also been developed.

Phase III

Determination of Reliability and Validity

Reliability

The reliability of STQ was established by Using Kuder Richardson Formula KR-20. The obtained coefficient of correlation for STQ was 0.79.

Validity

The content validity of this Scientific Temper Questionnaire has been established by having discussion with the experts from the field of Science and higher education.Thus, “Scientific Temper Questionnaire’ was found to be valid. The concurrent validity coefficient of the present scale was obtained 0.91.

Development of Norms

Stanine Scores

In order to develop norms for 'STQ’, The investigators had conducted a statistical analysis,in which at first, all raw scores have been converted into Z-scores and then converted into stanine scores. The details are presented in the following Table.3.

As depicted in the table-2, the individuals whose score are in the range of 10-21, will be considered as poor on scientific temper questionnaire, the scorer who score in the range of 22-34, will be considered considerably below average, score between range of 35-48 considered as below average, score between range of 49-61 considered as average, score range between 62-75 will be considered having good scientific temper, while score between 76-88 will be considered very good on their scientific temper and the individuals who score between the range of 89-100 on 'STQ' will be considered as superior on their scientific temper scale.

Table 3 — Z-score and Stanine score distribution and interpretation

Raw Score Range	Standard Score Z-Score		Standard Score Stanine Score	Interpretation
10-21	-1.6509	-1.24513	2	Poor
22-34	-1.20824	-0.76558	3	Considerably below average
35-48	-0.72869	-0.24914	4	Below average
49-61	-0.21226	0.230405	5	Average
62-75	0.267293	0.746842	6	Good
76-88	0.783731	1.226391	7	Very good
89-100	1.26328	1.669052	8	Superior

Conclusion:

The present questionnaire will be very helpful to assess scientific temper among people. Moreover, it would be beneficial for researchers as it would not only provide them a valid data to assess the current status of scientific temper existing among people but it would also provide data as what kind of traditions/ superstitions/wrong notions are prevailing among people which exactly are responsible to hinder scientific temper among them. These factors should be targeted in upcoming remedial programmes to remove ignorance among people and foster scientific temper in a true sense.

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