Scientific attitude – some psychometric considerations

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Abstract: In the present context of the revolution of science and technology, importance of science education is being recognised more and more. In fact, achievement in science has become one of the major quality parameters of students. Among several determinants of achievement in science, scientific attitude is an important one. Students’ scientific attitude should be a major concern of science teacher. In particular, the knowledge of different operational dimensions of scientific attitude and its measurement might enable a science teacher to identify inclination of science learners towards different endeavours in science. This psychometric consideration of scientific attitude is focal area of the present study. The study has explained the term ‘attitude’ in general, and ‘scientific attitude’, in particular. Various operational dimensions of the construct have also been discussed with reference to a detailed review of related literature. Emphasis has been given to the scientific attitude of secondary school learners. Different available tools have also been reviewed. A tool having sound psychometric basis and suitable for the present purpose has also been identified in light of this review, which may be used by a science teacher in secondary science classroom.

Key words: scientific attitude, secondary learners, operational dimensions, review of related tools.

I. Introduction

In the context of revolution of science and technology, importance of science education is being recognized more and more. It should be considered as an integral part of school education, as recommended by N.P.E(1986). Science strengthens commitments of man to free enquiry and search for truth as its highest beauty and obligation (Celenti, 1988). Therefore, the study of science imparts training in scientific method developing scientific attitude of learners. This is the quality which ensures sustainable development of an individual as well as the nation which is becoming more and more scientific gradually (Rao, 1996).

Development of scientific attitude is one among the most important outcomes of science education (Carin, 1997). Even it is important equally as cognitive aspects of science education. Scientific attitude encourages questioning mind and a spirit of enquiry. Therefore without this, studies of science will only mean acceptance of dogma and will never lead to development of proper orientation towards various scientific endeavors (Lacrose & Wisconsin, 2007). Whereas in case of lacking of it, any amount of knowledge in science will also contribute little to national development and to the process of social change, as well.

Not only this, scientific attitude is one among the major determinants of students’ achievement in science – which has become a major quality parameter of a student living in the present scientific society (Abell & Lederman, 2007). Now-a-days rate of admission of students in science courses is increasing at a rapid rate. Even parents are also driven strongly by the urge of admitting their children in science courses. But a mere enrollment in science courses will not result any ultimate benefit of learners unless students’ science learning is made effectively developing adequate scientific attitude through effective science teaching (Moore & Foy, 1997). Therefore scientific attitude is one among the major areas of concern of a teacher in the classroom situation in general. Particularly teachers’ clear understanding of the conceptual framework of scientific attitude, way of measuring students’ scientific attitude in view of various associated criterion and taking suitable measures to nurture the quality subsequently are very essential to ensure a quality science education...

This also necessitates extensive research work in science education, specifically in the area of scientific attitude of school learners. Few studies are available in this area. But studies are very much scattered, as well as isolated (Peters & Stout, 2006). A comprehensive and systematic review of the existing works are extremely inadequate. This also leads to selection of the present study. Following questions arise in the mind of present researcher in this regard.

- How is scientific attitude is explained and defined by researchers?
- What are various psychometric dimensions of it?
- Whether available tools on scientific attitude are adequate and are constructed in view of all the essential psychometric considerations?

Present study is an attempt of finding answer of all these questions. It aims at particularly to explain the conceptual framework of attitude in general, and scientific attitude in particular; to discuss various operational dimension of scientific attitude as suggested by different researchers, and also to review the related tools in
Scientific attitudes are attributes of an individual who not only behave outwardly in some fashion, but also hold certain beliefs, feelings, and actions towards scientific knowledge, scientific method, activity of scientist, and science career. Scientific attitude has three basic components: belief, feeling, and action. Belief is the cognitive basis of scientific attitude, which provides a learner several scientific information of scientific phenomenon, eminent scientists, scientific inventions etc.

Central component of scientific attitude is the feeling towards the belief. Effective science teaching, personality of science teacher, teaching-learning environment etc. plays a major role through which the belief of a learner is converted into his/her feeling towards it. Feeling is associated with emotion, on the basis of which a scientist develops his/her opinion.

Third component of scientific attitude is action or behavioral component which is mostly conative. It is the tendency of a science learner to act towards his/her scientific belief in accordance with feeling or opinion. For one reason or another, a people do not or cannot always act the way they feel, but tendency is there. Scientific attitude, according to Rao (1996), represents the belief of a person and his feeling towards scientific knowledge, scientific method, activity of scientist, and science career. Scientific attitude have three basic components: belief, feeling and action. Belief is the cognitive basis of scientific attitude, which provides a learner several scientific information of scientific phenomenon, eminent scientists, scientific inventions etc.

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The attempts so far discussed, considered scientific attitude having a single, uni-dimensional construct in relation to several attributes or behaviors and add the individual scores on each attribute or behaviour to find out the total score on ‘scientific attitude’. Gardner (1975), Jones and Batts (1983) considered multidimensional construct of scientific attitude. Gardner (1975) referred to ‘attitude towards science’ and ‘scientific attitude’ as two separate dimensions and considered scoring on each dimension separately, without considering a single common score for measuring a unique scientific attitude. Jones and Batts(1983) proposed a four dimensional construct of scientific attitude, considering the dimensions as independent measures. Though multidimensional
construct is recognized, but most of the available instruments consider ‘scientific attitude’ having a uni-dimensional construct, emphasizing on several scientific attributes as the measures.

IV. Review On Related Tools

Major features of few available tools are shown in the following table.

<table>
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<th>TABLE1: Major Features of Few Available Tools on Scientific Attitude</th>
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<tr>
<td><strong>Test</strong></td>
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<tr>
<td>1. Scientific Attitude Scale (SAS: Sood and Sanadhya, 1978), adopted by Rao (1996)</td>
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<td>2. Attitude towards Science Scale (Aktamis and Ergin, 2008)</td>
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<tr>
<td>3. Scientific Attitude Scale (SAS: Gohit and Sredevi, 2008)</td>
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<tr>
<td>4. Attitude towards Science Scale (Gohit and Sredevi, 2008)</td>
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<tr>
<td>5. Scientific Attitude Inventory (SAI: Lichtenstien, 2008) – the revised version SAI standardized by Moore and Sutman (1981)</td>
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<td>6. Scientific Attitude Scale: Yasar, et. al., 2009)</td>
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Study reveals the following points:
1. Poor psychometric property is found in Scale no.-5.
2. Scale no. 2 and 6 are valid for lower secondary group.
3. Content validity were only estimated in scale no.3 and 4.

Results of review reveal that scale no. 1 is appropriate for the present sample. Sound psychometric property, availability along with detailed manual, easy and readable items using gender and culturefair language, adaptation of the same by other researcher (Rao, 1996) etc. lead to its selection by many researchers.

Brief description of the scale is as follows, though some of its main features have already been shown in the table (Table 1) mentioned earlier.

Scientific Attitude Scale standardized by Sood and Sanadhya (1978) consists of 36 items (statements) together, having been constructed from six different dimensions (6 statements for each dimension), as mentioned in the table. It is a Likert-type scale. Five options (strongly agree, agree, neutral, disagree, strongly disagree) are there for each of the statements. Among these, 18 statements are of positive polarity (score 4 for strongly agree, score 3 for agree, 2 for neutral, 1 for disagree, 0 for strongly disagree), and remaining 18 are of negative polarity (reverse scoring). Scores for each individual statement are to be added to obtain the total score on scientific attitude. Rao (1996) adopted the scale in his study, estimated its reliabilities and validities over a group of 200 Indian sample (secondary students). Split-half method was used for estimating coefficient of reliability of the entire test, as well as for its each individual dimension. For the entire test, coefficients was found to be 0.86; and 0.76, 0.86, 0.84, 0.80, 0.73, 0.82 - respectively for the dimensions-rationality, curiosity, open-mindedness, aversion to suspension, objectivity of intellectual belief, and suspended judgment. Coefficient of intrinsic validity was also estimated by Rao (1996), considering sub-scale-sub-scale, and sub-scale-total correlation. Coefficients of intrinsic validity (sub-scale-total correlation) estimated were 0.62, 0.76, 0.80, 0.81,
0.85 and 0.82 respectively for different dimensions. Validity coefficients, in case of sub-scale-sub-scale correlation were found to vary from 0.31 to 0.63 (Rao, 1996)

V. Conclusion

The review therefore reveals that Scientific Attitude Scale (SAS: Sood and Sanadhya :1978) may be used by a teacher in science classroom for measuring secondary students’ scientific attitude. Following measures may be taken for its qualitative improvement.

The test may be standardised on the basis of response of a larger sample group. More number of relevant sub dimensions may be incorporated reducing the number of items under each dimension proportionately. Internal consistency reliability of the test (in terms of cron back alpha-coefficient) may also estimated. Factor analysis may also be conducted to estimate its factorial validity. A norm (percentile, stanine etc.) may also be established to ensure better interpretability of the scores.

Reference