

Study of Scientific Attitude in relation to Science Achievement Scores among Secondary School Students

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ABSTRACT

In science education, teaching methodologies focussing on developing scientific attitude among students facilitate them in scoring academically high and thus scientific attitude may work as determinant of academic performance of students. A descriptive survey was conducted on 208 students of secondary school students in Delhi. The data analysis showed that there was gender difference, in the favour of girl students, with respect to scientific attitude and science achievement scores. A significantly positive co relation between scientific attitude and science achievement scores of students was found. Interaction effects also supported these findings.

Keywords: Scientific attitude, science achievement score, academic performance

In formal school system, science, as a discipline, stimulates the learners to conduct an enquiry which is bias free and objective and if such practices are continued over the time then the learners get trained in scientific methodology, that is exploring something systematically and logically, and develop scientific attitude, which means the behavioristic disposition, on the part of the individual, to act in certain way(s) in definite situation(s).

At a broad level, in formal school system, one of the significant parameter to reflect upon students' over all academic performance is achievement in science (Mukhopadhyay, 2014) because it has scientific attitude as an operational dimension which is a tendency to respond favorably/unfavorably to some classified stimuli and in fact it is the ability to act/react with rationale, objectivity and consistency in definite and précised ways to some context/situation which may be problematic or novel in nature. Scientific method is the potential to attempt something in a trend that relies upon verified principles (Olasehinde & Olatoye, 2014).

It acts to regulate the behaviour which is directed towards/away from any context/situation(s)/object(s). It is further characterized by different

attributes like aversion to superstition, curiosity, suspended judgment, critical mindedness, open mindedness, ability to verify, faith in scientific method etc. (Rao, 1996).

Besides this respect for evidence, search for truth, intellectual honesty, willingness to change opinion are other qualitative aspects which prove indispensable in developing scientific attitude in classroom teaching-learning practices (Rao *et al.*, 1989). The nature of science as a discipline is compatible enough with scientific method to bloom in the personality of learners and at students' end it may prove a significant determinant of science achievement (Abell & Lederman, 2007).

So, such qualitative aspects of science in the long run may facilitate development at individual as well as national level (Rao, 1996). Science is fundamentally a body of knowledge collected through experimentation and observation and it is both a process as well as product that is science as a body of knowledge means science as a product and the ways/means to arrive at that product is the process approach of science. To develop scientific tendencies among learners, in the classroom and laboratories, the process aspects of science

like classification, observation, measurement, prediction, communication, hypothesis formulation, experimentation etc. must be emphasized but due to curricular constraints like huge content coverage in compact time period and stress to score in the theory oriented examinations, which require belching out on the part of learners, teachers have to adhere to product nature of science that is arriving at the conclusion without exploring the means to arrive at that conclusion. Such practices in the long run, lead to disinterest among students for science subject as low enrolment rate of students in secondary school (Olasehinde, 2008) and low scoring in science in examinations have also been observed (Olagunju, 1998).

However specifically, the plausible reasons for such trend may be the substandard teaching methodologies being practiced for science subject at primary school level like chalk and talk method which does not prove instrumental with respect to the students' positive attitude which is indispensable for developing their conceptual understanding of science subject (Stofflet & Stoddart, 1994) and also it is not so effective while teaching average and slow learners. To meet the global requirements of the contemporary period, in education system there is a dire need to prepare young minds who have strong foundations of scientific knowledge and are well versed in science process skills and endowed with scientific attitude.

But still, for the teachers, the assessment of some affective domain like scientific attitude is not so easy unlike the elements of cognitive and psychomotor domains like scientific knowledge and science process skills respectively. So, this facet of scientific attitude is the thrust area in science teaching that needs to be probed to enhance students' achievement in science and the present study attempts to probe this aspect that is study of the scientific attitude in relation to science achievement scores among secondary school students.

Review of Related Literature- Sharma (2007): studied the problem solving ability and scientific attitude as determinant of academic achievement of higher secondary students. Descriptive survey method, involving multistage random sampling, was used. The sample consisted of 240, male and female, XI class students from Hindi medium Government schools. It was found out that with respect to

achievement, there was a non-significant difference between both the genders and high achiever students had high level of scientific attitude. There was a significantly positive correlation between scientific attitude and achievement, scientific attitude and problem solving ability, achievement and problem solving ability but these correlations were mild among boys in comparison to girls.

Ataha & Ogumogu (2013) conducted survey based study to probe the scientific attitude at senior secondary level in science stream. The study revealed that science stream students had average level of scientific attitude and sex had no significant influence on it. Ksheerasagar & Kavyakishore (2013) studied the science achievement, of 600 secondary school students, in relation to scientific attitude by using stratified random sampling by selecting students from Government and private schools. It was found that in comparison to boys, girls had better science achievement and students of private schools had better science achievement than Government school students.

Further, scientific attitude was explored with respect to different levels like high, moderate and low and it was found out that the scientific attitude had main effect on achievement in science as the students with high level of scientific attitude had better science achievement than the students of moderate and low level of scientific attitude. Narmadha & Chamundeswari (2013) conducted study on secondary school students to investigate their attitude towards learning of science and achievement in science. Random sampling was exercised in the selection of students from matriculation, state and central board schools and it was found that achievement in science and attitude towards learning of science are significantly positively correlated.

Also, a significant difference in achievement in science and attitude towards learning of science among secondary school students in different categories of schools (in the favour of central board schools in comparison to matriculation and state board schools) was observed. Gender wise in all kinds of these school boards, girls have significantly better attitude towards learning of science than boys and in central board and matriculation level schools, girls performed better and hence had grater achievement in science than boys. Sekar &

Mani (2013) conducted survey on first year higher secondary school and found a significant gender difference, in the favour of girls, with respect to scientific attitude. Olasehinde & Olatoye (2014) investigated scientific attitude, attitude to science and achievement in science at senior secondary level.

A significantly positive correlation between attitude to science and scientific attitude, a non-significant positive correlation between scientific attitude and achievement in science and attitude to science and achievement in science was observed. The boys and girls did not differ significantly from each other with respect to attitude to science, scientific attitude and achievement in science. Srivastava (2014) probed the achievement in science as predictor of scientific attitude in intent and action.

Secondary school boys and girls students served as sample for the study. It was inferred that with respect to boys, achievement wise knowledge, comprehension and application domains do not influence scientific attitude but in case of girls, scientific attitude in terms intent and action can be predicted by comprehension and knowledge respectively. Srivastava (2015) studied the influence of scientific interest, scientific attitude and intelligence on achievement in science at secondary school level and it was revealed that achievement in science has positive correlation with scientific attitude, intelligence and scientific interest.

The high levels of intelligence, scientific attitude and scientific interest enable a student to achieve higher and science achievement can be predicted by intelligence and scientific interest. Nayak (2015) conducted a descriptive study to gauge the scientific attitude of undergraduate students (sample size 90) in relation to gender and stream of study and found a significant difference in scientific attitude in the favour of science stream students in comparison to arts and commerce stream students.

Also, the scientific attitude didn't differ significantly with respect to gender however female students of science and commerce streams had more favorable attitude on the different attributes of scientific attitude than their counterparts of same stream. A significant difference in the scientific attitude with respect to the stream of study was found as commerce students possessed more favorable

attitude on some attributes of scientific attitude like critical mindedness and ability to verify, in comparison to their counterparts in science and arts streams but scientific attitude on curiosity, suspended judgment, open mindedness and objectivity as attributes had no significant effect with respect to the stream of study.

Objectives of the study

Following objectives were formulated for the present study:

1. To study gender differences among boys and girls at secondary school level with respect to scientific attitude.
2. To study gender differences among boys and girls at secondary school level with respect to science achievement scores.
3. To find out the correlation between the scientific attitude and science achievement among secondary school students.
4. To study science achievement scores in relation to the different levels of scientific attitude of boys and girls at secondary school level.

Hypotheses

To explore above objectives, following null hypotheses were formulated:

- ♦ H_{01} : There is no significant difference in scientific attitude of boys and girls at secondary school level.
- ♦ H_{02} : There is no significant difference in science achievement scores of boys and girls at secondary school level.
- ♦ H_{03} : There is no significant correlation between the scientific attitude and science achievement scores of secondary school students.
- ♦ H_{04} : There is no significant interaction effect of gender and scientific attitude on science achievement scores of secondary school students.

Delimitation of the study

The present study was delimited with respect to school level that is secondary school level as it was conducted on class IX students.

METHODOLOGY

Design of the study

The research design of the present study was descriptive survey. The investigator attempted to find the difference between scientific attitude and science achievement among boys and girls students of IX class of two senior secondary schools of Delhi. The relationships between scientific attitude and science achievement and interaction effect of gender and scientific attitude on science achievement scores of these students were also found out.

Sample

In Directorate of Education, Delhi there are 13 districts and these districts, in their jurisdiction, have further 29 zones. Out of these districts, one district was randomly selected. In the selected district, there were three zones in total and out of these three zones, again two zones were randomly selected. In one zone, there were six Government Boys schools out of total 19 schools and one Government Boys Senior Secondary School was randomly selected. In other zone, there were eleven Government Girls schools out of total 21 schools in that zone and one Government Girls Senior Secondary School was randomly selected. Now, in two selected schools, 102 boys in Government Boys School and 106 girls in Government Girls School were randomly selected for the study. Thus, throughout the random sampling was exercised.

Variables

The present study had following variables:

- ♦ **Independent variable:** Gender was independent variable and had two level that is girls and boys. The investigator separately administered research tool for them. Another independent variable was scientific attitude which had three levels-(i) Very High, (ii) Average and (iii) Very low.
- ♦ **Dependent variable:** science achievement scores were the dependent variables in the present study.
- ♦ **Intervening variables:** These variables like, tiredness, previous knowledge & achievements, fatigue, motivational levels, family background etc., were assumed to be uniformly present

among boys and girl students at secondary school level.

Tools

1. **Scientific attitude scale (2009) by Sukhwant Bajwa & Monica Mahajan:** This scale can be administered on Indian adolescents studying in classes IX-XII. It consists of 49 statements, 21 positive and 28 negative, in five dimensions ranging from strongly agree to strongly disagree. The statements gauge the rationality, curiosity, open mindedness, faith in scientific method and aversion to superstition. The reliability of the whole test was determined by test-retest method and was found to be 0.970 by product-moment coefficient of correlation and it was significant at 0.01 level of significance. The content validity was established by working out the index of suitability and its value ranged from 0.92 to 1. Similarly, for concurrent validity the coefficient of correlation was significant at 0.01 level of significance.
2. **Science achievement:** It was measured from the science scores of SA-I (Summative Assessment-I) of the students. Directorate of Education, Delhi conducts SA-I examination for Government schools under its jurisdiction.

Procedure

The tool, scientific attitude scale, was administered, as per instructions given in the manual, on the sample.

According to the manual, response sheets were evaluated. The skewness of scientific attitude and science achievement scores of girls and boys were calculated and the skewness value for scientific attitude was -0.12 and for science achievement was 0.02 which shows that the sample is approximately symmetrical hence the collected data can be treated through parametric tests like t test, ANOVA and Karl Pearson's Product Moment Coefficient of Correlation (r).

RESULTS AND DISCUSSION

H_{01} : There is no significant difference in scientific attitude of boys and girls at secondary school level.

Table 1: t-test for scientific attitude with respect to boys and girls students at secondary school level

Gender	N	Mean	S.D.	σ_d	D	t-value
Boys	102	146.141	19.563	6.105	16.972	2.783[#]
Girls	106	163.113	21.834			

#significant at .01 level *significant at .05 level

(σ_d is the standard error of difference between the means and D is the difference between the means)

The obtained t value, 2.783, is significant at 0.01 level of significance so, there is a significant difference, in the favour of girls in comparison to boys at secondary school level, between their scientific attitude. Hence, this null hypothesis is rejected. This finding is in consonance with the findings of Narmadha & Chamundeswari (2013) and Sekar & Mani (2013) but opposes the findings of Olasehinde & Olatoye (2014) and Srivastava (2015) where with respect to scientific attitude non-significant difference between two genders was found. The plausible reason behind this finding may be better academic infra structures like science laboratory in girl schools than boy schools and more focus on process approach rather than product approach of science by teachers in girl schools so that over the time somewhat conducive environment, which facilitated the better development of scientific attitude among girls than boys, might have developed.

H₀₂: There is no significant difference in science achievement scores of boys and girls at secondary school level.

Table 2: t-test for science achievement scores with respect to boys and girls students at secondary school level

Gender	N	Mean	S.D.	σ_d	D	t-value
Boys	102	20.009	11.173	1.772	14.698	8.294[#]
Girls	106	34.707	13.882			

#significant at .01 level *significant at .05 level

The t value, 8.294, is significant at 0.01 level of significance hence there is a significant difference, in the favour of girls in comparison to boys at secondary school level, between their science achievement scores. So, this null hypothesis is rejected. This finding supports the work of Ksheerasagar and Kavyakishore (2013) and

Narmadha & Chamundeswari (2013) but Sharma (2007) and Olasehinde & Olatoye (2014) found non- significant difference in science achievement between boys and girls so the finding of this study does not support them. The plausible reason for this finding may be the quality teaching in girl schools in comparison to boy schools and in this respect, the teachers played a significant role in enabling the girl students to score more than boys. However, study habits of girl students, as another factor, might have supported them also.

H₀₃: There is no significant correlation between the scientific attitude and science achievement scores of secondary school students

Table 3: Coefficient of correlation between scientific attitude and science achievement scores among secondary school students

r value	t value
0.297	4.464 [#]

#significant at .01 level *significant at .05 level

The t value, 4.464, is significant at 0.01 level of significance so, there is a significantly positive correlation between scientific attitude and science achievement scores among secondary school students.

Hence, the framed null hypothesis is rejected. This finding is in harmony with the findings of Sharma (2007); Ksheerasagar & Kavyakishore (2013); Narmadha & Chamundeswari (2013) and Srivastava (2015) but supports the findings of Olasehinde & Olatoye (2014).

Scientific attitude enriches the cognitive domains of students to think in depth, account for the happenings and also develops a habit of not accepting the things unquestioned. So, when such students, with well nurtured scientific attitude, undergo learning process they have upper hand in comparison to their counterparts thus, a positive correlation is expected between scientific attitude and science achievement.

H₀₄: There is no significant interaction effect of gender and scientific attitude on science achievement scores of secondary school students.

Table 4: Main & Interaction effects of Gender and Different levels of Scientific Attitude on Science achievement scores

Source of Variation	Sum of Squares	df	Mean Squares	F
a. Gender	11146.131	1	11146.131	58.894 [#]
b. Scientific Attitude	1128.722	2	546.361	2.982 [#]
Interaction (AXB) Gender X Scientific Attitude	1029.931	2	514.965	2.721 [#]
Error: Within Treatments	38229.816	202	189.256	
Total	51534.6	207		

The interaction effect was studied with respect to Gender (A) and it varied at two levels.

Boys (A₁) and Girls (A₂) and Scientific Attitude (B) which varied at three levels that is Very High (B₁), Average (B₂) and Very Low (B₃). From table 4 following inferences were drawn:

- (i) **Main Effect-Gender (A):** The F ratio for the main effect of gender on science achievement scores of secondary school students, irrespective of their scientific attitude, is 58.894 for df 1 and 202 which is significant at 0.01 level of significance. This indicates that gender wise secondary school students differ significantly in science achievement. This also shows that the significance of mean-square of gender as variable indicates that the means for A₁ (Boys) and A₂ (Girls) averaged over the levels of scientific attitude differ significantly.
- (ii) **Main effect-Scientific attitude (B):** The F-ratio for the main effect of scientific attitude on science achievement scores, independent of gender, is 2.982 for df 2 and 202 which is significant at 0.01 level of significance. This shows that science achievement of secondary school students belonging to different levels of scientific attitude, that is very high, average and very low, differs significantly. Also, the significance of mean-square of scientific attitude as variable indicates that the means for B₁ (Very High), B₂ (High Average) and B₃ (Very Low) averaged over the levels of gender differ significantly.
- (iii) **Interaction Effect (AXB):** The F value for the double interaction between A (Gender) and B (Scientific attitude) with respect to Science achievement of secondary school students is 2.721 and it is significant at 0.01 level of

significance. It indicates that gender (A) effect that is the difference between A₁ and A₂ or between boys and girls, is dependent on the scientific attitude.

Gender and scientific attitude, as independent variables, had effect on science achievement scores and they themselves underwent interaction with respect to science achievement scores so, this null hypothesis is rejected.

Implications

The present study has implications for students, teachers and curriculum developers and parents.

Implications for students: Scientific attitude, scientific method etc. are applicable in almost all domains of interactions. All academic disciplines pave the ways to a learner to practice scientific method and adopt scientific attitude but science, as a discipline in comparison to others, offers somewhat more space for the same. In science classroom, teachers should have concern with students in facilitating them in developing scientific attitude (Mukhopadhyay, 2014) and students should participate in the learning process by questioning, self-questioning, cross questioning, reflecting at their own explanations. In the laboratory, students should not merely copy each other’s data but verify the same by adopting hands-on-approach while doing practicals, experiments or activities. Over the time, such practices may facilitate the students to develop scientific attitude and score better in science.

Implications for teachers: In class room as well as laboratory, process approach rather than product approach of science should be practiced as it motivates the students to respond what, why and

how of a phenomenon under consideration. Classroom teaching practices with focus on attempts in developing scientific attitude among students prove instrumental enough in leading to desired learning (Moore & Foy, 1997) so, teachers should not intimate the students the result(s) of some activity or practical in advance but should stimulate the students to find it at their own end.

Implications for curriculum developers: in science text books, at the end of a chapter there must be some open ended questions to facilitate the diversification of students' thinking. The presentation of content, rather than being in heavily texted mode, should be enriched with what, why and how aspects related to it. There should be sufficient number of practicals, experiments, activities pertaining to a particular concept.

Implications for parents: Family as an informal agency of education and parents as first teacher of a child should encourage, since beginning, him/her to think rationally and discourage the habit of accepting the things as such. Rather than waiting for the schools to organize field trips to science centre, zoo or any other extended learning resource the parents, if feasible, should take initiatives at their end. They should ask the child about his/her experience of the same and discuss.

CONCLUSION

In science education the teaching methodologies, to promote process nature of science, should focus not only on enabling students to score better but also on developing scientific attitude, over the time, among them also. Classroom learning scenario with ample scope of creativity, innovation and problem solving catalyze the process of the development of scientific attitude among students. At Departmental level, due care must be taken to ensure quality teaching, provision of pre-requisites at infra structural level in schools etc. so that there are no gender difference with respect to scientific attitude and science achievement among students as in the coming time for the sustainable development of nation both male and female citizens may contribute equally.

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