ATTITUDE TOWARDS SCIENCE AND ITS RELATIONSHIP WITH STUDENTS’ ACHIEVEMENT IN SCIENCE

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Abstract
This study was conducted to examine the relationship of attitude of secondary school students towards science with the achievement in the subjects of Physics, Chemistry, Biology and Mathematics. TOSRA was used to measure students’ attitude towards science and data was collected from 1,885 students of 10th grade. Simple correlation (r), Multiple regression analyses (R) and standardized regression coefficients (β) were used to investigate the relationships between attitude towards science and achievement in science. The results of the study indicated that attitude towards science had significantly positive relationship with the achievement of science students at secondary level.

Keywords: Attitude, Attitude towards science, achievement, achievement in science, TOSRA

1. Introduction

In this modern era, science has become the backbone for the prosperity in each and every field of life. For this purpose, our students will have to pay attention on their studies during their educational career. Science is an important area in the field education for the students of secondary level. After the secondary school classes, these students have to select such fields which lead to their professional career. These students have to perform different activities at this level. These activities provide students different concepts related to science as well as scientific enquiry.

According to Bennet (2003), science education is helpful for the students in understanding science ideas. Keeping in view the above discussion, attention has been paid to attitude of students toward science and its relationship with their achievements in the subjects of science. A large volume of research is present on factors affecting students’ achievement in science. Some of these factors are test anxiety, attitude towards science, parental socioeconomic status, self-efficacy, gender, parental influence, self-concepts, ability, learning environment, peers...
and the teachers (Rodriguez, 2004; Singh, Granville, & Dika, 2002; Okapala, Okapala, & Smith, 2001; Nair & Fisher, 2001; Joyce & Farenga, 2000; Gertyz, 1999; and Orr & Dinur, 1995).

The students’ achievement is mainly influenced by attitude towards science in all the above mentioned factors. Attitude of secondary school students towards science as well as their achievement in the subjects of science is very important because students have to select their professional carriers as a result of these two factors. Many researchers have conducted different research studies in other countries which cover the areas of attitude towards science and achievement in science (Eccles, 2007; Papanastasiou & Zembylas, 2004; Ferreira, 2003; Dhindsa & Chung, 2003; Mattern & Schau, 2002; Freedman, 1997; House, 1993; Simpson & Oliver, 1990). All these researches regarding to attitude towards science and achievement in science were conducted in different countries of the world, but this was first effort to find out effects of attitude towards science on the achievement of secondary school science students in Pakistan.

2. Objectives

Different objectives for this study were: 1) the description of data related to attitude towards science and achievement in science, and 2) exploration of relationship between students’ attitude towards science and their achievement in science.

3. Research Question

On the basis of objectives, the research question formulated was: Is there relationship between students’ attitude towards science and their achievement in science?

4. Significance of the Study

The study is very significant due to following reasons: 1) it would provide foundations for new studies in the field of attitude towards science. 2) The factors of attitudes towards science and students’ achievement in science will be helpful for researchers, science educators and parents for enhancement of students’ attitudes towards science and getting higher achievement in subjects of science.

5. Review of Related Literature

Osborne, Simon, & Collins (2003) have described that attitude towards science is very important in the field of science education for the past 40-50 years. Osborne et al. (2003) have defined attitude as “the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves” (p. 1053). Schibeci (1984) has described that two different terms are used for attitudes relating to science which are: scientific attitudes and attitude towards science. Bennet (2003) has described that attitude towards science refers to the views of students developed for science as the results of experiences in different environments in the field of science education.
Students’ attitude towards science is an important factor that is associated with achievement in science. According to Papanastasiou and Zembylas (2002), “A substantial body of research has accumulated over the last three decades, concerning the importance of various attitudes toward science and the relationships between these attitudes and achievements in science” (p. 470).

Parker and Gerber (2000) have explained that attitude towards science are very important for the achievement in science because the attitudes and achievement lead to the selection of careers by the students.

6. Review of Research Studies

Hough and Piper (1982) conducted a research to investigate the relationship between attitude towards science and science achievement. They collected data from 583 intermediate elementary students. These students were pre- and post-tested. After the analysis of data it was indicated that there was a significant positive relationship between students’ attitude towards science and science achievement ($r = 0.45$). The students with positive attitude towards science had higher achievements. On the other hand, the students with negative attitude had lower achievement in science.

Willson (1983) meta-analyzed 43 different studies to find out the correlations between attitude towards science and achievement in science. The populations of these studies were the students of kindergarten through undergraduate college level. Multiple regression analysis and ANOVA were used for the analysis of data to find out the correlations between attitude towards science and science achievement. From the meta-analysis of these 43 studies, it was concluded that attitude towards science and achievement in science had large positive correlations as a whole. It was also indicated that correlations were low at elementary level but from grades 7 to 11, the correlations between attitude towards science and science achievement were highly positive.

Oliver and Simpson (1984) conducted a longitudinal study in central North California to explore the influence of attitudes on achievement in science. Initially data was collected from a group of 5000 students in grades 6-10 in 1980-1981. The results of the study indicated that there was a strong positive relationship between attitude towards science and achievement in science at different grades.

Similarly, Simpson and Oliver (1990) conducted another longitudinal study on more than 4000 students in grades 6-10. These students were selected from 178 science classes. The results of this longitudinal study showed that male students had significantly more positive attitude towards science and their achievement in science was higher than female students. The results also made it clear that students’ attitude towards science as a whole became less positive from grades 6 through 10.

Weinburgh (1995) meta-analyzed different studies to find the differences in students’ attitude towards science on the basis of gender as well as correlation of attitude towards science with achievement in science. 18 different studies were examined and the number of students in these studies was 6,753. The results of this meta-analysis expressed that the mean correlation between attitude towards science and achievement in science was .55 for girls and .50 for boys. In the subjects of biology and physics, the correlations were positive for both boys and
girls, but stronger in girls than boys. The results of the analysis also explained that positive attitudes of all the students caused higher achievement in the subjects of science.

Freedman (1997) investigated the relationship of attitude towards science with achievement in science. The data was collected from 20 physical science classes. The analysis of data expressed that there was a significantly positive correlation of students’ attitude towards science with their achievements. It was concluded that achievement in science was affected by attitude towards science.

Mattern and Schau (2002) conducted a study for the determination of gender differences in relationships of attitudes toward science with achievement. 1,238 students of 7th and 8th grades were selected as sample. This sample was selected from eight different schools in Northern New Mexico. Three instruments (one for attitude towards science and two for achievement in science) were used for the collection of data. It was indicated that there was no significant effect of achievement in science on attitude among girls. While among boys, the results were different.

Ferreira (2003) examined gender issues with respect to attitude towards science and achievement in science. The results of the study declared that attitude of the students towards science were reflected in their achievement in science. There was a positive significant relationship between attitude towards science and achievement in science. Positive attitude of the students towards science caused the higher achievement in science.

Eccles (2007) also investigated the relationship between attitude towards science and achievement in science among middle school students in South Florida. The TOSRA by Fraser (1981) was used for measuring attitude towards science. The achievement in science was measured by using letter grades about the subject of science given to the students. It was indicated that there was a strong relationship between attitude towards science and achievement in science. The students’ attitudes towards science were more positive and their achievements were higher.

7. Methodology

7.1 Sample

The total number of students selected for the sample was 1,885 (998 male students and 887 female students). These students were selected from four districts (Okara, Faisalabad, Sargodha and Pakpattan) of Punjab province and they were studying science subjects at secondary level.

7.2 Instruments

7.2.1 Attitude towards Science

Test of Science-Related Attitudes (TOSRA: Fraser, 1981) was used for the measurement of students’ attitude towards science. Initially 42 items of TOSRA were used in this study but as a result of pilot testing, some items were deleted and revised version of TOSRA contained 31 items with following proportions of five subscales:

- Social Implications of Science with 6 items
- Attitude to Scientific Inquiry with 5 items
- Enjoyment of Science Lessons with 8 items
Leisure Interest in Science with 5 items

Career Interest in Science with 7 items

These 31 item TOSRA was used for data collection in the final study. Factor analyses were also conducted. As a result of factor analysis, two subscales of TOSRA: Enjoyment of Science Lessons and Leisure Interest in Science were merged into a single subscale named Classroom Enjoyment and Leisure Interest in Science. The Alpha Reliability value for this TOSRA was $\alpha = 0.899$.

7.2.2 Achievement Scores in Science Subjects

The students' achievement in science was a dependent variable of the present study. The students of 10th grade public secondary schools had already appeared in 9th grade Board examinations. The 9th class Board results of these students in the subjects of Physics, Chemistry, Biology and Mathematics were used as achievement measures.

7.3 Statistical Techniques for Data Analysis

The methods used for the analyses were the following:
1) Simple correlation analysis was used to describe the bivariate relationships between each individual achievement scale and each individual attitude scale.
2) Multiple regression analyses were used to investigate the multivariate relationships between each achievement scale with the set of four attitude scales as a whole.
3) The standardized regression coefficients (regression weights) were also examined to interpret the significant multiple correlation.

7.4 Results

This section explains the relationships of attitude scales with science achievement measures (Physics, Chemistry, Biology, Mathematics and Total scores).

All the Tables below present the simple correlation ($r$), multiple correlations ($R$), and the standardized regression coefficient ($\beta$) for relationships of Physics, Chemistry, Biology, Mathematics and Total achievement measures with four TOSRA scales.
Table 1: *Simple Correlations (r), Multiple Correlations (R), and Standardized Regression Coefficients (β) for Relationships of Physics Achievement Measures with Four TOSRA Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Physics Achievement Measure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Implications of Science</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Attitude to Scientific Inquiry</td>
<td>0.10**</td>
<td>0.06**</td>
</tr>
<tr>
<td>Classroom Enjoyment and Leisure Interest in Science</td>
<td>0.17**</td>
<td>0.12**</td>
</tr>
<tr>
<td>Career Interest in Science</td>
<td>-0.00</td>
<td>-0.06**</td>
</tr>
</tbody>
</table>

Multiple Correlation R = 0.24**

*P < 0.05, **P < 0.01, N = 1885

This table shows that the attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were significantly correlated (p < 0.01) with Physics achievement measures but relationship was positive. On the other hand, there was no relationship of Physics achievement measure with Social Implication of Science and Career Interest in Science. There was a significant multiple correlation (R) (p < 0.01) between the Physics achievement measure with the set of TOSRA scales. The investigations of signs for standard weights show that the relationship between Physics achievement measure with Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positive.

Table 2: *Simple Correlations (r), Multiple Correlations (R), and Standardized Regression Coefficients (β) for Relationships of Chemistry Achievement Measures with Four TOSRA Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Chemistry Achievement Measure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Implications of Science</td>
<td>0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td>Attitude to Scientific Inquiry</td>
<td>0.10**</td>
<td>0.05**</td>
</tr>
<tr>
<td>Classroom Enjoyment and Leisure Interest in Science</td>
<td>0.19**</td>
<td>0.15**</td>
</tr>
<tr>
<td>Career Interest in Science</td>
<td>0.00</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

Multiple Correlation R = 0.25**

*P < 0.05, **P < 0.01, N = 1885
It is clear from above table that attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were also significantly correlated (p < 0.01) with Chemistry achievement measures but relationships were positive. On the other hand, there was no relationship of Chemistry achievement measure with Social Implications of Science and Career Interest in Science. There was a significant multiple correlation (R) (p < 0.01) between the Chemistry achievement measure and the set of TOSRA scales. The investigations of signs of standard weights show that the relationship between Chemistry achievement measure with Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positive.

Table 3: Simple Correlations (r), Multiple Correlations (R), and Standardized Regression Coefficients (β) for Relationships of Biology Achievement Measures with Four TOSRA Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>r</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Implications of Science</td>
<td>0.07**</td>
<td>0.03</td>
</tr>
<tr>
<td>Attitude to Scientific Inquiry</td>
<td>0.09**</td>
<td>0.04</td>
</tr>
<tr>
<td>Classroom Enjoyment and Leisure</td>
<td>0.21**</td>
<td>0.16**</td>
</tr>
<tr>
<td>Interest in Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Interest in Science</td>
<td>-0.01</td>
<td>-0.08</td>
</tr>
<tr>
<td>Multiple Correlation</td>
<td>R</td>
<td>0.26**</td>
</tr>
</tbody>
</table>

*P < 0.05, **P < 0.01, N = 1885

Social Implications of Science, Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positively significant (p < 0.01) with Biology achievement measures. On the other hand, there was no relationship of Biology achievement measure with Social Implications of Science and Career Interest in Science. It is also clear from Table 3 that there was a significant multiple correlation (R) (p < 0.01) between the Biology achievement measure and the set of TOSRA scales. The investigation of signs for standard weights makes it clear that the relationship between Biology achievement measure with Classroom Enjoyment and Leisure Interest in Science was positive.
Table 4: Simple Correlations (r), Multiple Correlations (R), and Standardized Regression Coefficients (β) for Relationships of Mathematics Achievement Measures with Four TOSRA Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mathematics Achievement Measure</th>
<th>r</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Implications of Science</td>
<td></td>
<td>0.02</td>
<td>-0.02</td>
</tr>
<tr>
<td>Attitude to Scientific Inquiry</td>
<td></td>
<td>0.12**</td>
<td>0.08**</td>
</tr>
<tr>
<td>Classroom Enjoyment and Leisure Interest in Science</td>
<td></td>
<td>0.18**</td>
<td>0.13**</td>
</tr>
<tr>
<td>Career Interest in Science</td>
<td></td>
<td>-0.02</td>
<td>-0.07**</td>
</tr>
</tbody>
</table>

Multiple Correlation R 0.27**

*P < 0.05, **P < 0.01, N = 1885

Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were also significantly correlated (p < 0.01) with Mathematics achievement measures but relationship was positive. On the other hand, there was no relationship for Mathematics achievement measure with Social Implications of Science and Career Interest in Science. There was a significant multiple correlation (R) (p < 0.01) between the Mathematics achievement measure and the set of TOSRA scales. The investigation of signs of standard weights shows that the relationship between Mathematics achievement measure with Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positive, while negative for Career Interest in Science.

Table 5: Simple Correlations (r), Multiple Correlations (R), and Standardized Regression Coefficients (β) for Relationships of Total Achievement Measures with Four TOSRA Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Total Achievement Measure</th>
<th>r</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Implications of Science</td>
<td></td>
<td>0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>Attitude to Scientific Inquiry</td>
<td></td>
<td>0.13**</td>
<td>0.08**</td>
</tr>
<tr>
<td>Classroom Enjoyment and Leisure Interest in Science</td>
<td></td>
<td>0.23**</td>
<td>0.17**</td>
</tr>
<tr>
<td>Career Interest in Science</td>
<td></td>
<td>-0.03</td>
<td>-0.10**</td>
</tr>
</tbody>
</table>

Multiple Correlation R 0.31**

*P < 0.05, **P < 0.01, N = 1885

The total achievement measure was calculated by taking the sum of all scores in the subjects of science i.e. Physics, Chemistry, Biology and Mathematics. The data of Table 5 represents that Attitude to Scientific Inquiry and
Classroom Enjoyment and Leisure Interest in Science were positively significant (p < 0.01) with Total achievement measures. On the other hand, there was no relationship for Total achievement measure with Social Implications of Science and Career Interest in Science. Table 5 also indicates that there was a significant multiple correlation (R) (p < 0.01) between the Total achievement measure with the set of TOSRA. The signs of standard weights show that the relationships between Total achievement measure with Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positive, while negative for Career Interest in Science.

8. Conclusions

It is concluded from the above discussion that Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science are strong independent predictors of Physics achievement scores. Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science are strong independent predictors of Chemistry achievement scores. It is concluded from the above discussion that Classroom Enjoyment and Leisure Interest in Science is strong independent predictor of Biology achievement scores. Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science are strong independent predictors of Mathematics achievement scores.

The conclusions drawn from the above discussion that Attitude to Scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were strong independent predictors of Total achievement scores. One scale of TOSRA: Classroom Enjoyment and Leisure Interest in Science was positively significant with Biology achievement scores. The positive attitude of students for these two scales caused higher Biology achievement scores.

Two scales of TOSRA: Attitude to scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positively significant with Mathematics achievement scores. The positive attitude of students for these two scales caused higher Mathematics achievement scores. Two scales of TOSRA: Attitude to scientific Inquiry and Classroom Enjoyment and Leisure Interest in Science were positively significant with Total achievement scores. The positive attitude of students for these two scales caused higher Total achievement scores.

9. Discussion

The findings and results of this study replicated the results of some previous research studies that attitude towards science was positively correlated with the achievement in science. The achievement measures of all the four science subjects (Physics, Chemistry, Biology and Mathematics) as well as total achievement measure were positively correlated with the scales of TOSRA. The values of these correlations ranged from 0.07 to 0.23. The correlations were weak but were positively significant. But the results of some research studies show that the values of these correlations are very strong. Hough and Piper (1982) analyzed the data and the correlation was 0.45. Similarly, the correlation in the study of Freedman (1997) was 0.406. It is clear from the above discussion that attitude towards science is positively correlated with the achievement of students in science.

The researcher has explored the correlations of attitude towards science and students’ achievement in science by using adapted instruments of TOSRA. This fact may be taken into account that more items of these instruments can be used in future work to improve their reliability. This study was conducted on secondary school
science students only. This research can be expanded for students at all levels i.e., from students of primary level up to students of university level.

This research may also be conducted on students taking subjects of arts. So, its results can be generalized for whole of the population including students of science as well as arts. In the future research, qualitative research methods may also be included to check the validity of quantitative research methods. Qualitative research can influence students’ achievement in science. In qualitative research methods, Attitude towards Science can be measured by observations and interviews instead of questionnaires.
References


