ATTITUDE TOWARDS SCIENCE: A CASE STUDY OF HIGHER SECONDARY LEVEL STUDENTS OF SINDH PROVINCE

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ABSTRACT

This research is conducted, in order to perceive the attitude of higher secondary level students of Sindh towards science. Students (Male = 448, Female = 648) belonging to higher-secondary level (Class-XI & XII) from Hyderabad division were surveyed. Students were divided in Urban (N=455) and Rural (N=641) groups accordingly. "Test of Science Related Attitudes" known as TOSRA, initially developed by (Fraser, 1978) was adapted and translated in Urdu as well, was used as the attitude measurement instrument. Internalk consistancey was checked with Cronbach's alpha reliability test. After pilot study the test was administrated. Significant difference of the attitude towards science across the students was noticed based on their gender and their locale. The results show that, with small effect size, male students significantly scored higher on almost all of the attitude sub-scales of TOSRA as compared to female students. Interestingly, students belonging to rural areas significantly scored higher with medium effect size on all the attitude sub-scale towards science as compare to students from urban areas.

Keywords: Attitude towards Science, TOSRA, Science, Gender

INTRODUCTION

A diverse, dynamic, vibrant and well-prepared workforce in the areas of science and technology is vital for a country to achieve sustainable development and continue its pace in competitive progress. For Pakistan to enhance its capabilities to be considered as a developing country and cater to its developing projects, a huge number of engineers, technologists and scientists are needed. This workforce cannot be maintained till the society itself keep positive and sound attitude towards science and technology. This attitude must be implanted at very basic education system from beginning and the interest of the students has to be enhanced towards science through curriculum and good school environment. In Pakistan science curriculum is

generally considered as outdated and inadequate to impart students' interest in science and technology fields. The list of problems is too long to be discussed here. Overall school environment is discouraging students to ask question and kill curiosity. Laboratory facilities are mostly non available or obsolete in public sector schools and colleges. There are also many flaws in examinations system in Pakistan. Board and school examination system encourages memorization hence discourage students to internalize the subject matter. It is generally considered that the general perception of the population is not encouraging towards science. There could be lots of factors involved behind this phenomenon.

DEFINING ATTITUDE TOWARDS SCIENCE

In everyday life, people use the term "attitude" commonly but everyone has its own meanings, concepts and definitions. Commonly narrated terms for "attitude" such as self-esteem, feelings, motivation, enjoyment, etc; may or may not be truly characterize its definition. According to Koballa Jr. (1988), the term attitude was first time used in psychological studies by Thomas & Znaniecki (1918) in early 19th century. "Attitude" as described by Eagly & Chaiken (1993); "tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour". Whereas other scholars are of opinion that "the attitude of a person" is an expression of feelings based on his/her belief for an object (Kind, Jones & Barmby, 2007).

A general and widely accepted definition of attitude based on three factors such as cognition, affective and behavioural (Rajecki, 1990; Bagozzi & Burnkrant, 1979; McGuire, 1985). These three factors were defined by Reid (2006) as follows:

- **Cognitive**: Ideas factor; knowledge of the object; the beliefs,
- **Affective**: Like or dislike factor; a feeling about the object, and
- **Behavioural**: The objective factor; a tendency-towards-action.

Similarly, Oppenheim (1992) describe attitude as below: "attitudes are reinforced by beliefs (the cognitive component), often attract string feelings (the emotional component) which may lead to particular behavioural events (the action component)".

Researchers observe these factors closely connected together. We may have a feeling or an opinion about science as we know about it, and therefore it may result into take some actions. While the other researchers are of the opinion that these three factors should be considered more independently (Ajzen, 2001; Crano & Prislin, 2006). By narrowing down on these concepts, one's attitude towards an object or subject is almost similar to asking someone about their judgment on the subject or object. Whereas, the

judgment of a person shouldn't be influenced by his or her mood such as being happy or sad and emotion such as fear and anger (Ajzen, 2001).

FACTORS AFFECTING ATTITUDE TOWARDS SCIENCE

In general, many socio-cultural and socio-economic factors influencing students' attitudes towards science have been revealed by many researchers. Many of such findings contradicting each other as well. For example, George & Kaplan (1998) investigated parents' role and found significant impact on children's attitude towards science. Whereas, another study conducted on parental role by George J. M. (2001) did not find statistically significant influence on the development of student's attitude towards science with exception of the seventh grade students.

Gender is considered as one of the most important and significant factors effecting attitude towards science, as Gardener (1975) comments, "sex is probably the most significant variable related towards pupils' attitude to science". It has been shown in various studies (Schibeci R. L., 1984; Becker, 1989; and Wienburg, 1995) that the difference of attitude towards science exists between genders, but it is unclear how the process affects attitudes towards science (Wienburg, 1995; Simpson & Oliver, 1990).

Other studies conducted on talented elementary school children by Shymansky & Kyle (1988) and Swiatek & Lupkowski-Shoplik (2000) found the trend favouring science and technology for boys whereas girls favouring languages, reading and writing. Further to this, these studies observed that negative attitudes towards science increase as girls get older. Reis and Park (2001) conducted a comparative study on gifted students. They found that, especially in science subjects, male students had shown higher capability than the females in physical sciences and mathematics. Whereas, the female students outperformed their counterparts in art subjects. Similarly, various research studies have also found that as compared to girls, boys scored higher on attitude scales used to measure attitude towards school science subjects. The attitude score difference between the groups was significantly higher for Physics as compared to biological sciences.

One of the major factors behind these gender difference findings was blamed to behaviour of teachers (Elizabeth, Peterson, Carpenter, & Lubinski, 1990). The climate of schools and colleges may be another factor for gender difference in science and math achievements. Some evidences lead to a conclusion that the lower level of teachers' attention in science classes towards the girl students was a major factor behind their lower level of science attitude (Handley & Morse 1984; Jones & Wheatley, 1990). Similarly, Jones M.G.(1989) has observed that boys receive more attention as compare to girls from teachers in science classes and therefore they participate more actively in school. One study concluded those boys' attitudes towards science drops faster as compared to girls whose initial

status towards science is higher (Francis & John, 1999). Studies conducted on locality based also concluded that compared to students belonging to rural area schools, rural school's students in metropolitan have shown higher positive attitudes toward science (Catsambis, 1995). Study conducted in Punjab province of Pakistan also revealed significant effect of gender and locale on students' attitude towards science (Muhammad, Hafiz & Christine, 2012).

OBJECTIVES OF STUDY

The major focus of this study was to explore the general perception and measure the level of attitude towards science, based on TOSRA scales, of students in Sindh Province at college and Higher Secondary Schools (HSS) or intermediate level. Therefore, objectives of the study were set as following:

- To verify the validity and reliability of science attitude measurement instrument known as Test of Science Related Attitudes (TOSRA) in Sindh province.
- To investigate the general perception of students towards science and technology.
- To select one case study in higher secondary level education in Sindh province of Pakistan.
- To investigate the difference of opinion, if exists between the male and female students of HSS level.
- To investigate the difference of opinion, if exists between rural and urban areas students.

RESEARCH QUESTIONS

By focusing on the above objectives of this study, this research attempts to answer the following research questions:

- When used on HSS level students of public sector institutes in Sindh province, is the adapted version of Test of Science-Related Attitudes (TOSRA), used in this study, valid and reliable?
- Is there any difference of opinion or attitude towards science that exist on gender bases?
- Is there any difference of opinion or attitude towards science that exist on locale (Urban-Rural) bases?

LIMITATION OF THE STUDY

This case study was limited to:

- Sindh province only.
- This is a case study focusing urban and rural districts of Hyderabad division only.
- Government HSS and colleges, and

- The students of Intermediate level classes taking science subjects as major.

OPERATIONAL DEFINITIONS OF THE VARIABLES

Attitude towards Science: It means students' attitude towards the subjects of science as measured by Test of Science-Related Attitudes (Fraser, 1981). Dimension scales of TOSRA used in this study include:

1. Social Implications of Science (S1),
2. Attitude to Scientific Inquiry (S2),
3. Enjoyment of Science Lessons (S3),
4. Leisure Interest in Science (S4) and
5. Career Interest in Science (S5).

Demographic Background: background based on gender, ethnicity, religion and locality (urban/rural).

ETHICAL CONSIDERATIONS

Ethical rules for researching humanitarian subjects are strictly followed in this study. In order to conduct the survey on the respondents, extreme care has been taken, so that no personal identity can be traced during and after the study. The respondents are not forced to take part in the study. The anonymity, privacy and confidentiality of the respondents are strictly followed in this study. Consent form was attached with the questionnaire and was read loudly before conducting the survey.

RESEARCH METHOD

The major goal of this case study was to work out the difference of attitude towards science that exists in students at HSS level (intermediate level) on the basis of demographic and locale backgrounds. Therefore, the population in this study was intermediate/ HSS level students of diverse background who were taking science subjects as major in various colleges and higher secondary schools (HSS) of Hyderabad division. A random sample of the students was selected from the colleges/HSS who volunteer to participate. Hyderabad division in Sindh province is consists of balanced proportion of rural and urban population as well as people from different socio-economic and ethnic backgrounds.

SAMPLE

The sample selection was based on following steps:

- Hyderabad division was distributed into two strata based on locality i.e., urban and rural.
- Each stratum was further subdivided into substrata based on gender.

- One boys' and one girl's college or HSS were selected from Rural-districts including Matiari, Tando Mohammad Khan, Jamshoro, and Dadu districts.
- In order to keep the urban and rural area ratio substantial, two to three boys and Girls colleges and higher secondary schools were randomly selected.

For a research survey, it is very important to decide appropriate sample size for the study. The research instrument of this study is a based on Likert-item scale. The sample calculation for such type of survey is not straight forward as it depends on number of factors. Typical Likert-item scale survey mostly provides a statistical response based on Normal Distribution (Likert, 1932). Sample size "N" for a Likert-item scale survey depends on the following factors:

- Confidence interval "zσ": represents standard deviation of Normal distribution
- Coefficient of variation "C": less than 1 in Likert-item scale
- Number of items in the scale "k": ranges from 4-10
- Correlation between the items "ρ":
- Tolerable error "D"

The reasonable sample size for Likert-item scale survey can be calculated using the following formula suggested by Park & Misook (2009)

$$N = \frac{z\sigma^2 C^2}{k D^2}[1 + (k-1)\rho]$$

Where, k is number of items in the scale, ρ is correlation between the items, C is coefficient of variation, zσ confidence interval and D is tolerable error. In Likert-scale surveys, confidence level of 2-sigma (95%) and tolerable error level of 2% is required. Using above formula and fixing the optimum values for the parameters, the sample size was calculated as approximately above 1000. The data is collected for this study from 1096 students from different colleges and higher secondary schools of Hyderabad division in Sindh province. Average student number in this study varies between 100 to 150 per college / HSS.

INSTRUMENT

In order to understand students' perception and attitude towards science, the Test of Science Related Attitudes (TOSRA) survey (Fraser, 1978) was piloted at a few colleges/HSS prior to administering it to the participating respondents. The pilot study helped to assess if the complete survey (70 Likert-items) would be significant to the purpose of this study. After analysis of the pilot study results, the final survey was conducted at randomly selected colleges of Hyderabad division for this research study.

The measuring the general attitude towards science, still TOSRA is considered as multidimensional instrument, first developed by Fraser (1978). TOSRA is widely used and tested in number of studies in the field of science education research (Welch., 2010; Lyn Jewell, 2011). The original TOSRA was developed to measure attitudes towards science of middle and high school level students. It consists of seven sub-scales: (i) Social implications of science; (ii) Normality of scientists; (iii) Attitude to scientific inquiry; (iv) Adoption of scientific attitudes; (v) Enjoyment of science lessons; (vi) Leisure interest in science; and (vii) Career interest in science. Each sub-scale comprises ten items and can be scored separately. These scales seem to be distinct, but they all are congruent in a way that they are all measuring the same parameter; overall attitude towards science.

In order to implement TOSRA locally, the questionnaire was translated into national language and then it was standardized for intermediate students of Sindh province. Similar approach was adopted at various places around the world and in Punjab province of Pakistan (Muhammad, Hafiz, & Christine, 2012). After pilot testing and analyzing the data, 50 items were adapted from TOSRA. In present study, 5 out of seven scales were used. The Normality of scientist and Attitude to scientific inquiry sub-scales did not work properly in this study. Perhaps low level of knowledge of respondents about the lives of scientists is the main reason for confusing response about the statements belonging to this scale.

For reliability analysis of translated TOSRA, the sample data was analyzed using SPSS. TABLE-1 shows the alpha coefficient for each scale before and after deleting some original items which are affecting reliability of the scale. Overall alpha score for TOSRA questionnaire also raised to 0.912.

TABLE-1
ALPHA COEFFICIENT FOR REVISED AND ORIGINAL TOSRA SUBSCALES

	Scale 1	**Scale 4**	**Scale 5**	**Scale 6**	**Scale 7**
Initial Survey	0.580	.446	0.785	0.755	0.672
Post Pilot study	0.707	0.801	0.779	0.767	0.701

DATA ANALYSIS

As discussed earlier Likert-type scale is fundamentally an ordinal data but the sub-scales of TOSRA are composite of a set of Likert-type quotations/statements. The questions are scored "positive" and "negative" and then combined to produce final score in continuous data type. Therefore, generally, any parametric statistical tests that predominantly require interval or continuous data can be performed on TOSRA instrument. In order to analyze the association between the data variables, One-way Analysis of

Variance (ANOVA) is used in this study. In fact, there are few important assumptions to be considered before apply this model; i.e. each sample of the data from the population it represents must has been selected randomly and the distribution of data should be normal distribution. To assess the normality of the distribution of the TOSRA scales, the Kolmogorov-Smirnov and Shaprio-Wilk Normality tests were conducted. These results show all the sub-scales having statistically significant value of $p < 0.05$ which reveals that the hypothesis of normality of data for all the scales is rejected. This is very common in psychological studies. Though the normality tests suggested a violation of the assumption of normality, which is quite common in large samples as suggested by Pallant (2010), the histogram of the scores still showed to be reasonably normally distributed in a bell shape and the Normal Q-Q plot of the scales also showed scores in reasonably straight lines suggesting normal distribution

In order to quantify the level of these differences, the "effect sizes" were also calculated as suggested by (Thompson, 1998). This statistical analysis was relevant to answering following research questions:

Is there any difference of attitude between male and female students?: There was statistically significant difference was observed between the groups for four out of five modified TOSRA scales as shown in TABLE-2. Mean score for the gender groups and the effect size were calculated and compared using ANOVA table. Male students scored significantly higher all the scale whereas four out of five sub-scales are statistically significant with $p<0.001$. The effect size for social implications of science, classroom enjoyment, leisure interest in science and career interest in science is small ($\eta^2<0.01$). Whereas for adoption of scientific attitude sub-scale; it is considered as medium ($\eta^2<0.06$).

TABLE-2
ITEM MEAN, ITEM STANDARD DEVIATION AND DIFFERENCES BETWEEN GENDERS (ANOVA RESULTS AND EFFECT SIZES) FOR FIVE TOSRA SCALES

Scale/sub-scale	**Item Mean**		**Item SD**		**Difference**	
	Male	Female	Male	Female	F	Effect Size
Social Implications of Science	3.55	3.39	0.85	0.83	9.30**	0.008
Adoption of Scientific Attitude	3.51	3.34	0.65	0.68	23.2**	0.021
Classroom Enjoyment	3.48	3.39	0.83	0.76	3.10	0.003
Leisure Interest in Science	3.45	3.31	0.73	0.64	9.90**	0.01
Career Interest in Science	3.41	3.28	0.72	0.63	9.90**	0.01
**p<0.01, *p<0.05, Male (n=448) and Female (n=648)						

Is there any difference of attitude between the students belonging to rural and urban areas?: The significance of differences between the scores of urban and rural students on each of the attitude scales were investigated using one-way ANOVA and the magnitude of these differences were estimated using the effect size. Mean score for the group of students were compared and shown in TABLE-3 based on Urban and Rural localities. There was statistically significant ($p<0.005$) opinion difference was observed between the groups for all TOSRA sub-scales as shown in table. Surprisingly urban students had shown less positive attitude as compared to the rural students. These results are quite consistent with the observations made in Punjab province (Muhammad, Hafiz & Christine, 2012). The effect sizes also fall in medium range for all the sub-scales.

TABLE-3
ITEM MEAN, ITEM STANDARD DEVIATION AND DIFFERENCES BETWEEN LOCALITIES (ANOVA RESULTS AND EFFECT SIZES) FOR FIVE TOSRA SCALES

Scale	**Item Mean**		**Item SD**		**Difference**	
	Rural	Urban	Rural	Urban	F	Effect Size
Social Implications of Science	3.58	3.29	0.84	0.82	31.6**	0.028
Adoption of Scientific Attitude	3.49	3.24	0.64	0.70	37.6**	0.033
Classroom Enjoyment	3.54	3.27	0.83	0.71	34.1**	0.030
Leisure Interest in Science	3.45	3.25	0.71	0.63	24.5**	0.022
Career Interest in Science	3.42	3.21	0.70	0.62	24.5**	0.022
**p<0.01, *p<0.05, Rural (n=641) and Urban (n=455)						

DISCUSSION

This study reveals that in Sindh province male students at college level showed higher level of attitude towards science as compared to girls of same class. These results are in consistence with the findings made by many researches (Francis & John, 1999; Schibeci & Riley, 1986; Simpson & Oliver, 1990; Wienburg, 1995). Interestingly, this finding is in contradiction with the findings made in Punjab province of Pakistan, where the study was conducted on secondary level (Class-X) students (Muhammad, Hafiz & Christine, 2012). Given almost the same condition to the students in both provinces in Pakistan, these finding may have shown in consistence with the

study where it has been shown that boys' attitude towards science goes more positive compared to girls as they grow up (Wienburg, 1995; Catsambis, 1995; Simpson & Oliver, 1990). As specified by the findings of this study, a gender difference in attitude towards science in Sindh Province is in favour of the male students. This might be attributed to the socio-cultural roles of boys and girls as age of secondary level. In Pakistani society, due to social pressures, adult girls mostly spend their time at home and therefore having less exposure to the external world (Halai, Rizvi, & Rodrigues, 2007).

Based on TOSRA findings, the observed attitude difference between the urban and rural students is in agreement with the findings made by (Rani, 2000) and (Serin & Mohammadzadeh, 2008). But these findings are in contradiction with the findings made by (Hammrich, 1994) and (Koballa Jr., 1988). These results are also in consistence with the study conducted in Punjab Province (Muhammad, Hafiz, & Christine, 2012). Despite the lesser facilities and socio-economic conditions prevailing in rural areas of Pakistan, students belonging to these areas have higher attitude towards science as compare to urban area students where living standards are high and the modern world facilities are provided. Interest towards science subjects might be forced due to the reasons that the students belonging to average socio-economic backgrounds relates science, specially for Medical and Engineering fields, to higher income carriers and better guaranteed future.

RECOMMENDATIONS

Though this study focused at attitude towards science for higher-secondary students across a large population of science students in Sindh, findings are relevant to the Pakistani context as well. In order to understand the proper attitude of population in Sindh towards science, research studies need to be conducted on different education levels especially primary and secondary levels. Further to this, other studies need to be conducted for identifying and characterize underlying factors might be affecting attitude towards science, such as parental role, parental financial conditions, school environment, teachers' role, as well as use of modern technological gadgets such as mobile phones and tablets. In order to graft positive attitude towards science, multiple activities can be introduced in schools, such as visits to science museums, showing science movies and documentaries in schools, frequent holding of science exhibitions and fares, publication of science books in local languages etc. Comparative studies would also be helpful to observe the effects, before and after such activities on the overall attitude towards science.

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