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Students' Attitude towards Science: A Case of Pakistan

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This study was conducted to examine students' attitude towards science. The sample of the study consisted of 3526 students of 10th grade (Boys = 1914, Girls = 1612) and were from urban (n = 2304) and rural (n = 1222) localities of Pakistan. The instrument administered was ''Test of Science Related Attitudes'' (TOSRA) developed by Fraser (1981). Results of the study depicted a significant effect of gender and locale on students' attitude towards science. Girls had significantly higher attitude towards science than boys on total scale and on all sub-scales of TOSRA with only one exception of Career Interest in Science subscale on which boys were slightly high than girls but it was not significant. Locality wise results showed rural students to score significantly higher on the total scale and on the subscales of Social Implication and Career Interest in Science than the urban respondents, while the urban respondents scored significantly higher on the subscale of Adoption of Scientific Attitudes than the rural respondents. There was no significant variation between the rural and urban respondents in their Attitude towards Scientific Inquiry, Enjoyment of Science Lessons and Leisure Interest in Science. This study has wide implications for educationists.

Keywords: attitude, science, gender, locale

Advancement in science and technology has created a greater demand for more people to study science and this is particularly pertinent in Pakistan which is struggling for a respectable status among international community and where the number of scientists and engineers are very small as compared to developed countries. To ensure the influx of new scientists, it is important to view how science is taught in schools and how this approach affects students willingness to take an active role in their science learning. Research has consistently shown attitudes as an important component of science education (Gardner, 1975; Joyce & Farenga, 2000; Osborne, Simon, & Collins, 2003; Schibeci & Riley, 1986) impacting not only pupils participation and interest (Greenfield, 1996; Koballa, Crawley, & Shrigley, 1990; Simpson & Oliver, 1990; Weinburgh, 1995), but also their performance in science (Linn, 1992). Moreover, Wilson (1983), Oliver and Simpson (1988), Rana (2002), and Papanastasiou and Zembylas (2004) reported a high correlation between positive attitude towards science and achievement in science. Numerous studies document that students attitude towards science decreases with increase in grade levels (Francis & Greer, 1999; Pell & Jarvis, 2001) and this decline is more rapid in middle and high school years (Rani, 2000; Weinburgh, 1995).

There is no consensus among researchers on the meaning of attitude because attitude is a multi-faceted construct. Different researchers define attitude differently. Ramsden (1998) describes that in literature researchers interchangeably use the words attitude, interest, and motivation. According to Salta and Tzougraki (2004), an attitude is the tendency to think, feel or act positively or negatively towards objects in our environment. Gardner (1975) defined attitude as "a learned predisposition to evaluate in certain ways objects, people, actions, situations or propositions involved in learning science". Like attitude, the definition of attitude towards science has also been an issue among the researchers. According to Osborne et al. (2003), attitude consists of different sub-constructs which ultimately give rise to a person's attitude towards science. Different components of attitude towards science have been discussed by different researchers (Crawley & Black, 1992; Gardner, 1975; Koballa, 1988; Oliver & Simpson, 1988; Salta & Tzougraki, 2004).

Bennett (2003) makes the distinction between attitude towards science and scientific attitude. According to him, attitude towards science is linked with the views and images that the individual develops about science as a result of interaction with different situations, while the term scientific attitude is linked to the ways of thinking or scientific method, which covers the skills and is related to the undertaking of practical work. According to Yara (2009), attitude towards science denotes interest or feeling towards studying science. It is the students' disposition towards liking or disliking science.

Although Osborne et al. (2003) mentioned ambiguity in defining attitude towards science in the past, however a remarkable contribution towards its embellishment was made by Klopfer (1971), who categorized a set of affective behaviours in science education. Fraser (1981) based on Klopfer's scheme, described seven components of attitude towards science. He categorized these components as subscales of his science attitude scale "Test of Science-Related Attitudes (TOSRA)". While Fraser's ideas fitted with Klopfer's scheme, the main difference was the division of the first category of Klopfer's scheme, i.e., the manifestation of favorable attitudes towards science and scientists into two separate scales, i.e., Social Implications of Science and Normality of Scientists.

The above discussion has unveiled the concept of attitude towards science and it is clear now that this concept is best described by Fraser (1981) who designed a comprehensive scale (TOSRA) to measure the seven distinct and wide-ranging categories of attitudes toward science (Social Implications of Science, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lesson, Leisure Interest In Science, Career Interest In Science and Normality of Scientists) at secondary level.

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Researches in science education indicate a number of factors influencing students' attitude towards science. Studies completed so far in this area have linked attitude towards science with gender (Greenfield, 1996; Schibeci & Riley, 1986; Stables, 1990), parental education (Mordi, 1991), socio-economic status (Okebukola & Jegede, 1990), and age and grade (Ye, Wells, Talkmitt, & Ren, 1998). Walberg (1984) mentioned nine different factors i.e., students ability, maturity, motivation, quality of instruction, quantity of instruction, psychological environment at home, classroom environment, peer group outside the classroom and the time involved with video/television media that contribute to an individual's attitude towards science. Schibeci and Riley (1986) reported that sex, race, home environment, amount of homework, and parents' education had an effect on students' attitudes in science. Most researchers (Nieswandt, 2005; Osborne et al., 2003) consider the effects of curriculum on science attitudes. On the other hand, some studies have indicated that personality and behaviour of the teacher is very important in the formation of pupils' attitudes (Mcmillan & May, 1979). Jegede and Fraser (1989) have reported that socio-cultural factors and attitude influence each other in science. Similarly, Rana (2002) found parents socio-economic status, students' self-concept and gender as the important factors influencing students' attitude towards science. Therefore, it can be seen that this is quite a complex situation in which many factors may be acting simultaneously to influence attitude.

Although the worldwide debate on what factors influence attitude towards science is in progress, a consensus appears to emerge within the researchers that gender has a significant effect. Gardner (1975) and Schibeci (1984) reported that gender has more consistent and significant effect on attitude towards science. Similarly, Becker (1989) and Weinburgh (1995) after conducting meta-analysis of a range of research studies from 1970 to 1991 also concluded that of all variables that may influence attitude towards science, gender is the most significant. Weinburgh in meta-analysis of eighteen studies representing 6753 students (3337 boys and 3416 girls) reported that boys consistently showed more positive attitude towards science. Smist, Archambault, and Owen (1997) studied gender differences in attitude towards science of 572 secondary level students. The scale used by them in this study was also TOSRA and boys were found to have higher attitude towards science than girls on the total score of this instrument, but in case of sub-scales, girls expressed more positive attitude towards Normality of Scientists and Attitude to Scientific Enquiry and boys had more positive attitude toward Leisure Interest in Science, Career Interest in Science and Enjoyment of Science Lessons. In contrast, no significant gender differences were found on the subscales of Social Implication of Science and Adoption of Scientific Attitude scales. Similarly, TOSRA was used by Joyce and Farenga (2000), who conducted a study to examine attitude towards science of 111 high ability students of ages 9 and 13 years. Boys showed more interest to participate in physical sciences than girls. Some studies have reported that girls have more attitude towards science as compared to boys (Akpinar, Yildiz, Tatar, & Ergen, 2009; Dhindsa & Chung, 2003; Greenfield, 1996; Morrell & Lederman, 1998.

There appears to be a difference in attitude towards science that is linked to gender but this does not remain static over age nor context. Moffat (1992) reported that boys had higher positive attitude towards science than girls and group attitude towards science decreased as grade level increased. Similarly, Francis and Greer (1999) concluded that interest of both the gender decreased as grade level increased although they found like Moffat's study that girls had less interest in science than boys. Pell and Jarvis (2001) also reported a decline in enthusiasm for science in both gender of ages 5-11 years. In contrast, Morrell and Lederman (1998) found no gender differences in attitudes among 5^{th}, 7^{th} and 10^{th} grade students. Similarly, Greenfield (1996) also concluded no gender differences in attitude towards science among students from grade 3 to 12 in four major ethnic groups of America. Barrington and Hendricks (1988) and Cokadar and Kulce (2008) also did not offer any support for the effect of gender on attitude towards science.

The above mentioned studies demonstrate students' attitudes at fixed snapshots in time but do not give a clear message of what experiences led to the formation of these attitudes nor whether they are stable and sustained in long term. However, some longitudinal studies offer some explanations in this regard. For example, Breakwell and Robertson (2001) conducted a longitudinal study to examine the change in attitude towards science over a period of ten years in students between ages 11 to 14 years. The results indicated that boys had more positive attitude and better performance in science as compared to girls. Boys also participated more in extra-curricular activities and liked science more at school than their girls counterparts. In another longitudinal study, Rani (2000) found that students attitude towards science generally declined over the middle and high school years, and boys were found to have high attitudes towards science and their attitudes dropped faster than girls. Similarly, Reiss (2004) conducted a seven year longitudinal study to explore gender patterns in science attitudes and concluded differences in attitudes of both gender in favor of boys.

Some researchers have focused on cross-national comparisons of students attitude towards science. The findings of such studies are noteworthy in a sense because the same instrument (TOSRA) was administered on respondents in different countries. In this regard, Ye et al. (1998) conducted a cross-sectional survey research on grades 7 to 12 in China and America about students' attitudes toward science. It was concluded that attitude of students was influenced by different factors. American students considered science subjects easy but disliked it due to mathematical calculations whereas Chinese students were encouraged by their schools to study science and they liked reading science books and news. Grade levels and gender differences were not significantly different between students of the two nations, although boys showed slightly higher attitude towards science than girls.

A number of studies have been reported in the literature regarding the relation of attitude towards science with locale. Ankarah-Dove (1998) mentioned the low quality and turnover of teachers, inferior buildings, insufficient facilities, deprived health conditions and above all low socio-economic state of affairs in rural area schools of developing countries. Consequently, there are concerns about the quality of education in rustic areas. Likewise, National Institute on the Education of At-Risk Students in USA (1997) reported poverty in American rural areas and also indicated low performance of students from these areas. Similar results were reported by Sherman (1992) and Stern (1994). In contrast, Monk and Haller (1986) reported no differences in achievement of rural and urban students in New York (America). From the above discussion it can be concluded that Locality (rural/urban) may have a significant effect on cognitive and affective patterns of the students, but the researchers could not find many studies on attitudes regarding this variable. Even though a small number of researches have been reported on locality of respondents, urban respondents were marginally better in attitude than rural respondents (Zacharia & Barton, 2004). A recent notable

contribution in Pakistani context was made by Muhammad, Tabassum, and Pell (2008) who reported that girls from semi-urban areas performed better on attitude towards science.

Attitude is an important component of science education and its thorough understanding is very necessary to enhance students' achievement and success and their participation in science related careers but this aspect is neglected badly in Pakistan. This study was thus an attempt to explore the attitudes towards science among Pakistani students. The major aim of the study was to find out the levels of students attitude towards science and to investigate the attitude towards different subscales of TOSRA regarding gender and locale.

Hypotheses

1. Boys and girls would significantly differ in attitude towards science (total score of TOSRA) and on different dimensions of TOSRA.
2. Rural and urban students would significantly differ in attitude towards science (total score of TOSRA) and on different dimensions of TOSRA.

Method

To investigate the hypotheses, we took a mixed method approach for the selection of subjects for the study.

Sample

Multi-stage sampling techniques were applied to draw the sample from the population of 10^{th} class science students of all public secondary schools situated in the jurisdiction of Punjab province. The reason for selecting 10^{th} grade students was that the secondary level is the most crucial stage in the life of Pakistani students because their future career depends on the achievement in science subjects at this stage. An additional research (Lindahl, 2003) indicates that secondary level students have more clear and developed state of attitude towards science and they can respond better on science-related attitude scales. Moreover, it is the requirement of a valid and in-depth study that target population and sample from that population must be manageable. The total strength of students at secondary level is more manageable than the strength of students at other levels. To ensure the true representation of the population, thirty-six districts of Punjab were divided into four groups on the bases of literacy. Two districts were selected conveniently from each group. Therefore, there were eight districts selected conveniently from thirty-six districts of the Punjab province. Schools in each selected district were divided into two strata, i.e., urban and rural schools. Each stratum was further divided into two sub-strata, i.e., boys schools and girls schools. Three boys and three girls public schools were selected randomly. One section of 10^{th} class (in case of more than one section) from each selected school was randomly taken as a sample. In this way twelve schools from each district (three urban boys, three rural boys, three urban girls and three rural girls schools) were included in the sample. Hence, sample comprised 96 schools from eight districts of Punjab.

Instrument

Test of Science-Related Attitude (TOSRA; Fraser, 1981). In order to measure attitude towards science, Test of Science Related Attitude (TOSRA) was adapted for this study. This instrument has 60 items and is organized into seven scales having Likert type statements. Seven subscales in TOSRA are Social Implications of Science, Normality of Scientists, Attitude to Science Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lesson, Leisure Interest in Science, and Career Interest in Science. The possible responses on each statement of the attitude scale are assigned as 5 = Strongly Agree, 4 = Agree, 3 = Not Sure, 2 = Disagree, and 1 = Strongly Disagree. The sum of all statements of each respondent shows his/her total score on the scale. So, the maximum possible score on the attitude scale is 60 items x 5 score = 300, and the minimum score is 60 items x 1 score = 60. It means that higher score on the scale reflects more positive attitude towards science and vice versa.

TOSRA has been used in a number of research studies and its reliability coefficient value ranges from 0.83 to 0.96. This instrument has also been cross-validated in Australia, America, and Pakistan (Giddings & Waldrip, 1996; Joyce & Farenga, 2000; Rana, 2002; Rickards & Fisher, 1996). Rana (2002) translated this instrument into Urdu Language to find out higher secondary school students attitude towards science. The reliability coefficient value of modified Urdu translated version of TOSRA used by Rana was 0.93. This translated version of TOSRA was used in order to measure students' attitude towards science.

Pilot Testing of the Instrument

The translated version of TOSRA in Urdu language was administered to 280 science students of 10^{th} class. Out of 280, there were 70 boys and 70 girls from one rural and one urban school. The reliability of the scale was calculated as 0.79. During data collection for pilot study, researchers felt that respondents were facing problems in understanding some of the statements. Therefore, some changes were made in translation with the help of bi-lingual experts in accordance with the understanding level of the students and local culture. The instrument with rephrased items was again administered on 280 students from the four schools of same categories (urban boys, rural boys, urban girls and rural girls schools). With Cronbach alpha reliability analysis technique reliability of the scale increased from 0.79 to 0.89 due to rephrasing the items in cultural embedding. Based on analysis, second subscale of TOSRA 'Normality of Scientists' was rejected because its reliability was very low ($\alpha = 0.14$). The possible reason for such low reliability is the lack of knowledge, contents, and activities about scientists in Pakistani curriculum. Some other researchers also excluded some of the items from TOSRA subscales according to their need (Ledbetter & Nix, 2002; Stolarchuck & Fisher, 2001; Walker, 2002). In the end, there were total 52 items in the final instrument. Reliability of the scale and its subscales are given in the Table 1.

Procedure

The researchers personally visited all the ninety-six schools included in the sample from the eight selected districts and administered TOSRA. Data was collected with the permission of head teacher and class teacher of the concerned school. Data collection was not possible in a single continuous session due to holidays and school exams so it took about three months to complete the task. As the respondents belonged to science group, in majority of the schools data was collected in science laboratories

and where it was not possible to use laboratories TOSRA was administered in the classrooms. After brief introduction by the researchers, respondents were briefed about the purpose of the study and it was explicitly conveyed that this data collection would not have any effect on their school results or performance appraisal. It helped them to work in a congenial environment. The researchers distributed the scale to the respondents and everyone was requested to write his/her full name with father's and school's name. To minimize the missing data, it was ensured that students' had filled the questionnaire clearly and completely.

Table 1
Reliability Analysis of TOSRA and Its Subscales (*N* = 280)

Scales/ Sub-scales	Number of Items	Serial Number in final Scale	Cronbach Alpha
Social implications of science (S)	8	1, 6, 11, 16, 22, 32, 40, 46	0.58
Attitude to Scientific Inquiry (I)	7	2, 17, 26, 33, 37, 41, 47	0.47
Adoption of scientific attitudes (A)	10	3, 7, 12, 18, 23, 27, 34, 38, 42, 49	0.66
Enjoyment of science lesson (E)	10	4, 8, 13, 19, 24, 28, 35, 39, 43, 50	0.78
Leisure interest in science (L)	7	9, 14, 20, 29, 31, 44, 51	0.64
Career interest in science (C)	10	5, 10, 15, 21, 25, 30, 36, 45, 48, 52	0.64
Total TOSRA	52		0.89

Table 2
Comparison of Boys and Girls on TOSRA and Its Subscales (N = 3526)

Scale/Sub-scales	Gender		*t*
	Boys *M(SD)*	Girls *M(SD)*	
TOSRA	201.42 (20.91)	205.19(20.10)	5.42**
Social implication of science	32.91 (4.31)	33.20 (3.86)	2.11*
Attitude to scientific Inquiry	24.95 (4.33)	26.12 (4.16)	8.16*
Adoption of scientific attitudes	37.41 (4.86)	38.76 (4.63)	8.40*
Enjoyment of science lesson	42.49 (5.43)	43.28 (5.44)	4.23*
Leisure interest in science	27.93 (4.31)	28.36 (4.34)	2.93*
Career interest in science	35.89 (6.10)	35.56 (5.98)	1.65

df = 3524. *p < .05. **p < .01.

Data Analysis

Mean scores of respondents on TOSRA scale and subscales were calculated. *t*-test was used to see the significant differences among different categories of respondents like men and women and rural and urban.

Results

Table 2 reflects significant gender difference on total score of TOSRA, $t(3524) = 5.42$, $p < .01$, indicating girls ($M = 205.19$, $SD = 20.10$) to have higher attitude towards science than boys ($M = 201.42$, $SD = 20.91$). In case of subscales the results are significant for all subscales showing girls to have higher score than boys except for Career Interest in Science subscale on which boys scored high but was not significant.

Table 3 shows significant difference between rural and urban students on total TOSRA, $t(3524) = 2.44$, $p < .01$, indicating rural respondents ($M = 204.31$, $SD = 20.12$) to have higher attitude towards science than urban respondents ($M = 202.52$, $SD = 20.87$). In case of subscales results are significant for Social Implication of science, $t(3524) = 3.98$, $p < .05$, Adoption of Scientific Attitudes, $t(3524) = 2.02$, $p < .05$, and Career Interest in Science, $t(3524) = 5.01$, $p < .05$, showing rural students to score high on Social Implication of science ($M = 33.42$, $SD = 3.79$) and Career Interest in Science ($M = 36.44$, $SD = 5.56$) than urban students ($M = 32.84$, $SD = 4.25$; $M = 35.37$, $SD = 6.26$) and urban students to score high on Adoption of Scientific Attitudes ($M = 38.14$, $SD = 4.82$) than rural students ($M = 37.80$, $SD = 4.77$). The results were not significant for the subscales of Attitude to Scientific Inquiry, Enjoyment of Science Lesson, and Leisure Interest in Science.

Table 3
Comparison of Rural and Urban Students on TOSRA and its Sub-scales (N = 3526)

Scale/Subscales	Locale		*t*
	Urban *M(SD)*	Rural *M(SD)*	
Total TOSRA	202.52(20.87)	204.31(20.12)	2.44**
Social implication of science	32.84 (4.25)	33.42 (3.79)	3.98*
Attitude to Scientific Inquiry	25.45 (4.42)	25.54 (4.04)	.558
Adoption of scientific attitudes	38.14 (4.82)	37.80 (4.77)	2.02*
Enjoyment of science lesson	42.79 (5.46)	42.99 (5.43)	1.02
Leisure interest in science	28.03 (4.39)	28.29 (4.22)	1.70
Career interest in science	35.37 (6.26)	36.44 (5.56)	5.01*

df = 3524. *p < .05. **p < .01.

Discussion

It is evident from the results of this study that girls have higher level of attitude towards science than boys. This finding is similar to the findings of some recent studies which reported that girls outperformed boys in their attitude towards science (Akpinar, Yildiz, Tatar, & Ergen, 2009; Dhindsa & Chung, 2003; Greenfield, 1996; Morrell & Lederman, 1998) but in contradiction with the findings of other researches which reported boys to have higher attitude than girls (Francis & Greer, 1999; Schibeci & Riley, 1986; Simpson & Oliver, 1990; Weinburgh, 1995). On the other hand, some more studies conducted by Barrington and Hendricks (1988), Boone (1997), Neathery (1997), Shepardson and Pizzini (1994), and Stables (1990) showed that gender has no effect on students attitude towards science. Gender differences in attitude towards science, in favour of girls, as indicated by the results of this study can be attributed to the socio-cultural roles of boys and girls in

Pakistani society. Girls in Pakistani society spend most of their time at home because they are less socialise than boys (Halai, Rizvi, Rodrigues, 2007; Social Policy Development Centre (SPDC) Survey, 2003) and therefore have plenty of time to study and can complete the assignments given by teachers which could contribute to their higher level of attitude towards science. Regarding no gender difference on Career Interest in science subscale, the reason might be that both boys and girls both want to peruse science as a career.

Locality wise results showed that there was a significant difference between rural and urban students on total TOSRA and on the subscales of Social Implication and Career Interest in Science in favour of rural students. These findings are in agreement with the findings of Rani (2000) and Serin and Mohammadzadeh (2008), but in contradiction with the findings of Hammrich (1999) and Zacharia and Barton (2004). These results force us to think that rural area students in Pakistan have lesser facilities and socio-economic situations but have higher attitudes towards science than the students of urban areas with much more facilities and high socio-economic status. In a study conducted on higher secondary school students in Pakistani perspective, Rana (2002) also concluded that students with average socio-economic backgrounds obtained highest mean scores on TOSRA than the students with high socio-economic backgrounds. The possible reason for high attitude of rural students towards science might be the socio-economic situations. Engineering and medical are considered the most valuable and worthwhile professions for which science subjects are precursors and rural students due to limited facilities have very less options for better future and have fewer choices of activities and subjects at secondary level as compared to urban students. In this scenario science subjects are considered ideal for better future careers and to have a superior socio-economic status consequently, therefore, rural students show higher attitude towards science. Urban students high score on Adoption of Scientific attitude can be attributed to the fact that in urban areas science subjects are considered important for career and urban students are forced by the society and parents to adopt scientific attitudes to adjust in the modern society.

The present study indicated that gender and locale had significant effect on students' attitude towards science. It is obvious from the findings of this study that girls have higher attitude towards Social Implication of Science than boys and similar pattern can be seen through the findings of all other subscales except for the Career Interest in Science subscale, on which both the gender had similar attitudes. These findings are in agreement with the findings of Rana (2002) for Social Implication of Science subscale and Attitude to Scientific Inquiry subscale and with Smist et al. (1997), and Rana for Adoption of Scientific Attitudes subscale but contradicts with the findings of Kahle and Lakes (1983) and Rana for Leisure Interest in Science and Career Interest in Science subscales. The reason behind this contradiction of results might be the different sample of these studies. The sample used by Rana was of higher secondary level (intermediate level), students which are mature than secondary level (matric level) students of the present study. The secondary level students are not sure about the future careers in science.

Recommendations

This study looked at science attitudes across a large population of science students in Pakistan and while some of the findings are pertinent to the Pakistani context others gave far more reaching implications. Further investigations should identify other factors like self-efficacy, motivation, and anxiety which can influence attitude towards science. It is also suggested that for understanding, interpretation, and implications of this study more evidence is needed by conducting studies which incorporate qualitative data collection methods such as observations and interviews from students and teachers.

On the other hand, in order to improve students' attitude towards science, schools should manage visits to science museums, show scientific movies, and conduct science related activities. Classroom activities should be managed in such a manner that students understand and learn syllabus completely and have more time for individual activities. This would help them to have positive feelings about science.

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