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Exploration of Scientific Attitude of Science Students at Secondary Level: Need for Scientific Oriented Society

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Abstract

The 21st century is indeed a century of technological and scientific advancements. There is need to be scientifically literate and live our lives scientifically. This demands a scientific attitude which will help to shape our lives and to make informed decisions. This study was carried out to explore the scientific attitude of students at secondary school level. It was a qualitative research where survey method was employed. The respondent of this study were students of 8th,9th and 10th grades. The data was collected from 210 respondents. A standardized scientific attitude questionnaire was used to collect data. It had 36 items and the maximum score a student could score was 180. The data revealed that there is no role of gender in the scientific attitudes both male and female possessed same scientific attitude score. Similarly, there was no statistically significant difference in the scores of students studying in government and private schools. However, it is worth noting that the scientific attitude of students found to be decreased with the increase of their grades. It is recommended to develop scientific attitude of students even at higher grades so that they can think scientifically and apply their knowledge and solve their problems in a scientific manner. It is also recommended for teacher's scientific orientation so that they can induce scientific attitude among students.

Keywords: *Curiosity, Objectivity, Scientific Attitude, Science Education, Scientific Knowledge.*

Introduction

United Nations UN sustainable development goal 4 indicates that quality of education at secondary level is essential to promote sustainable development around the globe, therefore, quality of education provides the foundation towards sustainable living with peace in this digital era. World can be transformed through global citizenship, care of human rights, and acceptance of global diversity (UN, 2015). Quality of education is essential for 21st century students at secondary level in order to promote sustainable lifelong skills (Nazak, Asghar & Javed, 2019) which cannot be achieved in the absence of scientific attitude of students that must be built among students at early stages of growth. Structure of learning outcomes SLOs can be achieved by teachers through the proper use of appropriate learning media and models, which acts like a catalyst for students towards creation of scientific attitude (Syarif, Syamsunardi & Saputro, 2020). Active involvement of students in the learning process, teachers' guidance, proper counselling, and immediate teachers' feedback are considered as key elements through which optimal and maximum

learning objectives can be achieved. Most of the teachers use discovery method in order to enhance scientific thinking skills among learners, an alternative approach towards problem solving during the teaching learning process (Prakasiwi & Ismanto, 2018) which is directly associated with SLOs (Syarif, Syamsunardi & Saputro, 2020) through which scientific attitude among learners can be created (Castronova, 2002), therefore, students' cognitive and scientific attitude are improved with discovery approach of learning (Syarif, Syamsunardi & Saputro, 2020).Since science is considered as systematical and logical study of the universe which creates curiosity among students and promotes scientific attitude, might be helpful towards sustainable development in this digital era. The element of curiosity among students is enhanced through observations, experiments, and measurements, which improves quality of life. Keeping in view the significance and rationale of scientific attitude, the present study was conducted to explore the scientific attitude of science students at secondary level.

Statement of Problem

Science is important in today's life, but there appears to be fewer students taking science–related courses in high school and from which most of the students do not show satisfactory results. It is also been observed that even though students study science subjects, they do not have scientific attitude. Consequently, the students do not apply scientific approach in daily life. Therefore, it is necessary for students to develop scientific attitude in order to remain interested in studying science, adopt scientific approach and apply scientific knowledge in life. The purpose of this study is therefore to explore scientific attitude of students studying at grade 8^{th}, 9^{th} and 10^{th} level.

Research Questions

1. What is the scientific attitude of students?
2. Whether there is significance difference in the scientific attitude of students studying in government and private institutions?
3. Whether there is significance difference in the scientific attitude of male and female students?

Literature Review

According to Summers and Abd-El-Khalick (2018) have stated that problem solving skills, collaborative approach, and critical thinking way are the ingredients of non-cognitive ability, which are based on scientific attitude of student and can be observed among students (Shah & Mehmood, 2011) through following features:

a. Curiosity or inquisitive interest during the learning process
b. Critical approach towards problem solving
c. Open minded approach
d. Rely on solid evidence
e. Appreciation quality after observation of phenomenon
f. Quality to search for truth
g. Positive vision

Panneerselvam et al. (2015) have suggested that attitudes are built and developed due to lack of inborn characteristics. Scientific attitudes of students can be modified and reshaped by science teachers on the basis of aspects like cultural values, needs and demands, emotions, and individual differences. Scientific attitude provides tendency of readiness of mind towards acquirement or achievement of scientific knowledge and skills with motivation. Similarly, Widowati et al. (2017) has argued that basics of scientific attitude depends upon methodology used by science teachers, teachers administered some activities through physical experiments in order to explore scientific reasoning during the teaching learning process, but at the same time many teachers face obstacles to design and plan strategies to improve scientific attitude during

instruction. Amjad and Muhammad (2012) had indicated that development of scientific attitude is the modification of behavior which is difficult to transform. Although Olasehinde and Olatoye (2014) had found that there exists positive correlation between scientific knowledge and attitude, higher the level of scientific attitude reflects higher performance and vice versa, however, some studies show the negative relationship between scientific attitude and the academic achievement level, might be the reason that students do not put much importance to science as it is not related with their academic achievement. This is the reason, which is the cause of creating less scientific attitude among students as the assessment is only being made for the testing of reproducing scientific knowledge , however, there is no mechanism to test or examine the scientific attitude among students.

Most of the teachers like lecture method for learning of science subjects due to merits of lecture method because large amount of knowledge can be transferred in less time, which promotes memorization of scientific concepts and route learning (Zulirfan, Iksan, Osman, & Salehudin, 2017) and development of scientific attitude among learners is difficult under the umbrella of rote learning approach (Mallya, Mensah, Contento, Koch, & Barton, 2012; Suyana, 2011), so it can be concluded that lecture method approach develops low order thinking mentioned in the Blooms' taxonomy (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001), while promotion of higher order thinking among students is the core objective of the teaching and learning of science (Saido, Siraj, Nordin, & Al-Amedy, 2015).

It is being observed in daily life that despite of having high qualifications, individuals lack scientific attitude that is helpful in understanding natural phenomena and living life scientifically, therefore, there is a need to shift learning approach in the 21st century from traditional lecture method (teacher centered approach) to discovery or inquiry method (learner centered approach). Many learners like to do task in laboratories in real time situation (Widowati et al. (2017) but activities or experiments performed in laboratories must be linked with real life (Koretsky, et al., 2018) which promotes the development of scientific approach.

The purpose of science education is to build useful human resources because it is an art of life Fitriani et al. (2016) had stated that "science learning in school could be applied by connecting the materials in the learning with real life." So, science teaching approaches should be focused. There is need to focus on process and output (Effendi et al., 2018) due to rapid growth in information technologies along with behavior change in the teaching learning process in this digital era.

The main strength of science learning is to do task with own hands which facilitates students' autonomy on the learning process, and enhances science knowledge, skills, abilities, and attitude towards concept clarification, therefore aspect regarding scientific attitude cannot be ignored during the teaching learning process (Duchl & Bybee, 2014). So, intellectual, emotional growth can be possible on the basis of scientific attitude.

Developing countries like Pakistan needs more and more scientists in the field of agriculture, health, space technology, and industry, in order to meet the challenges of modern and technological era for the benefits of society, which is only possible through scientific attitude among students especially in the subjects of physics, chemistry, biology, computer, and mathematics (Pitafi et al., 2012). The temperament of human mind is essential towards the formation of scientific attitude(Zulirfan, Iksan, Osman & Salehudin, 2017) because factual evidence makes stronger belief on phenomenon (OECD, 2017) and actual evidence supports scientific approach (Osman, Iksan & Halim, 2007) which makes strong scientific attitudeas foundation of scientific knowledge (Gokul & Malliga, 2015). The process to think, feel, perceive, and behave is based on attitude which is directly linked with cognition (Karlinger, 1970). The internal scientific approach is created among learners through scientific attitude focused on logical thinking (Kaur, 2013) linked with previous knowledge (Wartawan, 2017) used as reflective approach or strategy (Balci & Demirbas, 2012) based on inquiry learning models (Gumilar & Wardani, 2020) and effective quantum teaching model (Ratnasari et al., 2018).

Students having scientific attitude are better performers in science subjects because learning of science is based on psychological needs and can provide benefits in later life experiences. The level of curiosity, innovations, learning by doing, self-directed learning approach are linked with scientific attitude and can be made through proper formation of scientific attitude among learners. It can be concluded that scientific attitude works as stimulus towards critical thinking approach.

The theme of this paper is to provide awareness about how to modify and transform scientific attitude among learners in teaching of science subjects through research-based learning activities.

Methodology

The present study is a descriptive study and survey method was used to collect the data. After defining problem and completing related literature review, there was a need to develop theoretical framework. The interrelationships among the variables that are considered as dynamics of the study were discussed. The following theoretical framework is the structure that supports a theory of a research study. It identifies a plan for investigation and interpretation of the findings.

The following constructs were considered to be the key variables in the present research.

1 Scientific Attitude of Students, including its six dimensions, which are "Rationality, Open-mindedness, Curiosity, Aversion to superstitions, Objectivity of intellectual beliefs, Suspended Judgement"
2 Effect of Students' Gender
3 Institutional sector

Comparison was made to explore the science attitude of male and female students.

Population

The population of this study consisted of all students studying in government and private schools of Rawalpindi and Islamabad at grade 8^{th}, 9^{th} and 10 level.

Sample Size

Selected sample of the study was students of eighth, ninth and tenth grades. A sample of 210 was selected through convenient sampling technique. It consisted of 49 male students and 161 female students.

Research Tool

In order to collect the data, Scientific Attitude Scale (SAS) was used for this study. It is standardized tool developed by Sood and Sandhya (1992). This tool is being used till today in many studies. This scientific attitude scale was constructed on Likert scale with options strongly agree, agree, neutral, disagree and strongly disagree.

It is considered symmetric or balanced because there are equal amounts of positive and negative positions. Fifty per cent items were of positive polarity and remaining fifty per cent were of negative polarity. This instrument was administered on a sample and respondents were asked to assign any one of the five following categories after reading each statement carefully.

After the administration of instrument, it was scored by keeping into consideration the scoring procedure suggested by Likert.

For

SA	response	5 scores
A	response	4 scores
N	response	3 scores
D	response	2 scores
SD	response	1 score

For items of negative polarity, the scoring system was reversed. In order to survey for this study, an online questionnaire was used to seek the data from the respondents.

Domains of Tool

The major domains of questionnaire were:

1. "Rationality (R)
2. Open-mindedness (OM)
3. Curiosity (C)
4. Aversion to superstitions (AS)
5. Objectivity of intellectual beliefs (OIB)
6. Suspended judgment (SJ)"

Scientific Attitude Scale contains 36 item statements. Half of the statements carried positive polarity whereas, half of the statements carried negative polarity. Here is the distribution of items:

DIMENSION	Negative Polarity Items	Positive Polarity Items
1.Rationality	1, 2, 6	3, 4, 5
2.Curiosity	8, 9	7, 10, 11,12
3.Open-mindedness	13,14	15, 16, 17, 18
4.Aversion to superstitions	19, 21, 24	20, 22, 23
5.Objectivity of intellectual beliefs	25, 26, 28, 30	27,29
6.Suspended judgement	31, 32, 34, 35	33,36

The score of scientific attitude score of a participant was the sum of scores on all the items of the scale. Hence, score of a participant may fall in the range of 36-180 .

Validity and Reliability

The test used for this study was standardized by Sood and Sandhya (1992). The researchers found its reliability by test retest method over a sample of 200 science teachers. Its reliability was found to be 0.82, which is quite satisfactory to use the scale for the study. The researchers also found its internal consistency. As this tool contains has six dimensions, the researchers (Sood & Sandhya,1992) also found its inter-item correlation and found correlation among six constructs significantly high.

Data Collection

For data collection, the teachers of government and private schools were consulted. The researcher obtained the contact group numbers from the teachers and electronically circulate the questionnaire. The data was

received electronically automatically. After that the data was analyzed through SPSS-26. Descriptive as well as inferential statistics was used to test the hypotheses.

Table 1: Gender wise Gender Cross tabulation of the sample

Institution		Gender		
		Male	Female	Total
Govt.	No.	21	70	91
	% of Total	10.0%	33.3%	43.3%
Private	No.	28	91	119
	% of Total	13.3%	43.3%	56.7%
Total	No.	49	161	210
	% of Total	23.3%	76.7%	100.0%

In Table 1, the detail of respondents of the study is provided. It shows that there were 49 male and 161 females participated in this research. Out of which 91 male and female respondents were from government sector and 119 participants were from the private sector institutions.

Table 2: Grade wise Cross tabulation of the sample

Grade		Gender		
		Male	Female	Total
Grade 8th	No.	7	21	28
	% of Total	3.3%	10.0%	13.3%
Grade 9th	No.	21	35	56
	% of Total	10.0%	16.7%	26.7%
Grade 10	No.	21	105	126
	% of Total	10.0%	50.0%	60.0%
Total	No.	49	161	210
	% of Total	23.3%	76.7%	100.0%

Table 2 shows that there were 28 respondents from grade 8th out of which seven respondents were male and 21 respondents were female. Similarly, there were 56 respondents from grade 9th out of which 21 respondents were male and 35 respondents were female. Moreover, there were 126 respondents from grade 10th out of which 49 respondents were male and 161 respondents were female.

Table 3: Score Range of Overall Scientific Attitude

Mean	Std. Deviation	Variances	Range	Minimum	Maximum
113.833	12.71	161.77	50	96	146

In table 3, the overall obtained range of scientific attitude score is presented. It shows that the maximum score of obtained scientific attitude score was 146 while minimum score of scientific attitude score was 96 (M=113.83, SD=12.71).

Table 4: Comparison of Overall Scientific Attitude of sampled respondents on the basis of School sector

Scientific Attitude	Levene Test of Equality of Means		Sector	N	Mean	Std. Dev.	t	df	Sig. (2-tailed)	Mean Diff.	95% Confidence Interval of the Difference	
	F	Sig.									Lower	Upper
Equal variances assumed	0.406	0.525	Private	91	119.07	10.59	5.590	208	0.000	9.25	5.98	12.51
			Govt.	119	109.82	12.78						

Table 4 shows the comparison of overall scientific attitude of sampled students on the basis of school sector. An independent-samples t-test indicates that the scientific attitude scores were significantly higher for private institution's participants (M = 119.07, SD = 10.59) than for the scientific attitude scores of participants of government institutions (M = 109.82, SD = 12.78), *t* (208) = 5.59, p < .005. It shows that there is statistically significant difference in the variability of the two samples i.e. respondents of government and private sector.

Table 5: Comparison of Overall Scientific Attitude of sampled respondents on the basis of gender

Scientific Attitude	Levene Test of Equality of Means		Gender	N	Mean	Std. Dev.	t	df	Sig. (2-tailed)	Mean Diff.	95% Confidence Interval of the Difference	
	F	Sig.									Lower	Upper
Equal variances assumed	3.309	0.070	Male	49	113.42	14.27	-0.25	208	0.80	-0.527	-4.62	3.572
			Female	161	113.95	12.51						

In table 5, the comparison of overall scientific attitude of respondents has been presented on the basis of gender. To find the difference of overall scientific attitude among gender an independent-samples t-test indicates that the scientific attitude scores were not significantly higher for male respondents (M = 113.42, SD = 14.27) than for the scientific attitude scores of female respondents (M = 113.95, SD = 12.51), *t* (208) = 0.25, p > .005. It shows that there is there is no statistically significant difference in the variability overall scientific attitude in the two samples i.e. male and female respondents.

Table 6: Descriptive statistics of the overall scientific attitude on the basis of grade

	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Grade 8th	28	125.00	10.944	2.068	120.75	129.24	110.00	139.00
Grade 9th	56	109.125	9.471	1.26	106.58	111.66	96.00	122.00
Grade 10th	126	113.44	12.927	1.151	111.16	115.72	96.00	146.00
Total	210	113.83	12.719	.87	112.10	115.56	96.00	146.00

Table 6 shows the descriptive of scientific attitude across different grades. It shows that mean value of scientific attitude of 8th grade is 125, for 9th grade109.12 and 10th grade is 113.44.

Table 7: Comparison of overall Scientific Attitude of sampled respondents based on grade

Scientific Attitude	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4751.931	2	2375.965	16.925	.000
Within Groups	29059.236	207	140.383		
Total	33811.167	209			

Table 7 shows comparison of scientific attitude of the basis of grades. ANOVA was applied on it. It shows that there is significant difference between the groups $F_{0.05}$ (2,207)= 16.925, P=0.000. It shows that there is statistically significant difference exists between 8th grade, 9th grade and 10th grade. Although it is a significant finding, however, there was need to explore which of the specific groups differed. For this purpose, Tukey post hoc test was applied and Multiple Comparisons were made.

Table 8: Post Hoc test of Multiple Comparisons of Overall Scientific Attitude

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Grade 8th	Grade 9th	15.87*	2.742	.000	10.46	21.28
	Grade 10th	11.55*	2.475	.000	6.67	16.43
Grade 9th	Grade 8th	-15.875*	2.742	.000	-21.28	-10.46
	Grade 10th	-4.319*	1.902	.024	-8.00	-.56
Grade 10th	Grade 8th	-11.55*	2.47	.000	-16.43	-6.67
	Grade 9th	4.319*	1.90	.024	.5679	8.07

*. The mean difference is significant at the 0.05 level.

Table 8 shows that overall score of scientific attitude was significantly different between and among all grades.

Table 9: Comparison of Scientific Attitude constructs of sampled respondents on the basis of school sector

Scientific Construct	AttitudeSector	N	Mean	Std. Dev.	Levene's Test for Equality of Variances		t-test for equality of means				
					F	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of Difference Low	Up
Rationality	Equal variances not assumed Govt.	91	19.53	3.429	20.47	.000	5.12	168.17	.000	1.379	3.10
	Private	119	17.29	2.728							
Curiosity	Equal variances not assumed Govt.	91	21.53	3.628	5.192	.024	5.97	200.68	.000	2.093	4.15
	Private	119	18.41	3.928							
Open Mindedness	Equal variances not assumed Govt.	91	19.38	3.068	15.15	.000	3.74	205.07	.000	.935	3.01
	Private	119	17.41	4.544							
Aversion to	Equal Govt.	91	21.00	4.229	9.386	.002	2.64	164.12	.009	.356	2.46

superstitions	variances not assumed	Private	119	19.58	3.250							
Objectivity of Intellectual Beliefs	Equal variances not assumed	Govt.	91	18.00	3.699	9.210	.003	-3.44	159.73	.001	-2.44	-.617
		Private	119	19.52	2.736							
Suspended Judgment	Equal variances assumed	Govt.	91	19.61	3.732	1.110	.293	3.87	208	.000	.997	3.05
		Private	119	17.58	3.774							

Table 9 shows analysis of scientific attitude constructs of sampled on the basis of respondent's institutional sector. It shows that the scores on the scientific attitude subscale/construct were different for each construct. For the rationality construct, the respondents of government sector possessed high mean value (M = 19.53, SD = 3.49) than those of respondents of private sector (M = 17.29, SD = 2.72), $t(168.17) = 5.12$, $p < .005$. Levene's test indicated unequal variances (F = 20.47, p = .000), so degrees of freedom were adjusted from 208 to 168.17.

For the curiosity construct, the respondents of government possessed high mean value (M = 21.53, SD = 3.62) than respondents of private respondents (M = 18.41, SD = 3.92), $t(200.68) = 5.97$, $p < .005$. Levene's test indicated unequal variances (F = 5.192, p = .024), so degrees of freedom were adjusted from 208 to 200.68.

For the open mindedness construct, the respondents of government sector institutions possessed high mean value (M = 19.38, SD = 3.06) than respondents of private sector institutions (M = 17.41, SD = 4.544), $t(205.07) = 3.74$, $p < .005$. Levene's test indicated unequal variances (F = 15.15, p = .000), so degrees of freedom were adjusted from 208 to 205.07.

For the Aversion to superstitions construct, the respondents of private sector institutions possessed lower mean value (M = 19.58, SD = 3.25) than respondents of government sector respondents (M = 21.00, SD = 4.22), $t(164.12) = 2.64$, $p < .005$. Levene's test indicated unequal variances (F =9.38, p = .002), so degrees of freedom were adjusted from 208 to 164.12.

For the objectivity of intellectual beliefs construct, the respondents of private sector institutions possessed high mean value (M = 19.52, SD = 2.736) than for respondents of government sector (M = 18.00, SD = 3.69), $t(159.73) = 3.445$, $p < .005$. Levene's test indicated unequal variances (F = 9.210, p = .003), so degrees of freedom were adjusted from 208 to 159.73.

The comparison of suspended judgment construct between respondents of government and private sector shows that its value did not significantly higher in government sector institutions (M = 19.61, SD = 3.732) than for its value in private sector institutions respondents (M = 17.58, SD = 3.77), t (208) = 3.87, $p< .005$. It shows that there is there is no statistically significant difference in the variability of the two samples regarding suspended judgment of respondents of government sector and respondents of private sector institutions.

In table 10, the analysis of scientific attitude constructs on the basis of gender has been presented. It shows that the scores on the scientific attitude subscale/construct were different for each construct. Although the female respondents possessed high mean value (M = 18.30, SD = 3.03) than male respondents (M = 18.14, SD = 3.87), $t(66.94) = -0.26$, $p >0.05$. However, for the rationality construct, the difference was not statistically significant. Levene's test indicated unequal variances (F = 16.99, p = .000), so degrees of freedom were adjusted from 208 to 66.94.

Table 10: Comparison of Scientific Attitude constructs of sampled respondents on the basis of gender

Scientific Attitude Construct	Gender	N	Mean	Std. Dev.	Levene's Test for Equality of Variances		t- test for equality of means				
					F	Sig.	t	df	Sig. (2 tailed)	95% Confidence Interval of Difference	
										Lower	Upper
Rationality	Equal variances not assumed	Male	49	18.14	3.872	16.99	.000	-.26	66.94	.790	-1.36	1.04
		Female	161	18.30	3.03							
Curiosity	Equal variances assumed	Male	49	19.00	3.37	3.82	.052	-1.50	208	.135	-2.31	.314
		Female	161	20.00	4.27							
Open Mindedness	Equal variances not assumed	Male	49	17.42	5.00	17.70	.000	-1.4	65.14	.162	-2.63	.451
		Female	161	18.52	3.74							
Aversion to superstitions	Equal variances assumed	Male	49	19.00	3.10	2.45	.119	-2.5	208	.010	-2.75	-.37
		Female	161	20.56	3.87							
Objectivity of Intellectual Beliefs	Equal variances assumed	Male	49	21.00	3.32	1.94	.165	5.5	208	.000	1.72	3.83
		Female	161	18.21	2.97							
Suspended Judgment	Equal variances assumed	Male	49	18.85	3.43	2.45	.119	-2.5	208	.422	-.739	1.75
		Female	161	18.34	4.00							

For the curiosity construct, the female respondents possessed high mean value (M = 20.00, SD = 4.27) than for male respondents (M = 19.00, SD = 3.37), $t(208) = -1.50$, $p > 0.05$. Therefore, no significant difference was found among genders regarding this construct. So, degrees of freedom were adjusted from 208 to 65.144.

For the open mindedness construct, the female respondents possessed high mean value (M = 18.52, SD = 3.74) than for male respondents (M = 17.42, SD = 5.00), $t(65.14) = -1.4$, $p > 0.05$. Therefore, no significant difference was found among genders regarding this construct.

For the aversion to superstition construct, the female respondents possessed high mean value (M = 20.56, SD = 3.87) than male respondents (M = 19.00, SD = 3.10), $t(65.144) = -2.5$, $p < .005$.
For the objectivity of intellectual beliefs construct, the respondents of male respondents possessed higher mean value (M = 21.00, SD = 3.32) than for female respondents (M = 18.21, SD = 2.97), $t(208) = 5.5$, $p < .005$.
The comparison of suspended judgment construct between male and female respondents shows that for the male respondents, its value did not significantly higher (M = 18.85, SD = 3.43) than for the suspended judgment construct value of female respondents (M = 18.34, SD = 4.00), t (208) = -2.5, $p > .005$. It shows

that there is there is no statistically significant difference in the variability of the two samples regarding suspended judgment of male respondents and female respondents.

Table 11: Descriptive Statistics of constructs of scientific attitude across grades

Constructs of Scientific Attitude Scale		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Min	Max
Rationality	Grade 8th	28	21.00	4.00	.757	19.4454	22.55	15.00	25.00
	Grade 9th	56	18.37	3.41	.451	17.459	19.29	14.00	23.00
	Grade 10th	126	17.61	2.61	.234	17.149	18.07	14.00	24.00
	Total	210	18.26	3.24	.223	17.825	18.70	14.00	25.00
Curiosity	Grade 8th	28	21.25	3.16	.599	20.021	22.47	16.00	24.00
	Grade 9th	56	19.25	3.73	.498	18.250	20.24	14.00	24.00
	Grade 10th	126	19.66	4.37	.389	18.895	20.43	11.00	26.00
	Total	210	19.76	4.09	.282	19.209	20.32	11.00	26.00
Open Mindedness	Grade 8th	28	20.75	3.32	.629	19.459	22.04	18.00	26.00
	Grade 9th	56	17.12	3.43	.459	16.204	18.04	12.00	21.00
	Grade 10th	126	18.22	4.27	.381	17.467	18.97	12.00	26.00
	Total	210	18.26	4.08	.281	17.711	18.82	12.00	26.00
Aversion to Superstitions	Grade 8th	28	24.00	4.83	.912	22.126	25.87	16.00	28.00
	Grade 9th	56	18.75	.667	.089	18.5713	18.92	18.00	20.00
	Grade 10th	126	20.00	3.77	.335	19.33	20.66	13.00	29.00
	Total	210	20.20	3.76	.259	19.68	20.71	13.00	29.00
Objectivity of Intellectual Beliefs	Grade 8th	28	18.25	2.63	.497	17.22	19.27	15.00	22.00
	Grade 9th	56	16.25	1.404	.187	15.87	16.62	14.00	18.00
	Grade 10th	126	20.16	3.266	.290	19.59	20.74	14.00	26.00
	Total	210	18.86	3.271	.225	18.42	19.31	14.00	26.00
Suspended Judgment	Grade 8th	28	19.75	2.913	.550	18.62	20.87	16.00	23.00
	Grade 9th	56	19.37	3.14	.420	18.53	20.21	12.00	23.00
	Grade 10th	126	17.77	4.214	.375	17.034	18.52	12.00	29.00
	Total	210	18.46	3.879	.267	17.938	18.99	12.00	29.00

Table 11 shows the descriptive statistics of construct of scientific attitude across different grades. It shows that the mean value of rationality was high (M=21.00, SD= 4.00) at grade 8th. The mean value of curiosity was high(M=21.25,SD= 3.16) at grade 8th, the mean value of open-mindedness was found high(M=20.75,SD= 3.32) at 8th, the mean value of aversion to superstitions was found high(M=24.00,SD= 4.83) at grade 8th.

Surprisingly, the mean value of objectivity of intellectual beliefs was found high (M=20.16, SD= 3.26) at grade 10th. Similarly, at grade 8th, the mean value of suspended judgment was also found high (M=19.75, SD= 2.913) as compared to other grade levels.

Table 11 also shows that there does not exists statistically significant difference for curiosity among 8th grade, 9th grade and 10th grade. Although it is a significant finding, however, there was need to explore which of the specific groups differed. For this purpose, Tukey post hoc test was applied and Multiple Comparisons were made.

Table 12: Comparison of Scientific Attitude Constructs of sampled respondents based on grade

Scientific Attitude Construct		Sum of Squares	df	Mean Square	F	Sig.
Rationality	Between Groups	263.99	2	131.999	14.135	.000
	Within Groups	1933.06	207	9.338		
	Total	2197.06	209			
Curiosity	Between Groups	77.81	2	38.908	2.347	.098
	Within Groups	3431.75	207	16.579		
	Total	3509.56	209			
Open Mindedness	Between Groups	245.91	2	122.957	7.858	.001
	Within Groups	3239.15	207	15.648		
	Total	3485.06	209			
Aversion to superstitions	Between Groups	527.10	2	263.550	22.427	.000
	Within Groups	2432.50	207	11.751		
	Total	2959.6	209			
Objectivity of Intellectual Beliefs	Between Groups	607.01	2	303.508	38.561	.000
	Within Groups	1629.25	207	7.871		
	Total	2236.26	209			
Suspended Judgment	Between Groups	152.11	2	76.057	5.258	.006
	Within Groups	2994.15	207	14.465		
	Total	3146.26	209			

Table 12 shows comparison of constructs of scientific attitude across grades. ANOVA was applied on it. It shows that there is significant difference between the groups for five constructs i.e. for rationality, $F_{0.05}$ (2,207)= 14.135, P=0.000, open-mindedness $F_{0.05}$ (2,207)= 2.347, P=0.098, for open mindedness, $F_{0.05}$=(2,207)= 7.858, P=0.001, aversion to superstitions $F_{0.05}$ (2,207)= 22.47, P=0.000, objectivity of intellectual beliefs $F_{0.05}$ (2,207)= 38.56, P=0.000 and suspended judgment $F_{0.05}$ (2,207)= 5.258, P=0.006.

In order to further explore that which of the specific groups differed, Tukey post hoc test was applied and Multiple Comparisons were made.

Table 13 shows that statistical difference of constructs of scientific attitude among different genders. It shows that there was statistically difference of scientific attitude constructs among most of the grades. However, there was no statistical difference of constructs of scientific attitude at some grades. The construct of rationality was not significantly different between 9^{th} and 10^{th} grades. Similarly, the construct of curiosity was not statistically different between 8^{th} and 10^{th}, and 9^{th} and 10^{th}. The construct of open-mindedness was not statistically different between grade 9^{th} and 10^{th}. The construct of suspended judgment was not statistically different at grade 8^{th} and grade 9^{th}.

Table 13: Post Hoc test of Multiple comparisons of scientific attitude construct on the basis of grade

Scientific Attitude Construct	(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Rationality	Grade 8th	Grade 9th	2.625*	.707	.000	1.230	4.019
		Grade 10	3.388*	.638	.000	2.130	4.647
	Grade 9th	Grade 8th	-2.625*	.7073	.000	-4.019	-1.230
		Grade 10	.763	.490	.121	-.203	1.731
	Grade 10th	Grade 8th	-3.388*	.638	.000	-4.647	-2.130
		Grade 9th	-.7638	.490	.121	-1.731	.203
Curiosity	Grade 8th	Grade 9th	2.000*	.942	.035	.142	3.857
		Grade 10	1.583	.850	.064	-.093	3.260
	Grade 9th	Grade 8th	-2.000*	.942	.035	-3.857	-.142
		Grade 10	-.4166	.653	.525	-1.705	.872
	Grade 10th	Grade 8th	-1.583	.850	.064	-3.260	.093
		Grade 9th	.4166	.653	.525	-.872	1.705
Open Mindedness	Grade 8th	Grade 9th	3.625*	.915	.000	1.819	5.430
		Grade 10	2.527*	.826	.003	.898	4.157
	Grade 9th	Grade 8th	-3.625*	.915	.000	-5.430	-1.819
		Grade 10	-1.097	.635	.086	-2.349	.155
	Grade 10th	Grade 8th	-2.527*	.826	.003	-4.157	-.898
		Grade 9th	1.097	.635	.086	-.1553	2.349
Aversion to superstitions	Grade 8th	Grade 9th	5.250*	.793	.000	3.685	6.814
		Grade 10	4.000*	.716	.000	2.588	5.412
	Grade 9th	Grade 8th	-5.250*	.793	.000	-6.814	-3.685
		Grade 10	-1.250*	.550	.024	-2.335	-.164
	Grade 10th	Grade 8th	-4.000*	.716	.000	-5.412	-2.588
		Grade 9th	1.250*	.550	.024	.164	2.335
Objectivity of Intellectual Beliefs	Grade 8th	Grade 9th	2.000*	.649	.002	.719	3.280
		Grade 10	-1.916*	.586	.001	-3.072	-.761
	Grade 9th	Grade 8th	-2.000*	.649	.002	-3.280	-.719
		Grade 10	-3.916*	.450	.000	-4.805	-3.028
	Grade 10th	Grade 8th	1.916*	.586	.001	.761	3.072
		Grade 9th	3.916*	.450	.000	3.028	4.805
Suspended Judgment	Grade 8th	Grade 9th	.3750	.880	.671	-1.360	2.110
		Grade 10	1.972*	.794	.014	.405	3.538
	Grade 9th	Grade 8th	-.3750	.880	.671	-2.110	1.360
		Grade 10	1.597*	.610	.010	.393	2.801
	Grade 10th	Grade 8th	-1.972*	.794	.014	-3.538	-.405
		Grade 9th	-1.597*	.610	.010	-2.801	-.393

*. The mean difference is significant at the 0.05 level.

Discussion

The first research question of this study was to explore scientific attitude of students. The findings showed that the maximum score of obtained scientific attitude score was 146 while minimum score of scientific

attitude score was 96. Singh and Bai (2017) found the average score of 126.85 among grade IX students. The second research question was to find whether there is significance difference in the scientific attitude of students studying in government and private institutions. As far as scientific attitude of students of government and private institutions is concerned, no statistically significant difference in the variability of the two samples was found. This finding is in line to the Singh and Bai (2017) as the researcher found significant difference of scientific attitude among students of government and private schools where the students of private schools scored more than on scientific attitude scale than the students of government school.

The third research question of the study was to explore whether there is significance difference in the scientific attitude of male and female students. No statistically significant difference was found among male and female students. This finding is in line with Gupta (2015) and Singh and Bai (2017) as the researchers also found no significant difference between male and female scientific attitude. However, the finding is contrary to the Singh (2017), the researcher found significant difference in the attitude of male and female students where female students scored more than male students.

While exploring scientific attitude at different grade levels, it was found that the overall score of scientific attitude was significantly different between and among all grades. This is in line with the findings showed the student's scientific attitude decreases as the grade of student increases. This finding is in line with Tosun and Genc (2015), as they found that from grade 4th to grade 8th, the scientific attitude decreased.

The comparison of constructs of scientific attitude were also explored with respect to different independent variables. While comparing the constructs among government and private students, it was revealed that for the rationality and curiosity, open mindedness, for the Aversion to superstitions construct, the respondents of government sector possessed high mean value than those of respondents of private sector. However, for the objectivity of intellectual beliefs construct, the respondents of private sector institutions possessed high mean value than for respondents of government sector. Surprisingly, there was no significant difference regarding suspended judgment construct between respondents of government and private sector. It shows that there is no statistically significant difference in the variability of the two samples regarding suspended judgment of respondents of government sector and respondents of private sector institutions.

While analyzing constructs of scientific attitude constructs on the basis of gender, findings revealed that although the female respondents possessed high mean value than male respondents, however, no significant difference was found regarding overall scientific attitude scale. Therefore, the analysis of constructs of scientific attitude was made with respect to gender. It showed for the curiosity and aversion to superstition construct, the female respondents possessed high mean value than male respondents. The objectivity of intellectual beliefs construct, the respondents of male respondents possessed higher mean value than for female respondents. There was found no significant difference between male and female regarding suspended judgment.

The comparison of constructs of scientific attitude across grades showed that there is significant difference between the groups for five constructs i.e. for rationality, open-mindedness aversion to superstitions, objectivity of intellectual beliefs and suspended judgment. It shows that there does not exists statistically significant difference for curiosity among 8^{th} grade, 9^{th} grade and 10^{th} grade. Although it is a significant finding, however, there was need to explore which of the specific groups differed. Tukey post hoc test of Multiple Comparisons showed that statistical difference of constructs of scientific attitude among different genders. It shows that there was statistically difference of scientific attitude constructs among most of the grades. However, there was no statistical difference of constructs of scientific attitude at some grades. The construct of rationality was not significantly different between 9^{th} and 10^{th} grades. Similarly, the construct of curiosity was not statistically different between 8^{th} and 10^{th}, and 9^{th} and 10^{th}. The construct of open-mindedness was not statistically different between grade 9^{th} and 10^{th}. The construct of suspended judgment was not statistically different at grade 8^{th} and 9^{th}.

Conclusion

The findings obtained from the current study showed that although the scientific attitude score of respondent students was high however, it was lower in higher grades. Male and female students scored equally on scientific attitude scale. The scientific attitude scale score is the same for government and private school students. It provides evidence that even though private schools have more equipment, even though students are fully provided with scientific environment, they have facility of library, full of science books, to increase their scientific knowledge, availability of science laboratory, in which they do practical work, so they could be able to apply scientific knowledge into daily life but the scientific attitude of students of both school sectors is the same.

Therefore, it is concluded that scientific attitude is essential for an individual to survive in 21st century. The individuals having scientific attitude can better understand the natural phenomena, act accordingly and can improve himself/herself lives in a better way. At this point it can be concluded that there might be deficiency in teaching which is not enabling to raise curiosity in students. A teacher must formulate some definite objectives such as knowledge, understanding, application, skill, interest, scientific attitudes, and appreciation in order to achieve desirable behavioral changes among students by keep in mind the individual difference when they deal with students.

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