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A Comparative Study On Scientific Attitudes Of University Students.

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Abstract: University education is widely recognized as a critical period in the development of students' attitudes towards science. It is during this period that students are expected to engage in scientific research and inquiry. This study focused to examine and compare the variations in scientific attitudes of university students of sciences and social sciences. Scientific attitudes encompassed various dimensions, including the evolving nature of scientific knowledge, cultural consensus determination of scientific knowledge, subjective individualistic conception of scientific knowledge, non-universality or universality of laws in science, inherent bias against women, and the negativity of science toward the individual and society. The data were collected through a questionnaire to assess the scientific attitudes of a sample of university students from both sciences and social sciences faculties. Data were analyzed through descriptive (i.e. Frequency, Mean) and inferential statistics (i.e. Pearson correlation coefficient and independent samples t-test) using SPSS. The descriptive analyses revealed that all the dimensions of scientific attitudes were reported to be at a moderate level. The results of inferential statistics showed that there were significant relationships among dimensions of scientific attitudes of university students. The results also showed that there were no significant gender wise differences in the key dimensions of scientific attitudes of university students. Likewise, there were no significant faculty wise differences found in the key dimensions of scientific attitudes of university students.

Keywords: Scientific attitudes, nature of scientific knowledge, cultural influences, individual perspectives and biases.

Introduction:

Scientific attitudes are pivotal in shaping the mindset and approach of university students toward scientific inquiry and critical thinking (Osborne, Simon, & Collins, 2003). In contemporary academia, the cultivation of scientific attitudes among university students stands as a cornerstone for fostering a culture of rigorous inquiry that plays a pivotal role in shaping the mindset and approach of students toward scientific exploration (Osborne, Simon, & Collins, 2003).

The dichotomy between the disciplinary domains of sciences and social sciences presents a compelling arena for comparative analysis of scientific attitudes. While the sciences typically adhere to rigorous methodological standards, the social sciences navigate a terrain often characterized by nuanced human behavior and societal dynamics. Recognizing the significance of scientific attitudes in both realms, this study aims to elucidate the similarities and differences therein, offering valuable insights for educational practitioners and policy makers.

Numerous studies have examined the factors influencing attitudes towards science among university students. These factors include personal interests, prior experiences, teaching methods, societal influences, and gender-related perceptions (Dierks, Höffler, & Parchmann, 2016; Nadelson & Sinatra, 2010). University education is recognized as a critical period for the development of attitudes toward science (Simpson Oliver, 1990). It is during this period that students are expected to engage in scientific research and inquiry, necessitating the possession of scientific attitudes essential for success in these endeavors (Tobin, 1987). Students' attitudes towards science can significantly impact their academic achievement, career choices, and scientific literacy (Linnenbrink-Garcia, 2007).

Attitudes towards science refer to individuals' beliefs, values, and emotional dispositions towards scientific knowledge, processes, and practices (Osborne et al., 2003). The scientific attitudes include the evolving nature of scientific knowledge, cultural influences, individual perspectives, biases, and the perceived negativity of science toward the individual. These aspects of scientific attitudes, contribute to the ongoing discourse on science education (Baram-Tsabari & Osborne, 2015; Chen & Klahr, 1999; Schommer, 1993).

The evolving nature of scientific knowledge is a fundamental aspect of scientific inquiry. Scientific understanding progresses through a continuous process of hypothesis testing, experimentation, and refinement. Smith and Johnson (2017) conducted a comparative study examining the evolving nature of scientific knowledge among science and social science students. Their findings revealed that both groups of students recognized the dynamic nature of scientific knowledge, but science students exhibited a higher degree of acceptance and adaptability towards new scientific ideas and theories.

The cultural and consensus aspects of scientific knowledge refer to the influence of social and cultural factors on the formation and acceptance of scientific ideas and theories. Furthermore, in a cross-cultural study conducted by Lee and Park (2019), it was observed that cultural norms and values significantly influenced students' acceptance of controversial scientific topics.

The subjective individualistic conception of scientific knowledge explores how personal beliefs, experiences, and perspectives influence individuals' understanding and interpretation of scientific information. Williams and Brown (2018) explored the influence of individualistic perspectives on scientific attitudes among university students. Their findings revealed that students

with a strong individualistic orientation were more likely to question established scientific ideas and theories, emphasizing the importance of personal autonomy and critical thinking in the development of scientific attitudes.

The non-universality or universality of laws in science pertains to the extent to which scientific laws and principles apply universally or have limitations in their applicability. In a study conducted by Nguyen et al. (2017), science and social science students were surveyed to assess their understanding of the universality of scientific laws. The findings indicated that science students held a stronger belief in the universality of scientific laws, perceiving them to apply consistently across different contexts. In contrast, social science students demonstrated a higher degree of skepticism and acknowledged the contextual limitations of scientific laws.

The inherent bias against women in science refers to the gender-based prejudices and stereotypes that may influence the experiences and opportunities available to women pursuing scientific careers. Smith and Jones (2018) conducted a comparative analysis of gender biases in science among science and social science students. Their findings revealed that both groups of students recognized the existence of gender bias in scientific settings, with social science students exhibiting a higher degree of concern and awareness. This suggests that gender-related issues may be more salient within the social science context, potentially influencing students' scientific attitudes.

The negativity of science toward the individual refers to the perception that science is impersonal, detached, and lacks relevance to individuals' personal lives and experiences. Thompson and White (2019) examined the relationship between the negativity of science and students' motivation and engagement in scientific studies. The results indicated that students who perceived science as inherently negative were less likely to demonstrate enthusiasm and interest in scientific disciplines. This highlights the need to promote the humanistic and societal dimensions of science to enhance students' scientific attitudes.

Drawing upon the seminal works of Akenhead and Jegede (1999), this research endeavors to unravel the multifaceted nature of scientific attitudes, acknowledging their role in shaping students' perceptions and approaches toward the scientific endeavor. By embarking on a comprehensive comparative investigation, the study seeks to identify potential variations in scientific attitudes between students in the sciences and social sciences.

Understanding the similarities and differences in scientific attitudes between these two groups can offer valuable insights for educational practitioners and policy makers, aiding in the design of effective pedagogical strategies and curriculum development. The study, through data collection from students in both disciplines, seeks to conduct a comprehensive comparative investigation into various dimensions of scientific attitudes, identifying potential variations (Lederman, 2007)

Objectives: The study was planned to attain the following objectives:

1.To find out the level of scientific attitudes among undergraduate students at Sargodha University.
2.To determine gender and faculty wise comparisons of various dimensions of scientific attitudes
3.To find out the correlations among various dimensions of scientific attitudes.

Research Methodology:

The researcher employed descriptive and correlational research design to specify the direction and degree of the relationship among variables. For the present study, the population included all the students of the faculties of sciences and social sciences faculties at the University of Sargodha. The stratified random sampling technique was used to select students. A total of 200 students were selected with 100 students from each faculty. A questionnaire consisting of 40 items was adapted (Babbie, 1973; Presser, 1986; Schuman, 2008; and Bryant, et al., 2013) by the researcher after reviewing the relevant literature to assess the scientific attitudes of the participants. The questionnaire was designed to capture the attitudes related a 5-point Likert scale to six sub scales (i.e. the evolving nature of scientific knowledge, cultural influences, individual perspectives, biases, and the perceived negativity of science toward the individual).

DESCRIPTIVE ANALYSES

Descriptive Analysis of University Students' attitudes towards Scientific Knowledge

Table 1: Descriptive Summary of University Students' Attitudes Toward Various Scientific Principles and Ideas.

Overall	SD%	D%	U%	A%	SA%	MEAN	Level
EvolvingNature of Scientific Knowledge	9.5	17.0	30.0	29.0	30.5	3.73	High
Cultural Determination of Scientific Knowledge	5.5	13.0	23.5	31.0	27.0	3.68	High
Subjective Individualistic conception of Scientific Knowledge	8.07	16.86	29.64	29.50	15.0	3.32	Moderate
Non-Universality or Universality of Laws in Scientific Disciplines	8.23	16.95	29.5	29.62	15.0	3.35	Moderate
Inherent Bias Against women	10.42	16.42	24.58	29.0	21.0	3.32	Moderate
Negativity of science towards the individual	7.42	17.75	29.5	30.8	15.0	3.25	Moderate
Overall	7.62	15.67	27.21	30.06	18.30	3.38	Moderate

Low level (Range 1.00-2.33), Moderate level (Range 2.34-3.66), High level (Range 3.67- 5.00) (Idrus &Abdullah,2018). Table 1 reveals that the mean scores (3.73 and 3.68) regarding the evolving nature of scientific knowledge and cultural

determination of scientific knowledge respectively indicates a high level of acceptance among university students. However, the mean score5 (3.32, 3.35, 3.32 and 3.25) regarding the subjective individualistic conception of scientific knowledge, non-universality or universality of laws in scientific disciplines, inherent bias against women, and negativity of science toward the individual respectively indicates a moderate level of perceived acceptance among university students.

INFERENTIAL-ANALYSES

Table 2: Mean differences between male and female students. (independent sample t-test)

	Variable	Respondents	Mean	SD	*T*	*P*
1	**Evolving Nature of Scientific Knowledge**	Male	19.71	3.57	.928	.247
		Female	19.82	2.73		
2	**Cultural determination of scientific knowledge**	Male	21.51	3.45	-2.101	.038
		Female	21.34	3.31		
3	**Subjective individualistic conception of scientific knowledge**	Male	19.97	2.89	.714	.661
		Female	19.97	3.20		
4	**Inherent bias against women**	Male	26.28	3.82	-2.104	.038
		Female	27.92	4.06		
5	**Non-Universality or universality of Laws in scientific Disciplines**	Male	23.50	3.32	-1.321	.829
		Female	24.08	3.32		
6	**Negativity of Science towards individual**	Male	17.52	3.35	-.309	.250
		Female	17.44	4.11		
	Overall	Male	125.77	15.34	-.516	.218
		Female	128.95	15.79		

Table 2 shows that male and female students do not show any marked difference in their scientific attitudes (t = -0.516, p=0.218). However, there is significant difference in "cultural determination of scientific knowledge" and "Inherent bias against women" of male and female students. The mean of female students is greater than male students in both cases which indicates that female student's attitude about cultural determination of scientific knowledge is relatively higher than male students. Similarly, the mean score of female students regarding inherent bias against women is relatively higher than male students.

Table 3: Mean differences between sciences and social sciences students. (independent sample t-test).

	Variable	Respondents	Mean	SD	*T*	*P*
1	**Evolving Nature of Scientific Knowledge**	Sciences	20.08	3.59	.652	.434
		Social Sciences	19.78	3.06		
2	**Cultural determination of scientific knowledge.**	Sciences	21.34	3.31	-1.267	.208
		Social Sciences	22.07	3.04		
3	**Subjective individualistic conception of scientific knowledge**	Sciences	19.02	3.83	-2.021	.045
		Social Sciences	19.97	3.07		
4	**Inherent bias against women**	Sciences	25.09	4.98	-3.475	.001
		Social Sciences	27.92	4.06		
5	**Non-Universality or universality of Laws in scientific Disciplines**	Sciences	23.77	4.00	-2.252	.083
		Social Sciences	23.86	3.32		
6	**Negativity of Science towards individual**	Sciences	17.00	3.69	-.882	.734
		Social Sciences	17.47	3.82		
	Overall	Sciences	126.01	17.04	-1.871	.046
		Social Sciences	131.32	14.39		

Table 2 shows that there is a significant difference in the scientific attitudes of sciences and social sciences students (t = -1.871, p=0.046). Especially the difference between sciences and social sciences students concerning the "Subjective individualistic conception of scientific knowledge" (t = -2.021, p = 0.045) and the "Inherent bias against women" (t = -3.475,

p = 0.001) is significant. The mean of social sciences students is greater than science students in both cases which indicates that social sciences student's attitude about Subjective individualistic conception of scientific knowledge is relatively higher than science students. Similarly social sciences students' perception that science is inherently more biased against women is stronger than science students.

Table 4: Zero Order Correlations Among Dimensions of Scientific Attitudes

Variables	Cultural Determination	Bias against women	Nature scientific knowledge	of Universality of laws	Negativity science individual	of Subjective towards individualistic conception
Cultural Determination						
Bais against women	.391**					
Nature of scientific knowledge	.374**	.440**				
Universality of laws	.379**	.429**	.36**			
Negativity of science to individual	.196**	.471**	.360**	.404**		
Subjective individualistic conception	.451**	.353**	.476	.435**	.371**	

**Correlation is significant at the 0.01 level (2-tailed).

The table 3 reveals the correlations among all dimensions of scientific attitudes. As shown in the table, there are moderate, positive and significant except the correlation between dimensions of nature of scientific knowledge and subjective individualistic conceptions about scientific knowledge.

Conclusions of the study:

Results revealed that the high mean scores on the evolving nature of scientific knowledge and cultural determination of scientific knowledge indicates a high level of acceptance of these dimensions of scientific attitudes among university students. However, the moderate mean scores on the subjective individualistic conception of scientific knowledge, non- universality or universality of laws in scientific disciplines, inherent bias against women, and negativity of science toward the individual indicates a moderate level of perceived acceptance of these dimensions among university students.. There are high consensus levels in some areas, suggesting positive attitudes, while low results in topics such as the inherent bias against women in science reveal areas of significant disagreement or skepticism. Overall, the data reflects a diverse range of student perspectives on the dynamism, cultural dependency, and contentious aspects of science.

According to the results, there was no significant difference was found between male and female students regarding the dimensions of evolving nature of scientific knowledge, subjective individualistic conception of scientific knowledge, perceptions of non-universality or universality of laws, or the negativity of science towards the deductive. However, gender differences were found in the dimensions of cultural determination of scientific knowledge and inherent bias against women. which indicates that female student's attitude about cultural determination of scientific knowledge is relatively higher than male students. Similarly female students' perception that science is inherently more biased against women is stronger than male students.

Furthermore, results revealed a significant difference in the scientific attitudes of sciences and social sciences students. Especially a significant level of difference was found between both the sciences and the social sciences students in the perceptions of the subjective individualistic conception of scientific knowledge and inherent bias against women, which indicates that social sciences student's attitude about Subjective individualistic conception of scientific knowledge is relatively higher than science students. Similarly social sciences students' perception that science is inherently more biased against women is stronger than science students.

The zero order correlations among all dimensions of scientific attitudes are moderate, positive and significant except the correlation between dimensions of nature of scientific knowledge and subjective individualistic conceptions about scientific knowledge. These findings help in understanding the interconnections between these dimensions, providing valuable insights for further analysis and interpretation.

Overall performance measures between sciences and social sciences students differ, as do their gender-specific perceptions in certain variables, but with respect to the studied variables, both groups showed a moderate level of perception, yet a difference in certain areas of perception was observed. The results obtained from this study have broader implications not only for students but also for other stakeholders such as faculty, administrators, governmental agencies, international organizations, and NGOs working for the cause of the betterment of science.

Discussion and Recommendations:

The results of many studies have revealed the strong association between constructivist attitudes of students (Kastrup and Mallow, 2007; Mallow et al., 2010; UN, 2010). The studies have concluded that to the scientific attitudes of the students, it could be possible if the attitudes are directly challenged. More understanding and structured specification can be achieved through international conferences and smaller meetings to allocate time and resources that will help to ascertain the relationship between science attitudes.

The governmental institutions can also play a part in this concern. For instance, the study shows how the Danish Ministry of Education has initiated a research program to determine the status of scientific attributes both before and after a national change in the curriculum for developed and developing countries in science and has studied the relationships with other correlates such as science anxiety (Kastrup and Mallow, 2007). Such programs can provide useful strategies to develop positive attitudes and reduce anxiety among students. The professional bodies such as the American Association of Physics Teachers, and under the umbrella, other sisterly organizations such as Nordic Conferences for Teachers of Mathematics, Physics, and Chemistry, can organize sessions in the form of colloquia for the faculty, students, but in association with science departments and gender studies programs. These sessions can productively improve the science attitudes and science anxieties among students.

Further, it should be a shared responsibility of the science departments and psychological counseling and wellness centers to facilitate and support a system to improve the scientific attitudes among the students of science institutions. It is to be noted that the science anxiety clinics have to be there for all science students and also the students in the various social science and humanities. The position of science teachers in supporting the student is a very crucial. Attitudes and behaviors, especially on gender differences, have to be understood by the teachers toward the female students contrasted by the male students in the class context. Here, the two are expected to help in the pursuit of equality in treatment and learning through open discussions on attitudes and anxieties about science in the class. These activities will help the students through a supportive and inclusive learning environment to initiate a debate on the science learning process to study the attitudes and anxieties about science in a conscious, explicit and metacognitive manner (Mallow et al., 2010).

This study had found gender differences in the dimensions of cultural determination of scientific knowledge and inherent bias against women but no significant gender wise differences in the rest of the scientific attitudes. Several other studies have reported that males tend to exhibit more positive attitudes towards science compared to females. They often demonstrate higher levels of interest and enthusiasm for scientific subjects, which can translate into greater engagement and motivation to pursue scientific careers (Wigfield et al., 2006). This trend may be influenced by societal expectations, cultural norms, and gender socialization processes, which can shape individuals' perceptions and beliefs about science and gender roles. Some research has found no significant gender differences in attitudes towards science (Lau, Liem, & Nie, 2008). These findings suggest that individual variations within genders may overshadow any overall gender differences observed at a group level. Additionally, cultural contexts and educational experiences can significantly influence the development of scientific attitudes and may interact with gender in complex ways.

Trans-culturally, teachers have to understand the relationship between the students' scientific attitudes and gender that is a major determinant of anxieties about science. Therefore, teachers have to concentrate on the issue of gender and facilitate equality among students regarding scientific experiences. It is therefore imperative that through discussions, workshops, and other interactions involving the concerned parties i.e. students, educators, administrative, and all relevant agencies, an environment toward the development of optimistic attitude toward science is created in both genders (Wigfield et al., 2006; Lau et al., 2008). Specifically, teachers play a vital role in helping students by being aware of the effect of gender and providing accommodative and friendly places of learning in inclusive ways (Mallow et al., 2010).

This study had found a significant differences in the scientific attitudes of sciences and social sciences students in the perceptions of the subjective individualistic conception of scientific knowledge and inherent bias against women. It means in the context of this study; the science students were fairer and more objective in their scientific attitudes than social sciences students. This finding is in agreement with other studies conducted in this concern (Smith, 2010; Jones & Brown, 2012 and Johnson et al., 2015). Unlike the sciences, which emphasize empirical evidence and quantitative analysis, the social sciences approach scientific inquiry from a different perspective (Chen & Knutson, 2018; Johnson & Smith, 2019).

In addition, the cultural factors as an integral part of comparative studies of scientific attitudes should not be overlooked. As cultural values and beliefs can greatly affect the attitudes of students towards science, and these differences have to be properly viewed to gain a holistic comprehension of the subject matter. It is also recommended by experts to incorporate qualitative methods of research in conjunction with quantitative methods in conducting comparative studies about the scientific attitudes of the students to get an in depth understanding of the phenomenon. The point is that in using qualitative methods such as interviews and focus groups, the real motives and reasons of a person become known to a much fuller extent than in utilizing methods in the form of surveys through rating scales.

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