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SCIENTIFIC ATTITUDE AND CRITICAL THINKING SKILLS IN SECONDARY SCHOOL STUDENTS: THE IMPACT OF GENDER AND MANAGEMENT

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ABSTRACT

Students' future academic achievement in secondary school depends on developing both a scientific mindset and critical thinking abilities. The study aimed to measure the level of scientific attitude and critical thinking skills among secondary school students and to identify any significant differences in their scientific attitude and critical thinking skills based on gender and management style. A descriptive survey research design was employed to conduct the study. A sample of 200 Class IX students was randomly selected from government and private schools in the Kohima and Dimapur districts of Nagaland. Two research instruments were used for data collection: the scientific attitude questionnaire developed by the investigators and the Critical Thinking Skills Scale developed by Murthy (2014), which was modified to suit the needs and context of Nagaland. The collected data were analyzed using percentages, means, standard deviations, correlations, chi-square tests, and t-tests for independent samples. The study revealed that the level of scientific attitude and critical thinking skills among secondary school students varied. Scientific attitude and critical thinking skills were not significantly influenced by gender. Scientific attitude and critical thinking skills were significantly influenced by management. It was found that there is a positive correlation between scientific attitude and critical thinking skills among secondary school students. The findings of this study suggest that teachers should design an engaging science curriculum that incorporates more hands-on activities, project-based learning, classroom discussions, model exhibitions, science fairs, science museums, and field trips in order to foster a scientific mindset in their pupils.

INTRODUCTION

Science has been derived from the Latin word 'Scientia', which means knowledge, awareness, and understanding. The primary objective of science teaching at any level is to foster a scientific attitude and develop critical thinking. The terms "scientific attitude" and "scientific temper" are used interchangeably. Nehru (1946), in his book Discovery of India, states that "scientific approach and temper are a way of life, a process of thinking, a method of acting, and associating with our fellowmen". The "scientific attitude" in science education is another area of emphasis in the National Curriculum Framework (Pal, 2005). Quality higher education must strive to produce decent, considerate, well-rounded, and creative people in light of the demands of the twenty-first century. In addition to developing character, ethical and constitutional values, intellectual curiosity, scientific temper, creativity, a spirit of service, and 21st-century skills across a variety of disciplines, including the sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects, it must allow a person to study one or more specialized areas of interest in depth. To develop holistic individuals, a set of identified skills and values must be incorporated at each stage of learning, from preschool to higher education (Ministry of Education, 2020). Critical thinking concerns the 'Why' questions and assumptions influencing thoughts or actions. A person with essential thinking skills constantly seeks evidence to evaluate everyday problems. World Health Organization (1996)

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mentions that critical thinking is one of the core life skills. Critical thinking combines revised Bloom's cognitive subdomains, including knowledge, comprehension, application, analysis, synthesis, evaluation, and creation.

India is a multicultural society comprising diverse individuals from various backgrounds, beliefs, attitudes, and practices. It consists of a mini-society in any given classroom. Many students complete their education up to secondary level only. Therefore, people may face difficulties in utilizing the opportunity to pass down the scientific way of thinking and solving problems. It becomes difficult for an individual to convert unreasonable, superstitious practices into more rational ones and establish a critical perspective. It is essential to understand what a scientific attitude entails. Moreover, why do we need a scientific attitude? Nehru (1946) stated the importance of a scientific attitude in how problems could be resolved using a scientific perspective and in dealing with fellow beings at times when conflicts arise how to resolve any political, social, economic, health, habits, beliefs, and interpersonal dealings scientific attitude and its attributes like critical thinking have become indispensable skills of the present time. National Curriculum Work (Pal, 2005) and NEP -2020 (Ministry of Education, 2020). Stresses on the scientific attitude and critical thinking. These curriculum frameworks provide direction towards the present system and the outcome of the curriculum, assessing how effective it has been in promoting the objectives of Science at the secondary level. The Nagaland Board of School Education (NBSE) gives a direction on planning and inclusion of the elements lacking in the secondary science curriculum that would enhance the quality of science education in Nagaland as a state and India at large, impacting the global viewpoint starting from the hills of the northeast people and the beliefs practices in social conflicting situations how they tackle the conflicting situations using scientific attitude and critical thinking.

The present study focuses on the scientific attitude and critical thinking skills, as well as one of their attributes, among secondary school students in Nagaland who are studying under the Nagaland Board of School Education (NBSE) board. Adolescents are curious individuals who constantly explore the world around them. Therefore, the right attitude and behavior formation should occur during the time they reach the IX standard when they are wondering about their career and the path they should choose in life. This is a crucial stage for how they decide and deal with society and pressure, which will determine the outcome of their later life. The effectiveness of science teaching in primary and secondary school would be reflected in choosing the path they would take in the long run. To compare the scientific attitude and critical thinking skills among boys and girls, as well as those in private and government schools, the study is entitled "Scientific attitude and critical thinking skills among secondary school students in Nagaland." The objectives of the present study are to determine the scientific attitude and critical thinking skills and to investigate the correlation between scientific attitude and critical thinking skills among secondary school students in Nagaland.

This study is structured into six key sections. The Introduction outlines the concept, articulates the problem statement, and defines the study's objectives. Next, the Literature Review encapsulates current knowledge on scientific attitudes and critical thinking skills, emphasizing the theoretical underpinnings and highlighting research gaps that the current investigation aims to address. The Materials and Methods section elaborates on the research design, describes the data collection process, and specifies the analytical tools used to explore the relationships between the variables. The Results section presents the empirical outcomes, revealing which hypotheses were validated and which were not, while the Discussion interprets these findings about existing literature. Lastly, the Conclusion underscores the unique contributions of the study, discusses its significance, and offers suggestions for practice and avenues for future research.

LITERATURE REVIEW

The results of a study conducted in Katsina State, Nigeria, by Olasehinde and Olatoye (2014) on the scientific attitudes, attitudes toward Science, and science achievement of senior secondary school students do not support the idea that male and female students are equal in these areas. Girls outperform boys in Science, according to a study by Ahuja (2017) on scientific attitudes and science success scores among secondary school pupils. Harsharan Singh (2018) investigated the relationship between superstitious behavior and scientific views among professional college students, examining the influence of locus of control and gender. There was no discernible gender difference in the mean score for superstitious behavior. Khan et al. (2022) investigated the attitudes of pre-college STEM students toward Science, including their perceptions of gender disparities, their impact on physics test scores, and their decisions to pursue higher-level physics coursework. Aversion to superstitions was found to be higher than other characteristics of the scientific attitude under investigation, and it was discovered that boys scored higher on the physics and scientific attitude. Additionally, a strong correlation was observed between the two scores for both girls and boys. Singh (2014) investigated the scientific mindset of aspiring science instructors as well as junior and senior secondary school students in Botswana. The attitudes of male and female respondents were found to be similar, with the majority falling within the average range. Yadav and Singh (2017) investigated how gender affected the scientific mindset of biology students in upper secondary school. The results show that, at the formal operational level, there is no discernible difference in the scientific attitudes of male and female biology students. Sherafat (2016) investigated the impact of self-esteem, study habits, and critical thinking on the academic performance of secondary and senior secondary school students. Students attending private schools demonstrated better study habits and critical thinking skills than those attending public schools. According to Mittal's (2017) study on the critical thinking skills and dispositions of junior college students in relation to their goal orientation and learning methodologies, there were no discernible disparities in the critical thinking abilities of junior college boys and girls. The mean scores of ICSE board students were noticeably higher than those of CBSE and SSC board graduates. The critical mean was higher for science students than for commerce and art students, respectively. Kaur (2013) conducted a study on the relationship between scientific attitude and critical thinking among school teachers in Punjab's Mohali region; findings revealed that female teachers were more critical thinkers and had a stronger scientific attitude than male instructors. According to the results of a study by Ramya (2019)., on the "effect of social constructivist strategies of teaching science on scientific attitude, critical

thinking, and social skills of secondary school students," social constructivist teaching methods are more successful in improving students' scientific attitudes, critical thinking, and social skills. A strong relationship existed between secondary school students' scientific mindset, critical thinking, and social skills. A technology-rich environment and critical thinking abilities are positively correlated, according to McMahon, G. (2009), who researched critical thinking and ICT integration in a secondary school in Western Australia. In their study, Duran and Dökme (2016) examined the effect of inquiry-based learning on students' critical thinking skills. They found that inquiry-based learning had a significant impact on students' critical thinking abilities in Science and technology. The study conducted by Tous and Haghighi (2016) compared the critical thinking abilities of Iranian male and female English as a Foreign Language (EFL) learners. It concluded that there was no significant difference between the two groups. Solihati and Hikmat (2018) examined the presence of critical thinking exercises in senior secondary Indonesian language textbooks. Their findings showed that the textbooks lacked critical thinking-promoting components. The effectiveness of laboratories with various objectives and designs on students' critical thinking abilities was investigated by Walsh C. et al. (2022), who found that students' critical thinking abilities are enhanced by laboratories that emphasize the development of experimental skills. Suastra and Ristiati (2019) investigated the effects of the project-based learning model on students' critical thinking, scientific attitude, and self-efficacy. They discovered that authentic assessment can improve students' scientific self-efficacy, scientific attitude, and critical thinking abilities. Students' scientific attitude was examined by Budiharti and Waras (2018) as a treatment effect of blended learning supported by the I-Spring 8 application. They discovered that students' behavior is influenced by blended learning supported by the I-Spring 8 application on all aspects of scientific attitude, including critical thinking, creativity and discovery, cooperation and open-mindedness, perseverance, and inquisitiveness. Suryawati and Osman (2018) evaluated the impact of contextual teaching and learning on students' scientific attitudes and academic performance in Natural Science. They discovered no difference in students' scientific attitudes between the contextual strategy treatment group and the conventional strategy treatment group. To foster a positive attitude toward Science among lower secondary school students, Zulirfan et al. (2018) implemented an alternative strategy and assessed its efficacy. The study found that the take-home experiment strategy has a significant influence on students' development of a scientific attitude.

According to the literature study, there has been little research conducted on the relationship between critical thinking abilities and a scientific mindset, especially in Nagaland. To enhance scientific attitude and critical thinking abilities in the context of Nagaland, the researchers were compelled to ascertain the current state of science education and whether the goals of Science are being met in terms of fostering a scientific attitude, as outlined in the National Policy of Education-2020 (Ministry of Education, 2020). Determining our current state and the necessary improvements to our educational system is crucial. Based on the existing literature, the Conceptual Model of Scientific Attitude and Critical Thinking Skills, and the study's purpose, the following hypothesis was formulated.

H_{o1}: *Secondary school students in Nagaland do not have different levels of scientific attitude*

H_{o2}: *Secondary school students in Nagaland do not have different levels of critical thinking*

H_{o3}: *There is no significant difference between boys and girls in their mean scores of the scientific attitude of secondary school students in Nagaland*

H_{o4}: *There is no significant difference in mean scores of scientific attitude among government and private secondary school students in Nagaland*

H_{o5}: *There is no significant difference in critical thinking skills of secondary school students in Nagaland with respect to gender*

H_{o6}: *There is no significant difference in critical thinking skills of secondary school students in Nagaland with respect to management*

H_{o7}: *There is no significant correlation between scientific attitude and critical thinking skills among secondary school students in Nagaland.*

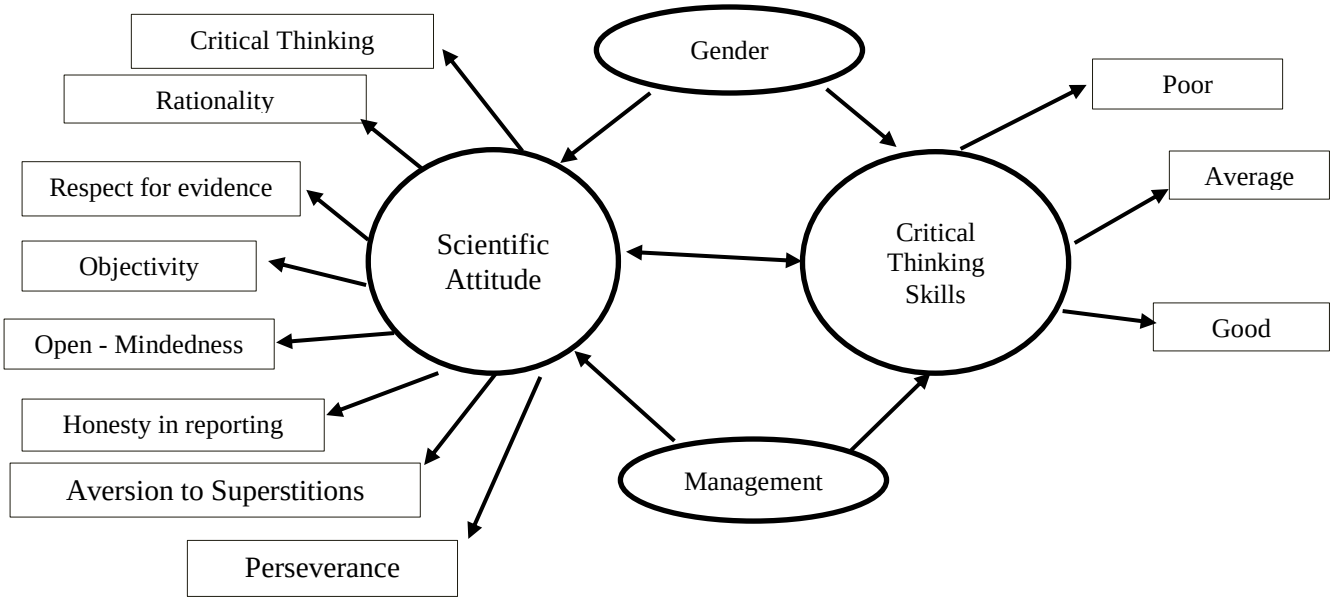

Figure 1. Conceptual Model of Scientific Attitude and Critical Thinking Skills, Source: Prepared by the authors

MATERIALS AND METHODS

The study investigates the level of scientific attitude and critical thinking skills among secondary school students. The study aims to determine whether there are significant differences in scientific attitude and critical thinking skills among individuals based on gender and management in Nagaland, using a descriptive survey method. This study employs a Quantitative methods approach for its research methodology, utilizing quantitative data collection methods as part of the study variables. The critical thinking of the participants is used as the dependent variable, and the scientific attitude is used as the independent variable. The current research sample comprises 200 students (102 boys and 98 girls) attending class IX in secondary schools located in the Dimapur and Kohima districts of Nagaland. The participating students were selected using the simple random sampling method, a type of probability sampling. The scientific Attitude Questionnaire, developed by the investigators and consisting of 35 statements, was used. The reliability and validity of the scientific attitude tool were 0.78 and 0.88, respectively. The Mysore Critical Thinking Skills Scale (Murthy, 2014) was modified and used by investigators, who presented four conflicting situations or dilemmas and asked respondents to write about the merits and demerits, providing reasons for their responses. Data were collected by the investigators, who personally visited secondary schools located in Dimapur and Kohima, with the approval of the principals and head teachers. Frequencies, Percentages, Mean, S.D., Correlation, Chi-Square test, and independent t-test were used for data analysis. The research benefits from its quantitative methodology, which yields a complete understanding of critical thinking and scientific attitudes among secondary school students. The research focused exclusively on secondary schools in the state of Nagaland.

RESULTS

Table 1. Level of scientific attitude scores

Score Range	Frequency	%	Level	Chi-Square Value
119 & Below 199	90	45%	Below-average level of scientific attitude	48.99*
120-122	20	10%	Average level of scientific attitude	
123 and above	90	45%	Above average level of scientific attitude	
N	**200**	**100%**		

Note: * significant Source: Survey data, 2024

The overall data were analyzed in the form of percentages to find out the level of scientific attitude among secondary school students in Nagaland, where analysis of Table 1 reveals that 45% scored below average level of scientific attitude, 10% scored the average level of scientific attitude, and 45% scored above average level of scientific attitude. The calculated Chi-Square value is 48.99, and the tabulated Chi-Square value for 2df at 0.01 level of significance is 9.21. The calculated Chi-Square value is greater than the tabulated Chi-Square value. Therefore, the hypothesis H_{o1} is not accepted. It shows that students varied in their level of scientific attitude scores. The analysis reveals that only 10% of students fall under the average level of scientific attitude. As a result, it was discovered that Nagaland secondary school pupils exhibit varying degrees of scientific mindset.

Table 2. Level of critical thinking scores

Score Range	Frequency	Percentage	Level	Chi-Square Value
51 & Below 51	01	0.5%	Below-average level of critical thinking	123.12*
52-54	129	64.5%	Average level of critical thinking	
55 and above	70	35%	Above average level of critical thinking	
N	**200**	**100%**		

Source: Survey data, 2024

Table 2 shows the scores in percentages, where 0.5% indicates a below-average level of critical thinking, 64.5% indicates an average level of critical thinking, and 35% indicates an above-average level of critical thinking. The calculated Chi-Square value is 123.12, which is greater than the tabulated value (9.21, 2df at 0.01 level of significance). Hence, the null hypothesis H_{o2} is not accepted at a 0.05 level of significance. This indicates that secondary school students in Nagaland exhibit varying levels of critical thinking, with the majority (64.5%) demonstrating an average level of critical thinking.

Table 3. T-test results comparing boys and girls on scientific attitude

Scientific Attitude & Dimensions	Gender	N	Mean	Standard Deviation	t-value
1. Critical Thinking	Boys	102	15.21	2.755	**2.319***
	Girls	98	16.17	3.139	
2. Rationality	Boys	102	17.62	2.949	**1.972***
	Girls	98	18.44	2.939	
3. Respect for evidence	Boys	102	17.14	2.932	0.156@
	Girls	98	17.07	3.050	
4. Objectivity	Boys	102	12.40	2.330	**3.524***
	Girls	98	13.64	2.645	
5. Open - Mindedness	Boys	102	6.16	1.733	0.137@
	Girls	98	6.12	1.818	
6. Honesty in reporting	Boys	102	17.34	3.020	0.726@
	Girls	98	17.05	2.653	

7. Aversion to Superstitions	Boys	102	16.69	3.464	0.772@
	Girls	98	16.31	3.498	
8. Perseverance	Boys	102	16.69	3.412	1.502@
	Girls	98	17.37	2.975	
Scientific Attitude	Boys	102	119.24	12.808	1.508@
	Girls	98	122.17	14.718	

Source: Survey data, 2024

It was found that from Table 3, the dimensions of critical thinking, rationality, and objectivity yielded calculated t-values of 2.319, 1.972, and 3.524, respectively. These values are found to be greater than the tabulated t-value of 1.96 for 1 df and 198 df at a 0.05 level of significance. Therefore, for these dimensions, there is a significant difference between boys and girls in their mean scores of the scientific attitudes of secondary school students in Nagaland. Whereas for the dimensions with respect to evidence, open-mindedness, honesty in reporting, aversion to superstitions, and perseverance, the calculated t-values were found to be .156, .137, .726, .772, 1.502 respectively, which are lesser than the table t-values of 1.96 for 1df and 198df at 0.05 level of significance. Therefore, for these dimensions, there is no significant difference between boys and girls in their mean scores of the scientific attitudes of secondary school students in Nagaland. The overall analysis shows that the calculated t-value is 1.508, which is found to be less than 1.96 for 1 df and 198 df at a 0.05 level of significance. Hence, the hypothesis H0 is accepted at the 0.05 level of significance. Therefore, there is no significant difference between boys and girls in their mean scores of the scientific attitude of secondary school students in Nagaland; however, girls show a slightly higher scientific attitude in their mean score compared to boys.

Table 4. T-test results comparing government and private school students on scientific attitude

Scientific Attitude & Dimensions	Management	N	Mean	Standard Deviation	t-value
1. Critical Thinking	Government	100	14.74	2.762	4.687*
	Private	100	16.62	2.909	
2. Rationality	Government	100	17.51	2.819	2.463*
	Private	100	18.53	3.033	
3. Respect for evidence	Government	100	16.38	3.041	3.535*
	Private	100	17.83	2.753	
4. Objectivity	Government	100	12.39	2.412	3.522*
	Private	100	13.63	2.565	
5. Open - Mindedness	Government	100	5.78	1.673	2.929*
	Private	100	6.50	1.801	
6. Honesty in reporting	Government	100	16.59	3.025	3.100*
	Private	100	17.81	2.517	
7. Aversion to Superstitions	Government	100	15.93	3.144	2.344*
	Private	100	17.07	3.710	
8. Perseverance	Government	100	15.85	2.776	5.512*
	Private	100	18.19	3.212	
Scientific Attitude	Government	100	115.17	11.393	6.129*
	Private	100	126.18	13.890	

Source: Survey data, 2024

It was found from Table 4 that the dimensions of scientific attitudes, such as critical thinking, rationality, respect for evidence, objectivity, open-mindedness, honesty in reporting, aversion to superstitions, and perseverance, the calculated t-values were found to be more than the t-value (1.96) for 1df and 198df at 0.05 level of significance. The mean score and standard deviation values for government school students were 115.17 and 11.393, respectively, whereas for private school students, they were found to be 126.18 and 13.890, respectively. Further, the total t-value of scientific attitude was found to be 6.129 with respect to management, which is greater than the critical t-value (1.96) for 1df and 198df at 0.05 level of significance. Hence, hypothesis Ho_4 is not accepted at a 0.05 level of significance. This indicates a significant difference in the mean scores of scientific attitudes among government and private secondary school students in Nagaland. Private secondary school students in Nagaland exhibit a more positive scientific attitude than their government secondary school counterparts.

Table 5. T-test results comparing boys and girls on critical thinking skills

Critical thinking	Gender	N	Mean	Standard Deviation	t-value
1. Poor	Boys	102	5.39	1.991	1.182@
	Girls	98	5.74	2.226	
2. Average	Boys	102	16.42	.959	2.885*
	Girls	98	16.99	1.732	
3. Good	Boys	102	32.05	.355	.585@
	Girls	98	32.09	.644	
Critical Thinking Skills	Boys	102	53.86	2.874	1.951@
	Girls	98	54.83	4.036	

Source: Survey data, 2024

Table 5 shows that the calculated t- t-value of critical thinking skills is lower than the tabulated t- t-value (1.96) for 1df and 198df at 0.05 level of significance. Hence, the hypothesis H_{o5} is accepted. Therefore, there is no significant

difference in mean scores of critical thinking skills of secondary school students in Nagaland with respect to gender.

Table 6. T-test results comparing government and private school students on critical thinking skills

Critical thinking	Management	N	Mean	Standard Deviation	t-value
Poor	Government	100	5.04	1.626	
	Private	100	6.09	2.400	3.622*
Average	Government	100	16.20	.636	5.318*
	Private	100	17.20	1.770	
Good	Government	100	32.01	.100	1.651@
	Private	100	32.13	.720	
Critical Thinking Skills	Government	100	53.25	2.105	4.577*
	Private	100	55.42	4.248	

Source: Survey data, 2024

Table 6 shows that the calculated t- t-value of critical thinking skills is greater than the table t- t-value (1.96) for 1df and 198df at 0.05 level of significance. Hence, the hypothesis H_{o6} is not accepted. Therefore, there is a significant difference in mean scores of critical thinking skills of secondary school students in Nagaland with respect to management.

Table 7. Correlation between Scientific Attitude and Critical thinking skills

		Scientific Attitude	Critical Thinking Skills
Scientific Attitude	Pearson Correlation	1	.428**
	Sig. (2-tailed)		.000
	N	200	200
Critical Thinking Skills	Pearson Correlation	.428**	1
	Sig. (2-tailed)	.000	
	N	200	200

Source: Survey data, 2024

Analysis of Table 7 shows that the mean scores for scientific attitude and critical thinking skills are 120.68 and 54.34, whereas the standard deviation was found to be 13.821 and 3.516, respectively. The correlation between scientific attitude and critical thinking skills is 0.428. The correlation coefficient is significant at a 0.01 level of significance. Hence, the hypothesis H_{o7} is not accepted. It is a weak but positive correlation. It was found that a positive and significant correlation exists between the two variables. Therefore, a significant correlation exists between scientific attitude scores and critical thinking skills scores among secondary school students in Nagaland.

DISCUSSIONS

Overall findings of the study: 45% scored below average level of scientific attitude, 10% scored average level of scientific attitude, and 45% scored above average level of scientific attitude. Secondary school students in Nagaland exhibit varying levels of scientific attitude. 0.5% show an average level of critical thinking, 64.5% show an average level of critical thinking, and 35% show an average level of critical thinking. Secondary school students in Nagaland exhibit average levels of critical thinking skills, with varying levels of critical thinking. It has been found that private secondary school students in Nagaland have a better scientific attitude than their government secondary school counterparts. It was found that the mean score for boys in critical thinking skills was 53.86, while the mean score for girls in critical thinking skills was 54.83. When these mean scores are compared, it is found that girls showed slightly higher critical thinking than boys of secondary school students in Nagaland. It was found that the mean score of government secondary school students was 53.25, while the mean score of private secondary school students was 55.42. When these mean scores are compared, it is found that private secondary school students have higher scientific attitudes than government secondary school students in Nagaland. The correlation between scientific attitude and critical thinking skills is 0.428. The coefficient of correlation is significant at 0.01 level. It is a weak but positive correlation. The two variables were found to have positive and significant correlations. A scientific attitude is essential as it increases environmental awareness (Hassan & Ratnakar, 2012). A positive relationship exists between scientific attitude and attitude toward Science (Olasehinde & Olatoye, 2014). Misra and Srivastava (2016) found that scientific interest is positively related to both scientific attitudes in intent and action among students. Sherafat (2016) states that Private school students exhibit higher critical thinking levels and study habits than their government school counterparts. In the context of the study conducted on scientific attitude and critical thinking skills in secondary school students: The impact of gender and management, Ahuja (2017) and Khan et al. (2022) found that there exists a gender difference in the scientific attitude which is contradicting the finding that there is no significant difference between boys and girls in their mean scores of the scientific attitude of secondary school students in Nagaland whereas supporting results were found in the studies of Yadav and Singh (2017). Mittal's (2017) and Tous and Haghighi's (2016) findings supported the results that there is no significant difference in mean scores of critical thinking skills of secondary school students in Nagaland with respect to gender. The correlation between scientific attitude and critical thinking skills is 0.428. The coefficient of correlation is significant at the 0.01 level, indicating that developing a scientific attitude can enhance critical thinking skills**.** Ramya (2019) found that a positive and high correlation exists between the scientific attitude, critical thinking, and social skills of secondary school students, and the results supported this finding.

As far as management is concerned, private secondary school students tend to have a higher scientific attitude than their government secondary school counterparts, which is attributed to better infrastructure, well-trained and quality

teachers, and parental support. However, some components are lacking in government schools, resulting in significant differences in scientific attitude. Secondary school students in Nagaland demonstrated an average level of critical thinking, with 64.5% falling into this category. Hence, the examination pattern should include questions that enable learners to analyze the material critically rather than relying on rote memorization. Private secondary school students tend to excel in comprehension and language skills, which enables them to analyze situations more effectively than their government secondary school counterparts. However, many students in government schools are not provided with the basic needs, support, and exposure that students in private schools receive. Many students in government schools lack reading and writing skills, which are essential for developing critical thinking. Hence, to improve and develop critical thinking, we need to enhance our language and comprehension skills.

CONCLUSIONS

The study aimed to measure the level of scientific attitude and critical thinking skills among secondary school students and to identify any significant differences in their scientific attitude and critical thinking skills based on gender and management. The current study has some educational implications for the development of scientific attitudes and critical thinking among secondary school students. The current study should serve as a path to rethink our approaches to functioning in science education at the state level and identify the dimensions that are lacking in learners. How to develop the scientific attitude and critical thinking skills as in line with National Education Policy -2020 (Ministry of Education, 2020). Through this study, light is shed on the system and practices of science education, where it is failing to serve the extreme below-average level, and why a vast imbalance in the scientific attitude exists. Girls were observed to perform better than boys in terms of scientific attitude among secondary school students in Nagaland. This is also due to equal support and opportunity given to the girl child in Nagaland for pursuing studies.

Some topics for additional research are recommended based on the results of the current study and the issues that were overlooked. The current study is restricted to class IX secondary school students enrolled in the NBSE Board programs. Comparable research can also consider other boards that may be conducted at the elementary or upper-secondary level. The variables of management and gender were the only ones included in the study. Additional factors, such as socioeconomic level, location, and parents' educational backgrounds, may also be taken into consideration. A bigger sample size and instructors from primary, secondary, and higher education levels might be the subjects of the study. Additionally, research can be conducted to investigate the relationship between scientific achievement, scientific mindset, and critical thinking.

Every citizen must possess a scientific mindset and critical thinking abilities to preserve peace and harmony. To lead a balanced life, one must cultivate a scientific mindset and continually progress toward national unity and integration. Critical thinking abilities are essential for arriving at reasonable solutions to issues that will inevitably arise, whether they are personal or at the national or international level. It is necessary to eliminate superstitious beliefs and practices that have been passed down and to use reasonable analysis to reach any reasonable conclusion for the advancement of individuals, society, and the economy. Therefore, in order to cultivate a scientific attitude in students, we must create an engaging science curriculum. This includes more hands-on activities, project-based learning, classroom discussions, model exhibitions, science fairs, science museums, and field trips. All of these should be given equal weight in the curriculum, where students' engagement with the teaching and learning process will foster a scientific attitude.

To encourage pupils to think, analyze, and draw logical conclusions, class activities should allow for debates and brainstorming on challenging subjects. Instead of relying solely on rote memory, evaluations, and tests should incorporate application-based questions that require students to apply their knowledge and experience to arrive at rational answers.

The research was conducted explicitly on secondary schools in Nagaland and does not establish broader applicability across different districts or geographic areas. This research was limited to government and private high schools under the National Board of Secondary Education (NBSE). Furthermore, research can be conducted to investigate the correlation between achievements in Science, critical thinking, and a scientific attitude.

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REFERENCES

Ahuja, A. (2017). Study of Scientific Attitude in relation to Science Achievement Scores among Secondary School Students. *Educational Quest- An International Journal of Education and Applied Social Sciences*, *8*(1), 9–16. https://doi.org/10.5958/2230-7311.2017.00002.2

Budiharti, R., & Waras, N. S. (2018). Analysis of students' scientific attitude and behaviour change effects in blended learning supported by the I-spring Suite 8 application. *Journal of Physics: Conference Series*, *1022*(1), 1-10. https://doi.org/10.1088/1742-6596/1022/1/012024

Duran, M., & Dökme, I. (2016). The effect of the inquiry-based learning approach on student's critical-thinking skills. *Eurasia Journal of Mathematics Science and Technology Education*, *12*(12), 2887-2908 https://doi.org/10.12973/eurasia.2016.02311a

Harsharan Singh. (2018). *Superstitious Behavior and Scientific attitude among students of professional colleges in relation to their gender and locus of control.* (Publication No. 10603/300510) [Doctoral Dissertation, Desh Bhagat University]. Shodhganga.

Hassan, D., & Ratnakar, G. P. (2012). A Study of Relationship Between Environmental Awareness and Scientific Attitudes among Higher Secondary Students. *Indian Journal of Applied Research*, *1*(12), 57–61.

Kaur, G. (2013). Scientific Attitude in Relation to Critical Thinking Among Teachers. *Educationia Confab*, *2*(8), 24–29. Retrieved from https://www.scribd.com/doc/233850471/Kaur-Gurpreet-2013-Scientific-Attitude-in-Relation-to-Critical-Thinking-Among-Teachers-Educationia-Confab-Vol-2-No-8-August-2013

Khan, M., Abid Siddiqui, M., & Malone, K. L. (2022). Scientific attitudes: Gender differences, impact on Physics scores and choices to study Physics at higher levels among pre-college STEM students. *International Journal of Science Education*, *44*(11), 1816–1839. https://doi.org/10.1080/09500693.2022.2097331

McMahon, G. (2009). Critical Thinking and ICT Integration in a Western Australian Secondary School. *International Forum of Educational Technology & Society*, *12*(4), 269–281. https://doi.org/10.2307/jeductechsoci.12.4.269

Ministry of Education. (2020). *National Educational Policy 2020 (NEP, 2020)*. Retrieved July 21, 2024, from https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Misra, K., & Srivastava, S. (2016). Factors Affecting Scientific Attitude of IX Grade Students. *Indian Educational Review*, *54*(1), 24-34. Retrieved from http://14.139.250.109:8090/index.php/ier/article/view/2981

Mittal, R. (2017). *Junior college students' critical thinking skills and dispositions in relation to their goal orientation and learning strategies.* (Publication No. 10603/282955) [Doctoral Dissertation, University of Mumbai]. Shodhganga.

Murthy, C. G. V. (2014). *Manual for Critical Thinking Scale*. Agra: National Psychological Corporation.

Nehru, J. (1946). *The discovery of India*. The Signet Press.

Olasehinde, K. J., & Olatoye, R. A. (2014). Scientific attitude, attitude to science and science achievement of senior secondary school students in Katsina State, Nigeria. *Journal of Educational and Social Research*, *4*(1), 445-452. https://doi.org/10.5901/jesr.2014.v4n1p445

Pal, Y. (2005). National Curriculum Framework 2005. Retrieved from https://ncert.nic.in/pdf/nc-framework/nf2005-english.pdf

Ramya, M. R. (2019). *Effect of social constructivist strategies of teaching Science on scientific attitude critical thinking and social skills of secondary school students.* (Publication No. 10603/341581) [Doctoral Dissertation, University of Mysore]. Shodhganga.

Sherafat, R. (2016). *Effect of critical thinking study habits and self-esteem on academic achievement among secondary and senior secondary school students.* (Publication No. 10603/200826) [Doctoral Dissertation, University of Mysore]. Shodhganga.

Singh, V. P. (2014). A Study of Scientific Attitude among Learners in Botswana. *School Science a Quarterly Journal of Science Education*, *52*(4), 32–37.

Solihati, N., & Hikmat, A. (2018). Critical Thinking Tasks Manifested in Indonesian Language Textbooks for Senior Secondary Students. *SAGE Open*, *8*(3), 1-8. https://doi.org/10.1177/2158244018802164

Suastra, I. W., & Ristiati, N. P. (2019, June). Developing critical thinking, scientific attitude, and self-efficacy in students through project-based learning and authentic assessment in science teaching at junior high school. In Journal of Physics: Conference Series (Vol. 1233, No. 1, p. 012087). IOP Publishing.

Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(1), 61–76. https://doi.org/10.12973/ejmste/79329

Tous, M. D., & Haghighi, S. (2016). Developing Critical Thinking with Debate: Evidence from Iranian Male and Female Students Developing Critical Thinking with Debate. In *Haghighi. Informal Logic*, *36*(1), 64–82. https://doi.org/10.22329/il.v36i1.4357

Walsh, C., Lewandowski, H. J., & Holmes, N. G. (2022). Skills-focused lab instruction improves critical thinking skills and experimentation views for all students. *Physical Review Physics Education Research*, *18*(1), 1–18. https://doi.org/10.1103/PhysRevPhysEducRes.18.010128

World Health Organization. (1996). *Life Skills Education Planning for Research*. Retrieved from https://iris.who.int/bitstream/handle/10665/338491/MNH-PSF-96.2.Rev.1-eng.pdf

Yadav, M. K., & Singh, V. K. (2017). Scientific Attitude and Gender Differences in Biology. *School Science a Quarterly Journal of Science Education*, *55*(1), 19–25. Retrieved from https://ncert.nic.in/pdf/publication/journalsandperiodicals/schoolscience/School_Science-March2017.pdf

Zulirfan, I., Osman, K., & Salehudin, S. N. M. (2018). Take-home-experiment: Enhancing students' scientific attitude. *Journal of Baltic Science Education*, *17*(5), 828–837. Retrieved from https://oaji.net/articles/2017/987-1539418416.pdf

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