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An Empirical Analysis of Scientific Attitude among Undergraduate Students in Agricultural Sciences

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ABSTRACT

This study explored the determinants of scientific attitude among undergraduate agriculture students in Telangana State of India, analyzing their attitude levels and demographic influences. A sample of 250 B.Sc. Agriculture students from Professor Jayashankar Telangana Agricultural University was surveyed using random sampling. Factor analysis, normal probability curve, and inferential analysis revealed that most students exhibited a moderate scientific attitude, with significant differences based on gender, age, and parental occupation. Male students and those below 19 showed higher engagement, while students from government-employed families had the highest scores. Findings suggested the need for targeted educational strategies, including curiosity-driven learning, hands-on experiments, gender equity, early exposure, and infrastructure upgrades, to enhance scientific attitudes in agricultural education.

Keywords: *Scientific Attitude; Undergraduate; Agriculture Students; Factors; Telangana State*

INTRODUCTION

Modern science education is crucial for cultivating agriculture students as stewards of our food systems and natural resources. As the global population rises, sustainable agriculture must prioritize healthy soil management and nutrient research to ensure food security and environmental stability (Hajam et al, 2022). Some agricultural education programmes feature outdated curriculum that do not represent modern farming practices or the necessity of sustainable agriculture. Because of this discrepancy, graduates may not be well prepared for the changing terrain in agriculture (Rohilla et al, 2024). By integrating the latest research and technology, science education helps in adoption of evidence-based practices. The curriculum for agriculture students should be continuously updated to reflect new developments and to meet the developing needs of the field, ensuring that they are well-equipped to tackle contemporary challenges (Lengnick, 2022).

A scientific attitude is a multidimensional construct encompassing cognitive, affective, and skill-based traits, shaping how agriculture students engage with scientific inquiry and problem-solving. The cognitive dimension includes critical thinking, logical reasoning, and evidence-based decision-making (Lederman,

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2006). The affective component involves openness to new ideas, curiosity, and a willingness to revise beliefs based on empirical evidence (Osborne et al. 2003). Skill-based traits include the ability to apply scientific methods, conduct experiments, and interpret data correctly (Zimmerman, 2005). These dimensions together create a strong scientific mindset that is required for innovation and progress in agricultural sciences. Through the analysis of factors such as gender, age, and educational background, this study will help identify strategies for improving science education and preparing students for agricultural challenges. Fostering a strong scientific mindset can improve students' ability to adopt new technologies, driving efficiency and productivity.

This understanding allows instructors to refine curricula and bridge theoretic knowledge with practical application, ensuring future agricultural professionals are equipped to meet global demands and contribute to innovation and sustainability. A systematic analysis of scientific attitudes enables the development of empirically grounded educational frameworks that enhance cognitive flexibility, epistemic curiosity, and higher-order problem-solving abilities. Identifying key determinants informs targeted pedagogical strategies to develop analytical reasoning, evidence-based decision making, and adaptive problem-solving skills relevant for the advancement of scientific inquiry and innovation in agricultural sciences. Hence, the present study was taken up with the following objectives.

1. To identify the underlying factors encompassing undergraduate agriculture students' scientific attitude in Telangana State.
2. To assess the level of scientific attitude among undergraduate agriculture students in Telangana State.
3. To compare Scientific Attitude Scores of Agriculture Students based on gender, age, and parental occupation

METHODOLOGY

Survey research design was adopted in this study. The data were collected using a self-designed tool "Agriculture Students' Scientific Attitude Scale". The study targeted all undergraduate students enrolled in the B.Sc. Agriculture programme across Telangana State of India. From this population, a sample of 250 students from different colleges under the State Agricultural University was selected using random sampling techniques to ensure a representative sample of the population. The scale had a five-point Likert scale with 24 items from Strongly Agree to Strongly Disagree, positive statements received a score between 1 and 5, whereas negative ones received a score between 1 and 5.

Reliability test was applied to evaluate the reliability of the tool. Cronbach's alpha reliability coefficient was computed using SPSS 21 software. Cronbach's alpha of 0.72 showing a satisfactory level of internal consistency. Nunnally (1978) also recommended that an instrument used in a research need to have reliability of 0.70 and above, the reliability value of the present tool was higher than the minimum required to consider the measure as reliable. Content validity of the tool was established through a panel of judges. In order to extract and evaluate the underlying factors of scientific attitude, a statistical technique of exploratory factor analysis was applied, applications of normal probability were used to find the level of students' scientific attitude, and inferential analysis was used in this study to compare the respondents in their scientific attitude.

FINDINGS AND DISCUSSION

Identifying Underlying Factors Influencing Scientific Attitude

To identify the underlying factors of undergraduate agriculture students' scientific attitudes, factor analysis using principal component matrix with varimax rotation was applied. This method was used to ascertain the data's structure and identify the fundamental elements of the students' perceptions of a scientific mindset (Field, 2013). To evaluate the suitability for factor analysis, both Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (1970) were employed. The KMO value of 0.69 exceeded the recommended threshold of 0.685, indicating appropriateness for factor analysis, while Bartlett's Test produced a Chi-Square value of 804.95 at a 0.05 significance level, confirming significant correlations among the variables. This finding validates the use of factor analysis by demonstrating significant correlations among the variables. Eight key factors emerged after applying exploring factor analysis (Table 1).

Table 1. Factors, Eigen values, % of Variances, Indicators with Factor Loadings on Agriculture Students' Scientific Attitude.

Sl.No.	Factor Name	Eigen value	% of variance	Loading	Items Converged
1	Curiosity to know new knowledge	1.92	8.03	0.719 0.698 0.605	Solving the science problem. Science examination. Feeling of lessons burden
2	Belief in cause-effect relationship	1.80	7.48	0.777 0.593 0.476	Scientific inventions. Scientific discovery. Science & Society
3	Rational Thinking	1.78	7.48	0.604 0.577 0.545 0.534	Superstitious knowledge. Science exhibition and science fair. Scientific thinking Examples to rational thinking (0.534).
4	Participate in the multi-scholastic activity	1.76	7.33	0.653 0.623 0.507 0.405	Use of technology in the classroom. Scientific knowledge life. Views on Scientist. Science syllabus.
5	Open-mindedness	1.613	6.719	0.751 0.548 0.526	Phenomena around us. Explorations. Scientific experiments.
6	Suspended judgment	1.54	6.44	0.678 0.671 0.475	Science and Human enterprise. Objectivity. Questioning skills.

Sl.No.	Factor Name	Eigen value	% of variance	Loading	Items Converged
7	Critically aware of surroundings	1.43	5.99	0.728 0.655	Negative impact. Nation development.
8	Seeking cause and effect relationship	1.21	5.05	0.657 0.403	World activity and environment. Learning science.

The factor analysis result provides an understanding of what the important factors are in influencing scientific attitudes among agriculture students. The eight factors identified and the corresponding Eigenvalues and variances reveal how some aspects of the scientific attitude were perceived and accorded more emphasis by the students, which thus contributed to understand their overall scientific orientation. These findings are in line with the studies of LaxmiPrasanna et al. (2022) & Hernandez et al. (2021), which focused on the usage benefits and positive attitudes toward science. The identified factors are explained in detail below.

1. Curiosity to Know New Knowledge- This factor highlights students' struggles with the complexity of science, as indicated by items like "Solving the science problem is difficult for me." This suggests that many students perceive science as a challenging subject, potentially hindering their motivation and engagement. These eigenvalues show one value being important at 1.92 with a percentage variance of 8.03%. These findings support the difficulties which need to be addressed so as to establish an even better environment for students' learning. Poor confidence while trying to solve a problem develops fear and also diminishes their interest in science. Hence, interactive learning environment with applied activities and practical experiments can assist the students to come out from all these obstacles and develop more interest in science.

2. Belief in Cause-Effect Relationship- This variable highlight students' perception regarding the relationship of scientific concepts and development in society. Items such as "Scientific inventions and discoveries are good for society" reveals a positive attitude toward the contribution of science toward societal development. This factor, with an eigenvalue of 1.80 and a variance of 7.48, suggests educational strategies to enlighten students on scientific causality and correct misunderstandings about science, in effect making students appreciate the phenomena even better. Strengthening this belief with experiential learning, case studies, and discussions on real-world scientific breakthroughs can further deepen a student's understanding on the interface of science innovating the world and societal development.

3. Rational Thinking This factor reveals the sense of logical judgment that students carry in the task of analyzing scientific concepts logically and on the basis of reasoned judgement rather than instinct or assumptions. This underlines the systematic problem-solving approach and evidence-based conclusions. Items under this heading give prominence to challenging assumptions, critically evaluating data, and use of rational logic in scientific inference. Strong basis in rational thinking can help students develop more profound scientific principles and think analytically about complex problems. rational thinking emerged as a significant factor (Eigenvalue = 1.78, Variance Explained

= 7.48%) with key contributing items, including Superstitious Knowledge (0.604), Science Exhibition and Science Fair (0.577), Scientific Thinking (0.545), and Examples of Rational Thinking (0.534).

4. Participation in Multi-Scholastic Activities: This factor shows students' view of science as an organized body of knowledge and their involvement beyond the classroom. The items involved in this factor indicates a scientific approach to scientific knowledge and an interest in a scientific career. Involvement in various scholastic activities enables students to apply scientific concepts to everyday situations, thus enabling them to better understand the principles. This involvement also fosters collaboration, creativity, and problem-solving skills, preparing students for future scientific pursuits. In this study, Participation in Multi-Scholastic Activities emerged as a significant factor (Eigenvalue = 1.76, Variance Explained = 7.33%) with key contributing items, including Use of Technology in the Classroom (0.653), Scientific Knowledge in Life (0.623), Views on Scientists (0.507), and Science Syllabus (0.405).

5. Open-Mindedness - Open-minded students are those who are receptive to new ideas, think diversely, and change their ideas based on evidence. Open-minded students are more receptive to scientific discoveries as well as alternative theories and innovations that support ideas that question established knowledge. This feature for the first time underlines the characteristic of intellectual flexibility, unbiased discussions, and objective evaluation of information toward scientific inquiry and progress. Encouraging students to hold debates, collaborative research, and interdisciplinary learning may develop the mindset that is very adaptive and exploratory. In this study, Open-Mindedness came up as the most important factor (Eigenvalue = 1.613, Variance Explained = 6.719%) with significant contributing items in the form of Phenomena Around Us (0.751), Explorations (0.548), and Scientific Experiments (0.526).

6. Suspended judgment- Suspended judgment refers to students' ability to withhold immediate conclusions until sufficient evidence is available, promoting critical evaluation, logical reasoning, and the avoidance of hasty generalizations in scientific thinking. Students who demonstrate this trait actively question assumptions, seek reliable data, and consider multiple viewpoints before forming an opinion. This factor highlights the need for patience and analytical skills, which ensures that scientific beliefs are empirically based rather than intuitive or based on preconceived notions. Encouraging research-based learning and inquiry-driven discussions can further enhance this attribute. In this study, Suspended Judgment was the key factor (Eigenvalue = 1.54, Variance Explained = 6.44%) with significant contributing items such as Science and Human Enterprise (0.678), Objectivity (0.671), and Questioning Skills (0.475).

7. Critical Awareness of Surroundings- Critical awareness of surroundings reflects students' ability to examine and question scientific advancements in their environment. It signifies active engagement in understanding the societal impact of scientific developments and fosters a mindset that encourages staying informed about emerging technologies and discoveries. A high level of critical awareness enables students to differentiate between authentic scientific information and misleading claims, cultivating a more analytical and discerning approach to knowledge. This aspect also focuses on curiosity and skepticism, highlighting the aspect of continuous learning and evidence-based reasoning when conducting scientific investigation. Critical Awareness of

Surroundings was found to be the most salient factor in this study (Eigenvalue = 1.43, Variance Explained = 5.99%) with high contributing items, such as Negative Impact at 0.728 and Nation Development at 0.655.

8. Seeking Cause and Effect Relationship- This factor highlights students' intrinsic motivation to understand the logic behind scientific phenomena by exploring cause-and-effect relationships. It reflects a natural tendency to question why and how things happen, fostering a deeper engagement with scientific inquiry. A strong inclination toward seeking cause-and-effect relationships enhances problem-solving skills, analytical thinking, and scientific reasoning. The findings indicate that students with higher scientific attitudes actively connect theoretical knowledge with practical applications, reinforcing their curiosity, rational thinking, and participation in scientific activities. In this study, Seeking Cause and Effect Relationship emerged as a key factor (Eigenvalue = 1.21, Variance Explained = 5.05%) with significant contributing items, including World Activity and Environment (0.657) and Learning Science (0.403).

Assessing Scientific Attitude Levels of Undergraduate Agriculture Students

The normal probability curve is a statistical tool used to analyze and interpret how data points are distributed in a population. Its application in this research when assessing the levels of scientific attitude among undergraduate agriculture students is appropriately reasonable since the clarity with which it demonstrates the distribution of attitudes relating to the mean is positively effective. The SD is 8.77 and the average score is 89.68. With such figures, the NPC provides an exhaustive overview of how scientific attitude scores vary. Researchers plot these scores on a normal distribution curve and determine the proportion of students falling under various categories, such as High Level (Mean + SD to Maximum Score), Moderate Level (Scores in between Mean-SD to Mean +SD), and Low Level (Minimum score to Mean –SD) scientific attitudes (Table 2).

Table 2: Level of Scientific Attitude among Undergraduate Agriculture students

Sl. No.	Level of Scientific Attitude	Frequency	Percentage
1.	High level	33	13.20
2.	Moderate level	165	66.00
3.	Low level	52	20.80

Table 2 depicts the distribution of scientific attitudes among undergraduate agriculture students, revealing that 66.00% (165 students) exhibit a moderate scientific attitude, 13.20% (33 students) demonstrate a high level, and 20.80% (52 students) show a low-level scientific attitude. This distribution indicates that the majority of students possess a moderate level of scientific engagement, with fewer students reaching the high levels of scientific curiosity and critical thinking. The results suggest that while many students engage with scientific concepts to a moderate extent, there is considerable scope for enhancing their scientific attitudes. The lower percentage of students demonstrating high levels of scientific attitude highlights the necessity for educational strategies aimed at nurturing deeper scientific curiosity and critical analysis. This scenario indicates that although students are somewhat engaged, further efforts are required to elevate their attitudes to a higher level. The results are supported by Ahire et al. (2024). But, LaxmiPrasanna et al. (2022) reported high levels of scientific attitude among the students.

Comparing Scientific Attitude Scores of Agriculture Students based On Gender, Age, and Parental Occupation

The hypothesis that "there are no significant differences in the scientific attitudes of agriculture students based on gender, age, or parents' occupation" was statistically tested using t-test and one-way Analysis of Variance (ANOVA) to evaluate the influence of demographic factors. The t-test assessed gender disparities in scientific attitudes, while ANOVA examined differences related to parents' occupation and age (Table 3).

Table 3: Comparison of Scientific Attitudes Scores with respect to Agriculture students' Gender, Age and Parental occupation

Sl.No.	Variable	Groups	N	Mean Value	Standard Deviation (SD) Value	t-value/ F-value	p-value
1	Gender	1. Male	165	90.87	9.42	11.05	0.0001
		2. Female	85	75.24	12.56		
2	Age	1. Below& 19 Yrs	115	90.53	5.67	60.345	0.001
		2. Age 20 Yrs	105	85.22	8.34		
		3. Above 20 Yrs	30	74.34	8.89		
3	Parental Occupation	1. Govt.	30	90.85	9.32	19.08	0.000
		2. Private	95	83.45	8.56		
		3. Others	125	90.59	9.12		

The study's findings, which are shown in Table 3, show that male and female students scored significantly differently on the scientific attitude scale. With a t-value of 11.05 and a p-value of 0.0001, male students (M = 90.87, SD = 9.42) showed more scientific attitudes than female students (M = 75.24, SD = 12.56). This shows that attitudes regarding science are significantly influenced by gender, with male students showing more favorable attitudes toward science. The one-way ANOVA results based on different age groups show significant differences in their scientific attitude scores. Students below 19 years (M = 90.53, SD = 5.67) had the highest scores, followed by those aged 20 years (M = 85.22, SD = 8.34), and those above 20 years (M = 74.34, SD = 8.89). Based on the p-value of 0.001 and the F-value of 60.345, age significantly influences attitudes toward science, with younger students exhibiting more favorable attitudes compared to their older counterparts. The ANOVA results from the same table-3 also reveal significant differences in scientific attitudes based on parents' occupation. Students with government-employed parents (M = 90.85, SD = 9.32) and those with parents in other occupations (M = 90.59, SD = 9.12) scored higher in scientific attitudes compared to those with parents in private sector jobs (M = 83.45, SD = 8.56). Students' attitudes toward science are highly influenced by their parents' occupation, as indicated by the F-value of 19.08 and p-value of 0.000, with those from government and other occupations showing more positive attitudes.

Comparative analysis with previous studies reveals consistent trends. Similar findings were reported by Hernández et al. (2021). Susilawati et al. (2022) found females showed more positive scientific attitude than male students'. LaxmiPrasanna et al. (2022) found that students' age was not notably affecting their attitudes. Nayak (2015) study revealed gender does not play a crucial role in shaping these attitudes.

CONCLUSION

The study had identified eight key factors shaping students' scientific attitudes: Curiosity for New Knowledge, Belief in Cause-Effect Relationships, Rational Thinking, Participation in Multi-Scholastic Activities, Open-Mindedness, Critical Awareness of Surroundings, Seeking Cause-Effect Relationships, and Positive Predisposition towards Science. These findings provide valuable insights into the cognitive and behavioral aspects influencing scientific attitudes among undergraduate agriculture students.

The study found that most students exhibit a moderate level of scientific engagement, with fewer demonstrating high scientific curiosity and critical thinking. Three variables of Gender, Age, and Parental Occupation were considered, and difference between the samples on the basis of these variables were observed. It has been found that Male students exhibited significantly higher scientific attitudes than female students. Younger students, particularly those below 19 years, showed stronger scientific engagement, with attitudes declining with age. Parental occupation also influenced attitudes, with students from government-employed families displaying the highest scores.

Educational institutions should focus on creating and maintaining classroom environments that actively stimulate curiosity and encourage questioning. To reinforce students' belief in cause-effect relationships, educators should integrate evidence-based methods into their teaching practices. This can be achieved by using real-world examples, conducting hands-on experiments, and facilitating debates that require students to apply scientific reasoning. Institutions must implement strategies to promote gender equity in science education. By providing equal access to resources and opportunities, educational institutions can help bridge the gender gap in science education. To leverage the higher scientific attitudes observed in younger students, educational programs should incorporate early exposure to scientific concepts and activities. Institutions should encourage parental involvement by providing resources and guidance on how to support scientific learning at home. Upgrading infrastructure and resources will help in encouraging critical thinking and scientific attitudes among agriculture students for their academic and career success.

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