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Relational Study Between Critical Thinking Ability And Achievement In Biological Science Of Ix Standard Students

JAGADEESHA M
Research Scholar, R.V. Teachers College (IASE), Research Centre in Education, Bengaluru City University, Bengaluru 560 011.

and

Dr. P.B. KAVYAKISHORE
Research Guide and Faculty of Education, R.V. Teachers College (IASE), Research Centre in Education, Bengaluru City University, Bengaluru 560 011.

ABSTRACT

The current study sought to look into the relationship of critical thinking abilities with achievement in biological science among IX standard students. It also aimed to compare achievement results across gender and school management type, including government, private aided as well as private unaided schools. The study employed a descriptive survey type. Simple random sampling was used to choose 198 IX standard pupils from schools in Bengaluru, Karnataka that followed the Karnataka State Syllabus. Data collection tools included the 'Critical Thinking Test in Biological Science' (CTT-BS) designed by Dr. P.B. Kavyakishore and a self-constructed 'Achievement Test in Biological Science' (ATBS) developed by the examiner and guide and the researcher collected the data personally and evaluated it using Pearson's correlation and independent samples 't' test in SPSS and MS Excel. The study finds that critical thinking ability is a significant relationship with achievement in biological science among IX standard students. It concludes that developing critical thinking and problem-solving skills improves students' understanding and performance in science related topics. Furthermore, the lack of significant gender inequalities demonstrates a progressive shift toward gender equality in secondary school science education. However, the higher performance of government school students compared to private school students is significant, implying that factors such as curriculum focus, teacher motivation and possibly teaching techniques may vary among school type, influencing learning results. The study emphasizes the need of developing critical thinking abilities in order to improve students' academic performance in scientific classes.

Keywords: Critical Thinking Ability, Achievement.

1. INTRODUCTION

Fostering critical thinking among school children has become an important goal in today's educational environment. "Critical thinking is the aptitude to examine, evaluate as well as synthesize information in a rational and reasoned way, which is necessary for problem solving and making informed decisions" (Paul & Elder, 2006).

Critical thinking in science education helps students approach problems with curiosity, assess ideas, interpret data and comprehend complicated biological processes. In India, NEP (National Education Policy) - 2020 highlights the significance of developing higher-order cognitive skills in pupils, such as analysis, evaluation and reasoning, rather than rote memorization. Science topics, particularly biology, provide numerous possibilities for students to develop and apply their talents in real-world situations. However, traditional methods of science instruction in many Indian schools frequently hinder students' engagement and critical thinking (NCERT, 2012).

Several studies have demonstrated a link between cognitive skills and academic achievement in science. For example, Anitha and Jayapragash (2015) discovered a substantial link amid critical thinking skills with science achievement of school childrens in Tamil Nadu. Sharma and Kumar (2018) discovered that students with stronger critical thinking skills had better conceptual understanding and academic performance in biology.

Despite the widely acknowledged relevance of critical thinking in science education, there is still a gap in the integration of these abilities into classroom instruction and evaluation, notably in the Indian educational system. This gap needs empirical research into how critical thinking skills affect academic accomplishment in specific topics such as biological science, particularly at the secondary school level.

2. NEED FOR THE STUDY

Secondary school biology education is essential for students who want to work in the biological sciences, medicine, environmental science and health-related industries. In this setting, strengthening critical thinking skills is vital for increasing scientific literacy and problem-solving abilities. However, there is little research in the Indian educational context that investigates the connection of critical thinking with subject-specific educational accomplishment.

In Karnataka, biological science is mostly taught at the IX standard level using a content-heavy curriculum that is frequently assessed through knowledge-based examinations. This approach may not accurately reflect students' cognitive involvement, particularly their ability to think critically (Kumar & Rani, 2017). Understanding if students' critical thinking skills contain a measurable contact on their academic success in biology can provide valuable information to curriculum architects, teacher educators and legislators.

Furthermore, the performance disparity between pupils in various school management types namely government, private aided as well as private unaided--raises concerns about the quality and equity of science education. Gender inequalities in scholastic accomplishment in science disciplines have also been a source of concern and must be examined within the larger context of cognitive development and abilities in critical thinking skills.

Consequently, this examination is timely and necessary to investigate the relationship between critical thinking capacity and accomplishment in biological science among IX standard students. The findings will aid in the development of instructional strategies that not only boost achievement but also

foster important cognitive capabilities, in line with the NEP 2020 goals and worldwide 21st-century education trends.

3. REVIEW OF RELATED LITERATURE

Critical thinking is a significant 21st-century talent that helps students analyze, evaluate and synthesize information for problem solving as well as decision making. In the context of science education, particularly in biological science, critical thinking increases students' grasp of complicated concepts and academic success. As students go through secondary school, particularly at the IX standard level, it becomes increasingly vital to cultivate their critical thinking skills in order to facilitate meaningful learning in courses such as biology. Many scholars have investigated the relationship between critical thinking and academic accomplishment, laying a solid framework for the current study.

Guamanga et al. (2024) investigated the influences critical thinking with psychological well-being of students on their academic achievement among 128 first year psychology students at a Spanish institution. The PENCRISAL test assessed critical thinking, whereas Ryff's Psychological Well-Being Scale assessed well-being. The marks students received in a critical thinking course affected their academic progress. The study discovered a high positive relationship among critical thinking and academic success, which were stronger than the correlation between psychological well-being and performance. This emphasizes critical thinking as an imperative cognitive capacity for academic success.

Bea Hana Siswati and Suratno (2023) used the case approach to investigate the role of cognitive capacity with critical thinking in the problem-solving abilities of students of biology education profession. For these 127 students participated. Using SPSS for regression analysis, the researchers discovered a substantial link between cognitive abilities, critical thinking skills as well as problem-solving competence. Cognitive ability contributed 68.4% of problem-solving skills, while critical thinking contributed 26.4%, for a total of 94.8%. This highlights the efficiency of the case method in enhancing critical thinking and cognitive functions in biology students.

Nasution et al. (2023) sought to determine how critical and creative thinking skills link to biology learning attainment among 85 senior high school and 90 students of university level in Indonesia. Regression research demonstrated a favorable relationship between critical thinking, creative thinking skills and biology achievement across genders along with educational levels. The findings indicated that both cognitive components had major impact on academic achievement in biology and should be included in curriculum planning and instructional strategies.

Zulfqar and Hayat (2023) examined the association with critical thinking skills and academic achievement at Pakistani higher education using quantitative and qualitative methods. A critical thinking abilities test was administered to 800 pupils and academic achievement was quantified using a CGPA. A simple linear regression revealed no important association amid critical thinking and academic achievement. In contrast, teacher interviews revealed moderate judgments of students' critical thinking abilities, implying that pedagogical techniques may not adequately develop these capabilities.

Research Gap: The studies listed above suggest that critical thinking is vital for students' academic progress, especially in science-related courses like biology. While the majority of these researches focus on senior secondary or university students, there is a significant vacuum in understanding how this link works among IX standard students in biological science. The present investigation looks for to fill this gap by examining how critical thinking capacity relates to biology accomplishment at the IX standard level, so bringing valuable knowledge into early secondary education and shaping future classroom practices for basic scientific learning.

4. STATEMENT OF THE PROBLEM

The research problem identified for the present investigation is: ***"Relational Study Between critical thinking ability and achievement in biological science of IX standard Students."***

5. OBJECTIVES OF THE STUDY

The following are the objectives for the study

1. To explore the relationship between critical thinking ability and achievement in biological science.
2. To compare the achievement in biological science between IX standard boys and girls.
3. To compare the achievement in biological science of IX standard students studying in government and private aided schools.
4. To evaluate the achievement in biological science of IX standard students studying in private aided and private unaided schools.
5. To contrast the achievement in biological science of IX standard students studying in government and private unaided schools.

6. RESEARCH HYPOTHESES

Null hypotheses were formulated for the present investigation:

1. There is no significant relationship between critical thinking ability and achievement in biological science of IX standard students.
2. There is no significant difference in the achievement in biological science between IX standard boys and girls.
3. There is no significant difference in the achievement in biological science of IX standard students studying in government and private aided schools.
4. There is no significant difference in the achievement in biological science of IX standard students studying in private aided and private unaided schools.
5. There is no significant difference in the achievement in biological science of IX standard students studying in government and private unaided schools.

7. METHODOLOGY

This investigation adopted a descriptive survey process to examine the relationship between critical thinking ability and academic achievement in biological science among IX standard students. This method was considered appropriate for the study as it helps in collecting detailed information from a representative sample of the population to understand existing conditions and relationships among variables.

The study's population consisted of IX standard students studying in government, private aided and private unaided schools located in Bengaluru, Karnataka, affiliated with the Karnataka State Board syllabus and from this population, sample of 198 students were selected using the simple random sampling technique, ensuring fair representation of boys and girls as well as various school management types. Care was taken to include a balanced number of students from each category to facilitate comparative analysis.

For the reason of data collection, three research tools were employed. First, the Critical Thinking Test in Biological Science (CTT-BS) developed by Dr. P.B. Kavyakishore (2010) was used to assess the students' ability to analyze and evaluate biological concepts and problems critically. Second, a self-constructed Achievement Test in Biological Science (ATBS), developed by Jagadeesha M. under the guidance of Dr. P.B. Kavyakishore, was used to evaluate the academic performance of students in biological science based on the IX standard syllabus. Third, a personal information proforma was used to collect demographic and background data namely name, gender and type of school management.

The researcher visited personally the elected schools and also administered the tests under standard classroom circumstances, ensuring a uniform testing environment. Instructions were given clearly to the students and they were encouraged to respond to the items sincerely and independently. The administration of tests was completed in one sitting for each school, maintaining confidentiality and standardization.

After collecting the data, it was statistically analyzed using SPSS and MS Excel software packages. The Pearson correlation coefficient (r-test) was applied to determine the strength and direction of the relationship between critical thinking ability and achievement in biological science. Further, the independent samples t-test was employed to contrast the mean achievement scores of students across gender and different types of school management. The level of significance was set at 0.05 level and 0.01 level, ensuring the reliability of the results and the validity of interpretations.

8. ANALYSIS AND INTERPRETATION OF DATA

The collected data was systematically analyzed using appropriate statistical techniques to observe the relationship between critical thinking ability and achievement in biological science and to determine the differentiation in achievement based on gender as well as type of management. The Pearson correlation coefficient (r-test) was employed to study the relationship between the variables, while the independent samples 't' - test was utilized to contrast the mean achievement scores of different groups and

the significance level was fixed at 0.01 and 0.05 levels for testing the hypotheses. The results and their interpretations are presented below:

Table-1: Correlation results on achievement in biological science and critical thinking ability.

Variable	N	df (N-2)	'r' value	Sig. Level
Dependent Variable: Achievement in Biological Science	198	196	0.249	**
Independent Variable: Critical Thinking Ability				

**Significant at 0.01 level (0.181).

The said table-1 shows the correlation results between critical thinking ability and achievement in biological science among IX standard students. The computed 'r' value is 0.249 with 198 students, which is found to be significant at the 0.01 level (critical value = 0.181 for df 196). This indicates positive and statistically significant relationship between the said two variables. This result implies that students who exhibit higher levels of critical thinking ability tend to perform better in biological science. The finding sustains the idea that critical thinking is a necessary cognitive ability that enhances scientific understanding and academic success. This is consistent with prior research which suggests that critical thinking fosters better conceptual clarity and application of knowledge in science learning contexts (Kaur, 2016; NCERT, 2020).

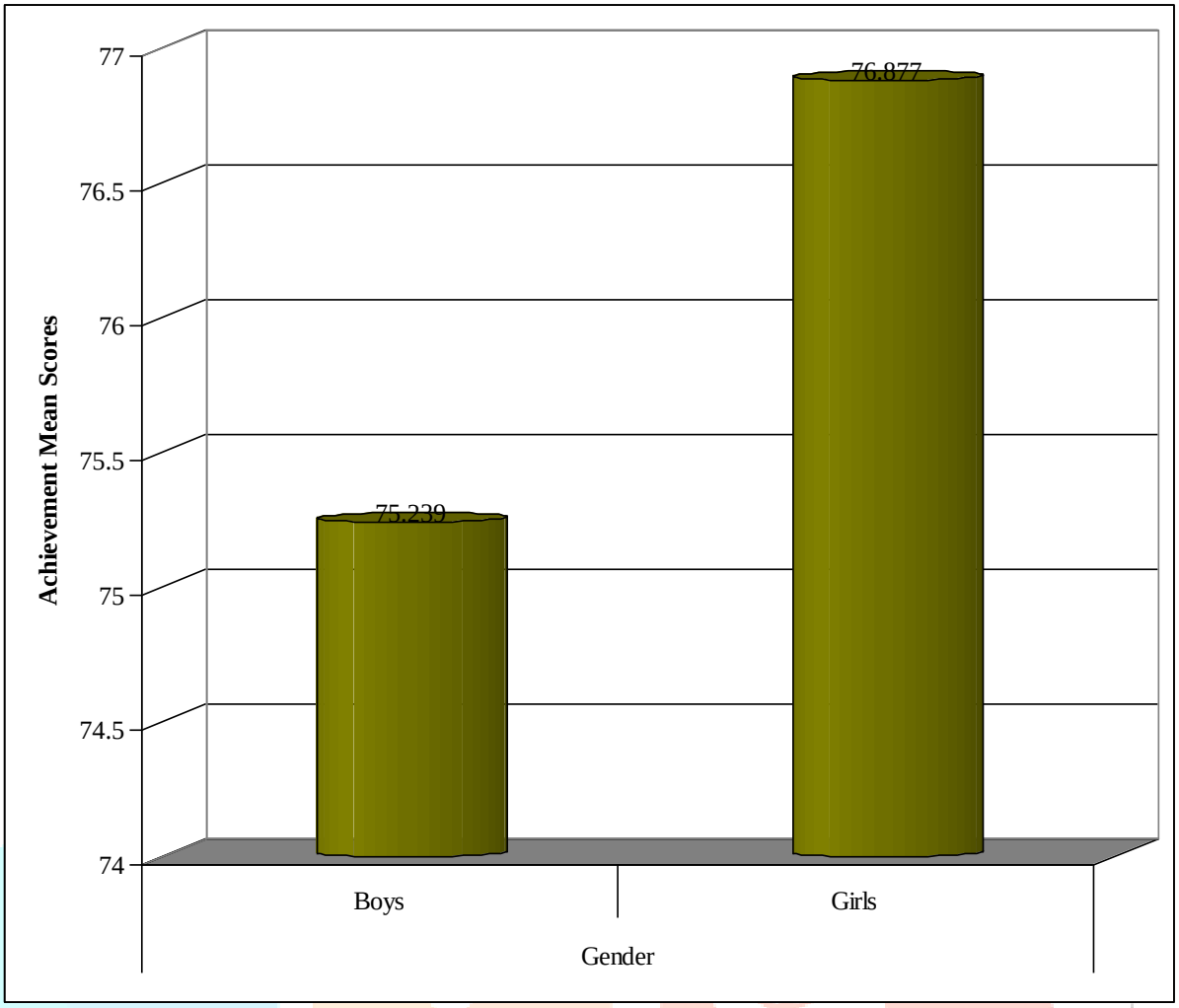
Table-2: Independent samples 't' test results pertaining to achievement scores in Biological Sciences of IX standard boys and girls.

Variable	Group	N	Mean	Std. Dev.	't' Value	Sig. level
Gender	Boys	92	75.239	7.849	1.35	NS
	Girls	106	76.877	9.184		

NSNot Significant ('t' Table Value for df=196 is 1.97).

Table 2 presents the results of an independent samples t-test conducted to compare the achievement scores in biological science between 92 boys and 106 girls; and mean score of boys is 75.239 with a standard deviation 7.849, while, the mean score of girls is 76.877 with a standard deviation of 9.184 and the obtained t-value is 1.35, which is not significant at the 0.05 level ('t' critical value = 1.97).

This result confirms that there is no significant difference in the achievement in biological science between boys and girls, even though the mean score of girls is somewhat higher than that of boys, the distinction is not statistically meaningful. This confirms that gender does not play a considerable role in determining performance in biological science at the IX standard level. Similar findings were reported in studies conducted by Shukla & Rani (2017) and Sharma (2019), which shows that gender-based academic disparities are narrowing in science education.



Graph-1: Comparison of achievement scores in biological science between IX standard boys and girls.

Table-2: Independent samples 't' test results pertaining to achievement scores in Biological Sciences of IX standard students studying in government, private aided and private unaided Schools.

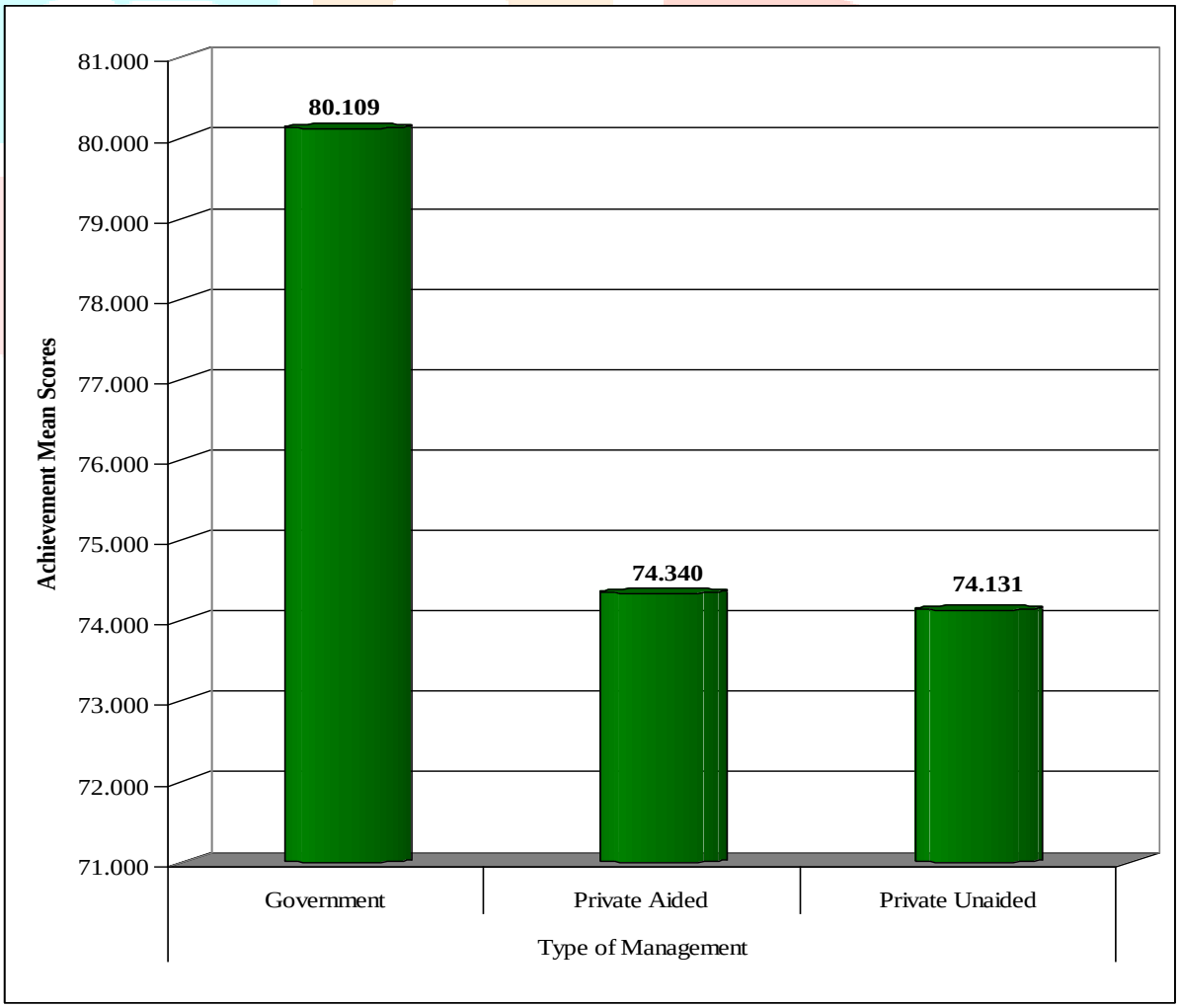
Variable	Group	N	Mean	Std. Dev.	't' Value	Sig. level
Type of Management	Government	64	80.109	2.732	5.09	**
	Private Aided	50	74.340	7.630		
	Private Aided	50	74.340	7.630	0.13	NS
	Private Unaided	84	74.131	10.845		
	Government	64	80.109	2.732	4.85	**
	Private Unaided	84	74.131	10.845		

^{NS}Not Significant; *Significant at 0.05 level; ('t' Table Value for df=132 is 1.97). ^{NS}Not Significant **Significant at 0.01 level; ('t' Table Value for df=112, 146 is 2.62 and 2.61 respectively).

The said table-2 summarizes the consequences of multiple independent samples t-tests examined to evaluate the achievement scores in biological science among students from different school management types (government, private aided private unaided institutions).

- The comparison between government and private aided school students shows a 't'-value of 5.09, which is significant at the 0.01 level and the mean score of government school students is 80.109, while that of private aided students is 74.340. This confirms that students from government schools significantly outperform their private aided counterparts in biological science.
- The comparison between private aided as well as private unaided school students yield 't'-value of 0.13, which is not significant, indicating no significant difference in their achievement scores. Both groups scored around similar marks range that is 74.00, suggesting similar academic performance levels.
- The comparison between government as well as private unaided school students reveals a 't'-value of 4.85, which is also significant at the 0.01 level and again, students from government schools scored higher (mean = 80.109) than those from private unaided schools (mean = 74.131).

These results confirm that, government school students in the sample have outperformed students than private schools in biological science. This could be attributed to better implementation of state syllabus content, teacher engagement or access to structured science learning programmes in government schools (Rao, 2021; NIEPA, 2022).



Graph 2: Comparison of Achievement scores in Biological Science of IX standard students studying in government, private aided and private unaided schools.

9. FINDINGS OF THE STUDY

This research was examined to explore the relationship of critical thinking ability with achievement in biological science among IX standard students, along with differences in achievement based on gender and management type and the findings derived from the analysis are as under:

1. There was a positive and significant correlation of critical thinking ability with achievement in biological science and this implies that students who had higher critical thinking skills tend to achieve better performance in biological science.
2. There was no significant difference in the achievement scores between boys and girls in biological science, although girls had a slightly upper mean score, the difference was not statistically significant, showing gender similarity in science achievement.
3. Significant differences were got in achievement scores related to type of school management and students from government schools scored significantly higher in biological science compared to students from both private aided as well as private unaided schools.
4. There was no significant difference between the achievement scores of students from private aided and private unaided schools.

10. CONCLUSION

The study confirms so as to critical thinking ability is a vital determinant of achievement in biological science of IX standard students and it strengthens the idea that fostering analytical thinking as well as problem-solving significantly enhances students' understanding and performance in science subjects. Furthermore, the absence of significant gender-based differences highlights the progressive move towards gender equality in science education at the secondary education level. Therefore, the better performance of government school students over private school students is significant and suggests that factors such as curriculum focus, teacher motivation along with possibly teaching methodologies differs across school types, impacting learning results.

11. EDUCATIONAL IMPLICATIONS

The resulst of this study carry numerous significant implications for teachers, curriculum developers and policymakers:

1. Integration of critical thinking exercises into the biology curriculum helps improve students' comprehension as well as application of scientific concepts. Activities namely case-based learning, inquiry-based experiments and open-ended questions should be encouraged.
2. Since, there is no significant gender differences were seen, equal learning opportunities and encouragement continued for both boys and girls without bias in science classroom learning.
3. The unexpected performance benefit of government school students suggests that government initiatives, teacher training programmes or curricular emphasis may yield positive outcomes and that practices should be identified, documented and shared across the schools.

4. Professional development for teachers across all said school management should include training in fostering critical thinking skills and effective pedagogical approaches to support all learners.

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