Bulletin of Nexus
Multidisciplinary International Research Journal, Double-Blind Peer Reviewed, Open Access Journal
ISSN : 3065-7865 / Volume-3, Issue-1 ,January 2026

Original Article

A Study on the Interplay of Cognitive Problem-Solving and Scientific Creativity in Secondary Education

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Manuscript ID: BN-2026-030103

ISSN: 3065-7865

Volume 3

Issue 1

January 2026

Pp. 11-20

Submitted: 10 Dec 2025

Revised: 20 Dec 2025

Accepted: 09 Jan 2026

Published: 31 Jan 2026

DOI: 10.5281/zenodo.18334166
DOI link: https://doi.org/10.5281/zenodo.18334166

Abstract

In the contemporary discourse of educational psychology and pedagogical reform, the relationship between convergent cognitive processing manifested as problem-solving ability and divergent cognitive processing manifested as scientific creativity remains a subject of intense theoretical debate and practical significance. This research report presents a comprehensive, empirical investigation into this interplay within the specific socio-demographic and educational landscape of Bilaspur, Chhattisgarh. Against the backdrop of a transitioning educational system that includes tribal welfare initiatives like Prayas Residential Schools, the proliferation of Central Board of Secondary Education (CBSE) curricula, and the nascent integration of innovation workspaces such as Atal Tinkering Labs, this study seeks to decouple and analyze the cognitive mechanisms defining adolescent scientific engagement. Utilizing the Majumdar Scientific Creativity Test (MSCT) and L.N. Dubey's Problem-Solving Ability Test (PSAT), the research evaluates a stratified sample of 100 secondary school students across the administrative blocks of Belha, Kota, Masturi, and Takhatpur. The findings elucidate a complex, non-linear relationship where high problem-solving efficacy serves as a necessary threshold but not a sufficient condition for scientific creativity, heavily mediated by variables of instructional medium, gender parity, and institutional infrastructure. The report concludes with a strategic framework for harmonizing these cognitive domains to foster a generation of innovators capable of navigating the knowledge economy.

Keywords: Cognitive Problem-Solving, Scientific Creativity, Secondary Education, Bilaspur (Chhattisgarh), Atal Tinkering Labs (ATL), Prayas Residential Schools, Convergent-Divergent Thinking, Gender Parity.

Introduction

The Global and National Educational Paradigm

The architecture of secondary education in the twenty-first century is undergoing a seismic shift, moving away from the industrial-era model of information retention towards a knowledge-economy model predicated on cognitive flexibility and innovation. In this evolving landscape, the twin pillars of **Cognitive Problem-Solving** and **Scientific Creativity** have emerged as the defining competencies for student success. The ability to solve well-structured problems—those with clear initial states and defined goal states—has long been the benchmark of academic achievement, particularly in the science, technology, engineering, and mathematics (STEM) disciplines. However, the complex, ill-defined challenges of the modern world, ranging from climate mitigation to epidemiological crisis management, require more than just algorithmic precision; they demand the generative, associative, and transformative capacities of scientific creativity (Ghorai, 2025).

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How to cite this article:
Singh, R. K., Chakravarti, A. R. P., Mishra, S., & Mishra, M. (2026). A Study on the Interplay of Cognitive Problem-Solving and Scientific Creativity in Secondary Education. Bulletion of Nexus, 3(1), 11–20. https://doi.org/10.5281/zenodo.18334166

Quick Response Code:
Website: https://bnir.us

In the Indian context, this dichotomy presents a unique challenge. The educational ecosystem is historically characterized by a rigorous emphasis on convergent thinking, driven by high-stakes entrance examinations for engineering and medicine. This system rewards speed, accuracy, and the application of learned heuristics—hallmarks of classical problem-solving. Yet, policy frameworks like the National Education Policy (NEP) 2020 and initiatives such as the Atal Innovation Mission are explicitly pivoting towards fostering "neoteric innovators," emphasizing design thinking and creative problem-solving (Athena Infonomics, 2023). The tension between these systemic realities—the examination-driven pressure for convergence and the policy-driven aspiration for divergence—forms the crucial backdrop for this study.

The Geo-Educational Context of Bilaspur, Chhattisgarh

To understand the interplay of these cognitive variables, one must situate them within a specific locus. Bilaspur district in Chhattisgarh offers a compelling case study of an educational system in transition. As a major administrative and educational hub, Bilaspur represents the confluence of urban aspiration and rural reality. The district is home to a robust network of educational institutions, ranging from elite private schools affiliated with the CBSE to government-managed schools under the Chhattisgarh Board of Secondary Education (CGBSE), and specialized tribal welfare institutions (District Administration Bilaspur, 2025).

The demographic texture of Bilaspur is heavily influenced by its tribal population, necessitating unique educational interventions. The *Prayas Residential Schools*, initiated by the Tribal Welfare Department, represent a targeted effort to provide high-quality secondary education and competitive exam coaching to students from Left Wing Extremism (LWE) affected areas and tribal communities (Tribal and Scheduled Castes Development Department). These schools are intense crucibles of problem-solving training. Simultaneously, the introduction of *Atal Tinkering Labs* (ATLs) in selected schools across the district aims to inject a culture of "tinkering," experimentation, and creativity into the curriculum (Education21).

This study posits that the unique interplay of these diverse educational environments—the rigorous coaching of Prayas, the experiential learning of ATLs, and the traditional pedagogy of state board schools—creates a natural laboratory for observing how problem-solving ability and scientific creativity interact, develop, or inhibit one another among adolescents.

Statement of the Problem

While global literature abounds with studies linking intelligence to creativity, there is a distinct paucity of research examining the specific relationship between *scientific* creativity and *cognitive* problem-solving within the context of semi-urban and tribal India. Most existing models are derived from Western populations or Indian metropolitan centers, leaving a gap in understanding how these constructs manifest in districts like Bilaspur.

Specifically, it remains unclear whether the intense focus on analytical problem-solving in Chhattisgarh's competitive academic culture acts as a catalyst for scientific creativity (by providing the necessary knowledge base) or as an inhibitor (by entrenching rigid thinking patterns). Furthermore, the role of mediating variables such as the medium of instruction (Hindi vs. English), the type of school management (Tribal/Government vs. Private), and gender in this specific socio-cultural milieu requires rigorous empirical examination.

Therefore, the present study is designed to answer the following research question: *What is the nature and extent of the relationship between Cognitive Problem-Solving Ability and Scientific Creativity among secondary school students in Bilaspur, Chhattisgarh, and how do demographic and institutional factors modulate this relationship?*

Objectives of the Study

The study is guided by the following comprehensive objectives:

1. **Assessment of Status:** To measure the prevailing levels of Scientific Creativity (across dimensions of Fluency, Flexibility, and Originality) and Cognitive Problem-Solving Ability among secondary school students in Bilaspur.
2. **Correlational Analysis:** To determine the statistical relationship between Problem-Solving Ability and the total Scientific Creativity score, as well as its individual dimensions.
3. **Comparative Analysis by Gender:** To investigate significant differences, if any, between male and female students regarding their problem-solving and creative capabilities, in light of recent trends in gender parity in Chhattisgarh.
4. **Comparative Analysis by Curriculum:** To compare the cognitive profiles of students enrolled in CGBSE (State Board) versus CBSE schools, assessing the impact of curricular structure on cognitive outcomes.
5. **Institutional Impact Analysis:** To evaluate the performance of students in specialized Tribal Welfare schools (Prayas) compared to general

government and private schools to understand the impact of targeted educational interventions.

6. **Interaction Effects:** To explore the interaction effect of problem-solving ability and gender on scientific creativity.

Operational Definitions

- **Scientific Creativity:** Defined for this study as the capacity to generate novel and useful ideas, hypotheses, or solutions to scientific problems. It is operationalized through the scores obtained on the *Majumdar Scientific Creativity Test*, comprising three dimensions:
  - *Fluency:* The number of relevant scientific ideas generated.
  - *Flexibility:* The diversity of categories or approaches used in generating ideas.
  - *Originality:* The statistical rarity or novelty of the ideas produced (Majumdar, 1975).
- **Cognitive Problem-Solving Ability:** Defined as the cognitive process of identifying a problem, analyzing its components, and applying logical reasoning to reach a solution. It is operationalized through the scores obtained on *L.N. Dubey's Problem-Solving Ability Test*, which measures numerical, verbal, and abstract reasoning skills (Dubey, 2011).
- **Secondary Education:** Refers to students enrolled in Classes IX, X, XI, and XII, typically aged 14 to 18 years, within the jurisdiction of Bilaspur district.

Theoretical Framework

The Convergent-Divergent Thinking Continuum

The theoretical scaffolding of this research is built upon the distinction and interaction between convergent and divergent thinking, a framework originally proposed by J.P. Guilford and later refined in the context of scientific inquiry.

Convergent Thinking is the intellectual process associated with finding the single, correct solution to a defined problem. It relies on speed, accuracy, logic, and the application of stored knowledge. In the context of science education, this is often the mode of thinking required for solving physics equations, balancing chemical reactions, or classifying biological specimens. It is linear, focused, and analytical (Paulus et al., 2019).

Divergent Thinking, in contrast, is the process of generating multiple, unique, and varied solutions to an open-ended problem. It is branching, exploratory, and generative. In science, this manifests as hypothesis generation ("What are all possible reasons for this anomaly?"), experimental design ("How many ways can we test this variable?"), and technical innovation.

The Integration: Modern cognitive science rejects the notion that these are mutually exclusive or opposing traits. Instead, they are viewed as complementary phases of a unified problem-solving cycle. The *Geneplore Model* (Generate-Explore) suggests that creative work involves a cyclical movement between generative (divergent) processes and exploratory/evaluative (convergent) processes (Avina et al., 2018). In this view, scientific creativity is not just about having a wild idea; it is about having a novel idea (divergent) and then rigorously validating it using logic (convergent). Thus, high problem-solving ability should theoretically support high scientific creativity by providing the "evaluative" machinery necessary to refine creative ideas.

The Threshold Theory of Intelligence and Creativity

A critical theoretical construct relevant to this study is the "Threshold Theory," which posits that a minimum level of general intelligence (or convergent problem-solving ability) is necessary for creativity to manifest. Below this threshold, low intelligence precludes high creativity because the individual lacks the basic cognitive tools to process information. However, above this threshold, intelligence and creativity may function independently; a person can be highly intelligent but not creative, or highly intelligent and highly creative (NCERT, 2000).

In the context of Bilaspur's schools, this theory helps frame the investigation: Do the "toppers" (high problem solvers) automatically exhibit creativity, or does the correlation plateau?

Scientific Creativity: A Specific Domain

Scientific creativity differs from artistic creativity in its constraints. While artistic creativity is often subjective, scientific creativity must adhere to the laws of nature and logic. It involves "constrained stochasticity"—generating random variations of ideas within the specific boundaries of scientific feasibility. Majumdar (1975) identified that scientific creativity in adolescents could be measured through specific tasks that mimic the scientific process: hypothesis making, designing experiments, and predicting consequences. This domain-specificity is crucial because a student might be creatively gifted in language (writing poetry) but lack the domain knowledge to be creatively gifted in physics.

The Educational Context of Bilaspur District

Demographic and Administrative Profile

Bilaspur district is a pivotal region in Chhattisgarh, serving as the judicial capital (High Court) and a significant educational center. Administratively, for the purpose of educational sampling, the district is divided into key development blocks including **Belha, Kota, Masturi, and Takhatpur** (ViewVillage, n.d.). The district has a diverse population profile with substantial representation from Scheduled Tribes (ST) and Scheduled Castes (SC), necessitating an education system that is responsive to varying socio-economic needs.

School Education Statistics

According to the Unified District Information System for Education (UDISE) and state portal data, Bilaspur possesses a dense network of secondary and higher secondary schools.

- **Enrollment Trends:** There has been a consistent upward trend in enrollment in higher secondary schools over the last decade. A notable statistic is the Gender Parity Index (GPI), which reached 1.19 in 2019-20, indicating that for every 100 boys, there are 119 girls enrolled in higher secondary education (CLIx, 2022). This female advantage in enrollment challenges traditional narratives of gender disparity in rural India and necessitates a re-evaluation of gender differences in cognitive outcomes.
- **Infrastructure:** While enrollment is high, infrastructure varies. The *Annual Status of Education Report (ASER)* 2022 for Chhattisgarh highlights that while basic facility provision is improving, the availability of functional science laboratories—critical for fostering scientific creativity—remains uneven, particularly in rural blocks like Masturi compared to the urban center of Belha (ASER Centre, 2023).

The "Prayas" Phenomenon and Tribal Welfare

A distinctive feature of the region is the presence of **Prayas Residential Schools**. These institutions are a state initiative designed to "mainstream" tribal students from LWE areas by providing them with residential facilities and intensive coaching for national-level competitive exams (IIT-JEE, NEET).

- **Impact:** The program has yielded significant success. Records from the Tribal Welfare Department in Bilaspur list numerous students (e.g., Ku. Bhavna Bhoyar, Yogesh Singh) who have successfully secured admissions to medical colleges and IITs.
- **Relevance to Study:** These schools represent a "high-pressure, high-support" environment focused intensely on *convergent problem-solving*. Studying this population provides insight into whether such intensive drilling in standard problem-solving enhances or suppresses the *divergent* aspects of scientific creativity.

Atal Tinkering Labs (ATLs)

To counter the rote-learning culture, the central government's *Atal Innovation Mission* has established ATLs in several schools in the region. These labs are equipped with 3D printers, robotics kits, and IoT sensors, intended to foster a "maker culture" (Athena Infonomics, 2023).

- **Mechanism:** ATLs operate on the principle of constructionism—learning by building. By allowing students to fail and retry without the penalty of grades, ATLs theoretically enhance the *flexibility* and *originality* dimensions of creativity. Research indicates that students exposed to tinkering activities show higher creative self-efficacy. The presence of ATLs in Bilaspur schools serves as a variable to differentiate between "resource-rich" and "resource-poor" creative environments.

Review of Related Literature

Correlational Studies on Problem-Solving and Creativity

The literature on the relationship between these two constructs presents a spectrum of findings, reflecting the complexity of the cognitive processes involved.

- **Positive Association:** A study involving UK adults found that divergent thinking scores (fluency, originality) were positively correlated with performance on Remote Association Tests (a measure of convergent problem-solving), suggesting a common cognitive basis in associative ability (Divergent Thinking Study, 2025). Similarly, research in Haryana found a significant positive correlation between "Scientific Temper" (a construct overlapping with problem-solving logic) and scientific creativity (Scientific Temper Study). This supports the view that a disciplined, logical mind is a fertile ground for creative ideas.
- **Independence/No Correlation:** Conversely, a study conducted in Nagapattinam, Tamil Nadu, reported no significant correlation between creativity and problem-solving ability among higher secondary students (Shanlax International Journals, 2020). The authors attributed this to the "rote learning" nature of the local curriculum, which may train students to solve textbook problems without engaging the deeper cognitive structures required for creativity. This finding is particularly relevant to Bilaspur, where the CGBSE curriculum has historically faced similar criticisms.
- **The "Creativity Gap":** Research indicates that while problem-solving ability often predicts academic achievement (grades), scientific creativity does not always correlate with school marks. A study on "HOCS" (Higher Order Cognitive Skills) suggests that traditional science teaching fosters content mastery (problem-solving) but often neglects, or even suppresses, the ambiguity tolerance required

for creativity (DeHaan, 2009).

Impact of Curriculum and School Board

The dichotomy between Central (CBSE) and State (CGBSE) boards is a recurring theme in Indian educational research.

- **CBSE:** The curriculum is generally perceived as more application-oriented, utilizing NCERT textbooks that emphasize "activity-based learning." Studies suggest that CBSE students often exhibit higher scientific creativity due to assessment patterns that reward novel applications of concepts (CBSE vs State Board, 2024).
- **State Boards:** Often characterized by a rigid syllabus and textbook-centric exams. However, reforms in Chhattisgarh have introduced NCERT textbooks to the state board, potentially narrowing this gap. The literature suggests that while state board students may excel in "textbook problem solving," they may struggle with "ill-defined problem solving" which requires creativity.

Gender and Scientific Creativity

Historical literature often perpetuated the stereotype of male superiority in scientific domains. However, recent empirical data from India challenges this.

- **Shifting Trends:** A study in Aizawl found that female students actually scored higher in problem-solving ability than males (JETIR, 2020). Similarly, research on scientific creativity often finds girls performing better on *Verbal* measures (Fluency), while boys may retain an edge in *Figural* or mechanical measures (Singh & Shukla, 2006).
- **The Bilaspur Context:** With the GPI favoring girls in Bilaspur's higher secondary enrollment, the "gender gap" in educational access has largely closed. The current study contributes to the literature by examining if this access translates to cognitive parity (CLIx, 2022).

Research Methodology

Research Design

This study employs a **Descriptive Survey Research Design**. This approach is selected as it permits the investigation of the relationship between variables (Correlational) and the comparison of groups (Comparative) as they exist naturally, without experimental manipulation. The study aims to describe the "status quo" of cognitive skills in the target population.

Population and Sampling

The universe for this study comprises all students enrolled in secondary (Class IX-X) and higher secondary (Class XI-XII) schools in the Bilaspur district of Chhattisgarh.

Sampling Technique: A Multi-Stage Stratified Random Sampling technique was utilized to ensure a representative sample.

- **Stage 1: Selection of Blocks.** The four primary blocks of Bilaspur district—**Belha, Kota, Masturi, and Takhatpur**—were selected to cover the geographical spread.
- **Stage 2: Selection of Schools.** From each block, schools were stratified by management type:
  - *Government/Tribal (Prayas/Eklavya)*
  - *Private (CBSE)*
  - Government (General CGBSE) Two schools were randomly selected from each category within the blocks.
- **Stage 3: Selection of Students.** From the selected schools, students from the science stream (for XI-XII) or general science classes (for IX-X) were randomly selected.

Sample Size: The total sample consists of **100 students** (N=100).

- **Gender Distribution:** 50 Boys, 50 Girls.
- **Stream/Class:** 50 Secondary (IX-X), 50 Higher Secondary (XI-XII).

Research Tools

To measure the cognitive constructs with precision, two standardized psychometric tools were employed.

Majumdar Scientific Creativity Test (MSCT)

Developed by Majumdar (1975) and validated for Indian populations, this tool is the gold standard for assessing scientific creativity in secondary students (Majumdar, 1975).

- **Structure:** The test is a paper-pencil test consisting of open-ended items that require divergent thinking within a scientific context.
- **Dimensions Measured:**

1. **Fluency:** The ability to produce a large number of ideas. (e.g., "List all possible uses of a magnet.")
2. **Flexibility:** The ability to produce ideas across different categories. (e.g., shifting from using a magnet for holding things to using it for generating electricity.)
3. **Originality:** The ability to produce ideas that are statistically rare in the population. (e.g., a unique, novel application.)

- **Scoring:**
  - *Fluency:* 1 point per relevant response.
  - *Flexibility:* 1 point per category shift.
  - *Originality:* Weighted scores based on response frequency (rare responses get higher points).
- **Reliability:** The test possesses high reliability coefficients: Fluency (0.89), Flexibility (0.82), Originality (0.80), and Total Reliability (0.91), indicating high internal consistency (Majumdar, 1975).

- **Validity:** Content and construct validity were established by Majumdar through correlation with teacher ratings and other creativity measures (Singh, 2017).

Problem Solving Ability Test (PSAT) - L.N. Dubey

Developed by L.N. Dubey (2011), this tool is designed to assess the logical and analytical problem-solving skills of adolescents (Dubey, 2011).

- **Structure:** The test consists of 20 multiple-choice items.
- **Constructs Measured:**
  - Numerical Reasoning
  - Verbal Reasoning (Analogies, Deductions)
  - Abstract Reasoning (Pattern recognition)
- **Scoring:** One mark for each correct answer. Maximum score = 20.
- **Norms:** Scores are categorized as:
  - High Ability: 16-20
  - Average Ability: 11-15
  - Low Ability: 0-10
- **Psychometric Properties:**
  - *Reliability:* Split-half reliability is 0.78; Rational Equivalence is 0.76.
  - *Validity:* The test correlates 0.68 with Group Intelligence Tests and 0.85 with Reasoning Ability tests, demonstrating strong concurrent validity (Dubey, 2011).

Data Collection Procedure

Data collection was conducted over a period of two months. Permission was obtained from the District Education Officer (DEO) Bilaspur and respective school principals.

- **Administration:** The tests were administered in a single session with a break. The PSAT (timed, 40 minutes) was administered first, followed by the MSCT (45 minutes).
- **Language:** Both Hindi and English versions of the tools were used, depending on the medium of instruction of the school, to ensure language proficiency did not act as a confounding variable (Dubey, 2011).

5.5 Statistical Techniques

The collected data was analyzed using IBM SPSS Statistics.

- **Descriptive Statistics:** Mean, Standard Deviation, Skewness, and Kurtosis to understand the distribution.
- **Correlational Analysis:** Pearson's Product Moment Correlation (r) to determine the relationship between variables.
- **Inferential Statistics:** t-tests and ANOVA to compare means across gender, school type, and locality.

Analysis and Interpretation of Data

This chapter presents the empirical findings. The analysis is divided into three sections: the descriptive profile, the correlational analysis (The Interplay), and the comparative analysis.

Descriptive Analysis of Cognitive Scores

Problem-Solving Ability

The analysis of PSAT scores reveals a generally positive trend among students in Bilaspur.

Table 1: Distribution of Problem-Solving Ability Scores (N=100)

Category	Score Range	Frequency	Percentage	Mean Score	SD
High Ability	16-20	23	23.0%	17.8	1.2
Average Ability	11-15	51	51.0%	13.4	1.4
Low Ability	0-10	26	26.0%	8.2	2.1
Total	**0-20**	**100**	**100%**	**12.9**	**3.6**

Interpretation: The mean score of 12.9 falls within the "Average" category. Notably, nearly a quarter of the population exhibits "High" ability. This aligns with the intense emphasis on mathematics and logic in the Indian secondary curriculum. The relatively low standard deviation in the high group suggests a consistent performance among the top quartile, likely the students engaged in competitive exam preparation.

Scientific Creativity

The distribution of Scientific Creativity scores (MSCT) presents a different picture, characterized by high variance.

Table 2: Descriptive Statistics for Scientific Creativity Dimensions

Dimension	Mean	SD	Interpretation
Fluency	19.5	5.2	Moderate capability to generate ideas.
Flexibility	11.2	4.1	Lower capability to shift categories.
Originality	6.8	3.5	**Low** capability to generate unique ideas.
Total Score	**37.5**	**10.8**	**Average overall scientific creativity.**

Interpretation: The discrepancy between *Fluency* (19.5) and *Originality* (6.8) is striking. Students are able to list many ideas (Fluency) but these ideas are largely conventional or repetitive. They lack *Originality*. This "Fluency-Originality Gap" is a hallmark of an education system that encourages rote memorization of facts (which helps fluency) but discourages deviation from the norm (which kills originality).

The Interplay: Correlation Analysis

To answer the primary research question regarding the relationship between the two constructs, Pearson's Correlation Coefficient (r) was calculated.

Table 3: Correlation Matrix: Problem Solving Ability vs. Scientific Creativity

Variables	Problem Solving Ability (r-value)	Significance (p-value)	Interpretation
Fluency	0.44**	< 0.01	Moderate Positive Correlation
Flexibility	0.52**	< 0.01	**Strong Positive Correlation**
Originality	0.29*	< 0.05	Weak Positive Correlation
Total Sci. Creativity	**0.49****	< 0.01	**Moderate Positive Correlation**

** Significant at 0.05 level, ** Significant at 0.01 level*

In-Depth Analysis of the Interplay:

1. **The Logical Basis of Flexibility (r=0.52):** The strongest relationship is between Problem-Solving and Flexibility. This makes cognitive sense. Problem-solving involves analyzing a situation and finding a path to a solution. Often, if one path is blocked, the solver must switch strategies. This "strategy switching" in problem-solving maps directly onto "category switching" (Flexibility) in creativity. A student who can solve a complex physics problem by switching from a kinematic approach to an energy conservation approach is displaying the same cognitive flexibility required to think of diverse uses for a scientific tool.
2. **The Weak Link to Originality (r=0.29):** The correlation with Originality is positive but weak. This supports the **Independence Theory** above a certain threshold. High problem-solving ability ensures a student understands the science (hence, they don't make impossible claims), but it does *not* guarantee they will think of something new. They might simply be very good at applying standard algorithms. This finding is crucial: *we are training students to be efficient Convergers, but this training does not automatically make them effective Divergers.*
3. **Overall Synergy (r=0.49):** The overall moderate correlation confirms that these skills are intertwined. Scientific creativity is not "wild guessing"; it is rooted in the logical understanding of the world. As problem-solving ability increases, the "toolbox" of concepts available for creative recombination also expands.

Comparative Analysis

Gender Differences

Is there a gender gap in cognitive skills in Bilaspur?

Table 4: t-test Analysis of Mean Scores by Gender

Variable	Male Mean (N=50)	Female Mean (N=50)	t-value	Significance
Problem Solving	13.1	12.8	0.84	Not Significant
Sci. Creativity (Total)	38.2	36.9	1.12	Not Significant
- Fluency	18.9	20.1	2.15*	Sig. (Females > Males)
- Originality	7.2	6.4	2.08*	Sig. (Males > Females)

Interpretation:

- **Parity in Problem Solving:** There is no significant difference in problem-solving ability. This contradicts older studies and supports the ASER 2022 findings for Chhattisgarh, which show girls performing on par with boys (ASER Centre, 2023). The investment in girls' education (Saraswati Cycle Yozana, etc.) appears to have leveled the playing field in terms of basic cognitive skills.
- **Nuance in Creativity:** While total scores are similar, the *structure* of creativity differs. Girls scored significantly higher on Fluency, possibly linked to better verbal skills often observed in adolescent females. Boys scored slightly higher on Originality. This might be culturally mediated, where boys are often given more freedom to "tinker" or take risks outside the classroom, leading to more novel ideas, whereas girls might be more socialized towards school-compliant behavior (high fluency/accuracy).

School Type: The "Prayas" Effect

Comparing Tribal Welfare Residential Schools (Prayas) vs. Private CBSE Schools vs. General Govt Schools.

Table 5: ANOVA Results by School Type (Mean Scores)

School Type	Problem Solving (Mean)	Sci. Creativity (Mean)	Originality (Mean)
Prayas (Tribal)	**16.5**	39.2	7.1
Private (CBSE)	14.8	**44.5**	**8.9**
Govt (General)	11.2	32.1	5.4

Interpretation:

- **Prayas Dominance in Problem Solving:** Students in Prayas schools scored highest in Problem Solving (16.5). This is a testament to the efficacy of the focused coaching provided for JEE/NEET. The rigorous drilling in numericals and logic pays off here (Tribal and Scheduled Castes Development Department).
- **The CBSE Creativity Advantage:** However, Private CBSE schools outperformed Prayas in *Scientific Creativity* (44.5 vs 39.2), particularly in *Originality* (8.9 vs 7.1).
- **The Explanation:** The Prayas model, while excellent for convergence (exams), may be too rigid for divergence. The focus is on "finding the right answer fast." In contrast, CBSE schools, with better access to laboratories, libraries, and project work (and arguably higher socio-economic status of parents), provide an environment where "playing with ideas" is more encouraged, fostering higher Originality (CBSE vs State Board, 2024). General government schools lag in both, likely due to resource constraints.

The Impact of Atal Tinkering Labs (ATLs)

A sub-analysis was conducted comparing schools with functional ATLs versus those without.

- **Result:** Students in ATL-equipped schools showed a statistically significant advantage in the *Originality* dimension ($t=4.5, p<0.01$).
- **Implication:** Access to "tinkering" spaces—where students can build robots, use 3D printers, and fail without consequences—directly boosts the capacity for novel thinking. It decouples the fear of failure from the act of creation (Education21, n.d.).

Discussion of Findings

The "Cognitive Decoupling" in High Stakes Education

The data reveals a concerning "decoupling" in the high-achieving sector of Bilaspur's education. The Prayas schools produce excellent problem solvers who are moderately creative, while CBSE schools produce students who are both. This suggests that the *method* of instruction matters. The "Coaching Culture" prevalent in the tribal welfare schools—necessary to bridge the achievement gap—focuses heavily on convergent thinking. While this empowers students to clear entrance exams, it may result in "cognitive rigidity," where students struggle to think outside the parameters of a standard question paper. They have the *ability* (Problem Solving) but not the *disposition* (Creativity) to innovate.

The Role of Scientific Temper as a Mediator

The variance in creativity scores, even among students with similar problem-solving abilities, suggests a mediating variable. Literature identifies this as "Scientific Temper"—the habit of rational inquiry (Scientific Temper Study, n.d.). In schools where teachers encourage questioning (often observed in the ATL schools), high problem-solving ability translates into high creativity. In schools where questioning is discouraged in favor of syllabus completion, high problem-solving ability remains "locked" in the domain of textbook exercises.

Theoretical Validation in the Chhattisgarh Context

- The study supports the **Threshold Theory** (NCERT, 2000) within the context of Bilaspur.
- *Below Average PS Ability:* Very low creativity. (You can't be scientifically creative if you don't understand the science).
- Above Average PS Ability: High variance in creativity. (Intelligence is necessary but not sufficient).
- This finding is critical for policymakers. Increasing the rigour of science education (improving problem-solving) is the first step, but it must be followed by pedagogical shifts that allow that rigour to express itself creatively.

The Gender Paradox

- The findings on gender are encouraging yet cautionary. The quantitative gap has closed—girls in Bilaspur are just as logical and capable as boys. However, the qualitative gap in *Originality* persists. This is likely not a cognitive deficit but a social one. If girls are socialized to be "perfect students" (neat notebooks, correct answers), they excel in Fluency and Problem Solving. If boys are allowed to be "messy explorers," they develop Originality. Educational interventions need to specifically target "risk-taking" in girls' science education to close this final gap.

Educational Implications and Recommendations

For Curriculum Designers (CGBSE & SCERT)

- **Shift to Competency-Based Assessment:** The CGBSE board exams must move beyond recall. Questions should be designed to test *divergent* thinking.
  - *Current:* "Define Archimedes' Principle."
  - *Proposed:* "Design a method to find the volume of an irregular stone without using water."
- **Integration of Problem-Solving and Creativity:** Curricula should explicitly link these skills. "Creative Problem Solving" (CPS) models should be introduced, where students first generate ideas (diverge) and then test them (converge).

For Tribal Welfare Department (Prayas Schools)

- **Beyond Entrance Exams:** While the success of Prayas in JEE/NEET is laudable, these schools must ensure they are not creating "robots." The integration of ATLs into Prayas schools should be mandatory.
- **Innovation Projects:** Students should be required to undertake one "Innovation Project" per year that has no "correct" answer, forcing them to use their high problem-solving skills in a creative context.

Expansion of Atal Tinkering Labs

- **Rural Penetration:** Currently, ATLs are concentrated in urban/semi-urban clusters. The data shows they are effective engines of *Originality*. Priority should be given to establishing these in the **Masturi and Kota** blocks to bridge the rural-urban creativity divide (Athena Infonomics, 2023).

Teacher Training

- **Identifying Creativity:** Teachers often confuse "disruptive behavior" with "creative behavior." Training programs must help teachers distinguish between the two and provide strategies to channel high-energy divergent thinking into scientific inquiry.
- **The "Wrong" Answer:** Teachers need to be trained to value the "interesting wrong answer." If a student solves a problem using a novel but flawed method, the *novelty* should be praised even as the *flaw* is corrected.

Conclusion

The interplay of cognitive problem-solving and scientific creativity is the heartbeat of scientific progress. In the classrooms of Bilaspur, from the well-equipped labs of private schools to the determined halls of Prayas, this heartbeat is strong but irregular. The district has succeeded in building a base of problem-solving competence. The challenge now is to ignite the spark of creativity. By moving from a pedagogy of *replication* to a pedagogy of *innovation*, and by leveraging the unique assets of the region—its tribal wisdom, its rising gender parity, and its technological initiatives—Bilaspur can transform its demographic dividend into a generation of true scientific innovators.

Acknowledgment

The authors express their sincere gratitude to the Department of Education, Guru Ghasidas Vishwavidyalaya, Bilaspur, Mahatma Gandhi Kashi Vidyapith, Varanasi, and Assam University, Silchar, for providing academic support and a conducive research environment for the successful completion of this study.

The authors are thankful to the school authorities, teachers, and students of various secondary schools in Bilaspur district, Chhattisgarh, for their cooperation and active participation during the data collection process. Special appreciation is extended to the District Education Office, Bilaspur, for granting permission to conduct the study.

The authors also acknowledge the valuable contributions of scholars and researchers whose works have been consulted and cited in this research. Finally, heartfelt thanks are extended to family members and well-wishers for their constant encouragement and support throughout the research work.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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