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IMPACT OF TEACHING INTERVENTIONS ON LOGICAL ABILITIES AMONG HIGHER SECONDARY STUDENTS OF HINDI SUBJECT

[1] Smita Mishra
Research Scholar
Department of Education
Noida International University
Greater Noida
[2]Dr. Aruna Singh
Associate Professor
Department of Education
Noida International University
Greater Noida

Abstract
Logical abilities, encompassing critical dimensions such as reasoning, verbal, numerical, spatial, and psychomotor skills, play a foundational role in shaping students' cognitive development, problem-solving capabilities, and overall academic success play a crucial role in shaping students' cognitive development and academic success, encompassing skills like reasoning, problem-solving, and critical thinking. Investigating pre- and post-intervention differences helps evaluate the effectiveness of targeted teaching strategies in enhancing these abilities among higher secondary students. The study utilized a quasi-experimental, cross-sectional design with a quantitative approach, involving 600 class XI and XII Hindi students from 10 higher secondary schools in rural and urban areas of Sarojini Nagar, Lucknow, selected through quota sampling. Logical aptitude was measured using the Distinctive Aptitude Test Battery manual (Sood V et al., n.d.), which employs a 7-point Likert scale with reverse coding. Data collection was conducted offline through scheduled appointments and paper-based distribution. The data were analyzed using reliability analysis, frequency analysis, and paired t-test in SPSS and MS Excel 16. The results reveal substantial differences in logical abilities and their various dimensions between pre-test and post-test scores in the experimental group, while the control group exhibited only minor changes, highlighting clear contrasts in the degree and nature of these variations. The study concludes that the teaching intervention program significantly enhanced logical abilities across all dimensions in the experimental group, while only minor changes were observed in the control group. These findings highlight the importance of structured, model-based teaching strategies in fostering cognitive development and logical reasoning skills among learners.

Keywords: Logical Ability, Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability, Clerical Speed Ability, Perceptual Ability, and Abstract Reasoning Ability

1. Background
Logical abilities are crucial for the cognitive and intellectual development of students, significantly influencing their problem-solving skills, critical thinking, and decision-making capabilities. These abilities are particularly relevant during the higher secondary stage, where students are exposed to complex academic challenges that prepare them for higher education and future careers. Research has

emphasized the need for interventions aimed at enhancing logical abilities, as these interventions contribute to academic success and overall cognitive growth (Shakya & Yadav, 2020).

Numerous studies have highlighted the role of educational interventions in improving students' logical abilities. For instance, Ramaa and Gowramma (2002) conducted a study on the impact of specific pedagogical strategies on the cognitive abilities of secondary school students in Karnataka. Their findings revealed that targeted interventions, such as problem-based learning and structured reasoning activities, significantly enhanced students' logical thinking and reasoning skills. Similarly, Mangal and Mangal (2013) argued that logical reasoning could be systematically developed through instructional methods that promote analytical thinking, such as inquiry-based learning and cooperative problem-solving exercises.

The dimensions of logical abilities, including deductive reasoning, inductive reasoning, and analytical thinking, have also been studied extensively. Singh and Poonam (2018) examined the development of these dimensions among higher secondary students in urban and rural settings in Uttar Pradesh. They found that students in urban schools exhibited higher deductive reasoning skills due to exposure to diverse learning environments and digital resources. In contrast, rural students benefited more from teacher-led interventions designed to bridge resource gaps. These findings underscore the importance of contextualizing interventions to address the diverse needs of students.

Intervention programs in education have been shown to play a transformative role in improving not only academic performance but also cognitive abilities. For instance, Mukherjee and Das (2021) explored the effectiveness of computer-aided instructional programs in enhancing logical abilities among higher secondary students. Their study concluded that students who participated in these programs demonstrated significant improvements in problem-solving and reasoning skills compared to those who followed traditional teaching methods. This underscores the importance of leveraging technology and innovative teaching strategies in modern education.

Pre- and post-intervention analyses provide valuable insights into the effectiveness of educational programs. Gupta and Sharma (2017) conducted a longitudinal study to assess the impact of a six-month intervention program focused on reasoning and analytical skills among higher secondary students in Delhi. Their findings indicated a marked improvement in post-intervention scores, highlighting the efficacy of structured and consistent intervention programs. Such studies underscore the need for robust pre- and post-assessment frameworks to evaluate intervention outcomes comprehensively.

Despite the growing body of research, there is limited evidence on the comparative analysis of logical abilities and their dimensions before and after interventions in the Indian context, particularly among higher secondary students. Given the increasing importance of cognitive skills in academic and professional domains, it becomes imperative to explore the impact of interventions aimed at improving logical abilities. This study seeks to address this gap by analyzing pre- and post-intervention differences in logical abilities and their dimensions among higher secondary students. The findings will contribute to the existing body of knowledge and provide actionable recommendations for educators and policymakers to enhance the logical abilities of students effectively.

1.1 Research Objectives-

1. To analyze the differences in pre-test and post-test logical abilities and their dimensions (Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability, Clerical Speed Ability, Perceptual Ability, and Abstract Reasoning Ability) among respondents in the control group.
2. To examine the differences in pre-test and post-test logical abilities and their dimensions (Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability,

Clerical Speed Ability, Perceptual Ability, and Abstract Reasoning Ability) among respondents in the experimental group.

1.2 Significance of the study

This study holds significance as it explores the impact of an intervention program on enhancing logical abilities and their various dimensions among higher secondary students. By examining pre- and post-intervention differences, the research provides valuable insights into the effectiveness of teaching model-based strategies in fostering cognitive development. The findings can guide educators, policymakers, and curriculum developers in designing targeted interventions to improve critical thinking, problem-solving, and decision-making skills, which are essential for students' academic and future professional success.

2. Literature Review

Jawad et al. (2021) demonstrated the effectiveness of classroom assessment techniques (CATs) in enhancing mathematical and logical reasoning, revealing significant cognitive improvements in students taught using CATs compared to traditional methods. Similarly, Hikmah et al. (2023) emphasized the role of positive attitudes in mathematical logic learning outcomes, accounting for 5.3% of variance and highlighting the need to foster learner disposition. Rashidov (2022) further supported active teaching strategies, showing how problem-based learning can enhance creative and logical thinking through interdisciplinary modules and cognitive engagement. Ainuzzahroh et al. (2024) connected traditional practices, such as making "Jenang Kudus," with scientific learning, demonstrating their potential to improve logical reasoning by linking real-world processes with academic concepts. Yanti et al. (2023) revealed that traditional games like "Engklek" could significantly enhance logical reasoning in early childhood education, improving indicators such as sorting, classifying, and pattern recognition. Yuliana et al. (2022) confirmed the benefits of a guided inquiry learning model in improving both cognitive outcomes and logical thinking abilities, with significant advancements over conventional methods. Similarly, Patri and Heswari (2021) highlighted the value of ethnomathematics-based e-modules, developed using the ADDIE model, in promoting cultural understanding and logical thinking skills among students.

Darmayanti et al. (2022) focused on adaptive reasoning abilities in solving HOTS problems, showing that students with converger learning styles excelled in proposing conjectures, drawing conclusions, and identifying patterns using Polya's problem-solving method. Building on assessment tools, Qomariyah and Darmayanti (2023) developed a valid and reliable instrument to evaluate mathematical reasoning abilities in three-dimensional material among high school students. Lastly, Gràcia et al. (2021) created a model to assess oral skills, identifying dimensions such as interaction management and argumentative strategies while correlating oral skills with emotional intelligence and metacognitive strategies, thus providing a robust framework for evaluating communication competence. Efriyadi and Nurhanurawati (2021) demonstrated that learning motivation and self-regulation positively influenced written mathematical communication skills during the COVID-19 pandemic, though verbal skills remained low, necessitating targeted interventions. Similarly, Amany et al. (2023) found that higher student interest directly enhanced written communication in solving realistic math problems, emphasizing the role of engagement in skill development. Megawati and Sutarto (2021) underscored the importance of numeracy literacy, identifying varied skill levels among students and its relevance to real-world problem-solving.

Integrating innovative methods, Putra et al. (2021) showed that project-based learning with a STEM approach significantly improved spatial and geography skills while fostering positive attitudes. Similarly, Negara et al. (2025) validated a flipped classroom design with drill-and-practice, demonstrating

substantial improvements in psychomotor skills among motorcycle engineering students. Gamification also emerged as a promising approach, with Darmayanti (2023) showcasing the effectiveness of the Gema Cow-Pu mathematical crossword puzzle in enhancing critical thinking. In psychomotor learning, Amorim et al. (2024) highlighted the strong predictive relationship between psychomotor skills and pre-academic performance in young children, while Noviyanti et al. (2022) confirmed the effectiveness of virtual home laboratories in improving students' psychomotor abilities. Gunawan et al. (2023) examined learning outcomes in Islamic Religious Education, emphasizing the role of emotional and process-driven factors. Owan et al. (2022) further revealed that social capital moderated the impact of innate ability on cognitive, affective, and psychomotor outcomes.

Eroğlu et al. (2022) compared face-to-face (F2F) and online education for psychomotor skill development in dental anatomy. F2F education showed better results, with statistically significant improvements in psychomotor skills ($p < 0.001$). While online training contributed to skill development, F2F remained the gold standard. Spaska et al. (2021) examined how debates impact tertiary students' analytical thinking. Using pre/posttests, observation, and focus groups, results indicated significant improvements in analytical, critical thinking, and problem-solving skills. Students positively associated debates with practical, job-related benefits. Hong et al. (2023) evaluated three teaching methods—online, offline, and semi-flipped classrooms (SFCs)—in oral medicine. SFCs outperformed both in final exams and questionnaires, combining online and offline education to enhance knowledge retention and clinical practice. Budiyono et al. (2021) investigated the discussion method in Indonesian language learning. Classroom action research showed that collaborative discussions improved logical thinking skills and learning outcomes compared to conventional methods, creating a supportive and engaging environment. Dubey & Saloman (2022) conducted a comparative study on reasoning ability in private vs. government school students in Raipur. Girls outperformed boys, and private school students exhibited better reasoning skills than their government school counterparts. Purwati and Alberida (2022) conducted descriptive research analyzing creative thinking skills among 58 high school students. Using a validated questionnaire, the results revealed that most students exhibited very low to low levels of creative thinking, indicating the need for improved teaching strategies to foster these skills.

Dewi et al. (2022) examined how numerical ability and abstract thinking influenced mathematical problem-solving in 70 eighth-grade students. Using proportional random sampling and various tests, they found that these abilities contributed 44.1% to students' problem-solving skills. Lestari et al. (2021) developed the Virtual Classroom Critical Thinking (VC2T) Model and validated its effectiveness with 33 high school students. The model significantly improved critical thinking skills, achieving medium n-gain, a strong effect size, and positive student responses. Sari et al. (2021) investigated the impact of an inquiry mind map tool on critical thinking and motivation in a quasi-experimental study involving 206 students. The tool enhanced both critical thinking and motivation, with no significant differences observed across schools or genders. Wu (2021) piloted the P4C approach in a Chinese school with six year-7 classes. The intervention improved students' critical thinking skills slightly, but teachers expressed concerns about integrating the approach into traditional curricula.

- **Research Gap**

Despite the growing emphasis on enhancing students' cognitive abilities, limited research has focused on assessing the pre- and post-intervention differences in logical abilities and their specific dimensions among Hindi studying higher secondary students from rural and urban areas. This study addresses this

gap by analyzing these differences within both control and experimental groups, offering valuable insights into the effectiveness of teaching model-based interventions.

3. Research Methodology

The study employed a quasi-experimental and cross-sectional design with a quantitative approach. Utilizing a quota sampling technique, the research encompassed a sample size of 600 respondents specifically studying Hindi in class 11^{th} & 12^{th} in selected 10 higher secondary schools, drawn from rural and urban areas of Sarojni Nagar, Lucknow. To measure the logical aptitude of class XI & XII students, the researcher used the Distinctive Aptitude Test Battery manual (Sood V et al., n.d.). The logical aptitude and its various sub-dimensions in this manual are measured on a 7-point Likert scale with reverse coding, where 1 = Extremely High Ability, 2 = High Ability, 3 = Above Average Ability, 4 = Average Ability, 5 = Below Average Ability, 6 = Low Ability, and 7 = Extremely Low Ability. The scale was administered in offline mode through scheduled appointments and paper-based distribution in selected schools. The pre-intervention data from both control group and experimental group were collected in the months of August & September, 2024. In the month of October 2024, a teaching model-based intervention program was administered to the experimental group for one month and then post intervention data were collected from both control group and experimental group in the months of November & December, 2024. The primary data collected were analyzed using statistical tools including reliability analysis, frequency analysis and paired t test analysis, performed with SPSS and MS Excel 16. The study also adhered to ethical considerations by obtaining informed consent, ensuring confidentiality and anonymity, and guaranteeing voluntary participation.

4. Results and Discussion

4.1 Demographic Profile of respondents

Table 1: Demographic Profile of respondents

Demographic Variable	Subcategory	Control Group	Experimental Group	Total
School Name	New Public Collegiate Inter College	30	30	60
	St. Meera Public Inter College, Lucknow	30	30	60
	St. Thomas College	30	30	60
	Creative Convent College Lucknow	30	30	60
	Sky Public School	30	30	60
	Universal City Convent	30	30	60
	Lala Ram Swaroop Inter College Banthara Lucknow	30	30	60
	Rajkiya Uttar Pradesh Sainik Inter College Lucknow	30	30	60
	J.P. Public Inter College)	30	30	60
	Lucknow Public Academy Inter College)	30	30	60
Total		300	300	600
School type	Private College	150	150	300
	Government College	150	150	300
Total		300	300	600
Residence	Urban Area	150	150	300
	Rural Area	150	150	300
Total		300	300	600
Gender	Male	163	163	326
	Female	137	137	274
Total		300	300	600

Age	15 to 16 Years	137	145	282
	17 to 18 Years	163	155	318
Total		300	300	600
Family type	Nuclear Family	162	166	328
	Joint Family	138	134	272
Total		300	300	600
Class	XI Class	139	112	251
	XII Class	161	188	349
Total		300	300	600
Stream	Arts	158	154	312
	Commerce	86	88	174
	Science	56	58	114
Total		300	300	600

4.2 Reliability Analysis of Data

Table 2: Reliability of Data

Scale	Cronbach's Alpha	Number of Items
Logical Ability in Control group (Pre)	.841	200
Logical Ability in Control group (Post)	.844	200
Logical Ability in Experimental group (Pre)	.853	200
Logical Ability in Experimental group (Post)	.869	200

All the scales showed high reliability of the data

4.3 Paired t-Test: Differences in Pre-Test and Post-Test Logical Abilities and its dimensions (Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability, Clerical Speed Ability, Perceptual Ability, Abstract Reasoning Ability) among respondents in the Control Group

- H_0 1: There is no significant difference in Verbal Ability between the pre-test and post-test in the control group.
- H_0 2: There is no significant difference in Numerical Ability between the pre-test and post-test in the control group.
- H_0 3: There is no significant difference in Spatial Ability between the pre-test and post-test in the control group.
- H_0 4: There is no significant difference in Psychomotor Ability between the pre-test and post-test in the control group.
- H_0 5: There is no significant difference in Reasoning Ability between the pre-test and post-test in the control group.
- H_0 6: There is no significant difference in Mechanical Ability between the pre-test and post-test in the control group.
- H_0 7: There is no significant difference in Clerical Speed Ability between the pre-test and post-test in the control group.
- H_0 8: There is no significant difference in Perceptual Ability between the pre-test and post-test in the control group.
- H_0 9: There is no significant difference in Abstract Reasoning Ability between the pre-test and post-test in the control group.
- H_0 10: There is no significant difference in Logical Aptitude between the pre-test and post-test in the control group.

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Table 3: Differences in Pre-Test and Post-Test Logical Abilities and its dimensions among respondents in the Control Group

Paired Samples Statistics, Correlations & Paired Differences								
		Mean	N	Std. D	Correlation	Sig.	t	Sig. (2-tailed)
Pair 1	Verbal Ability (Pre)	4.3333	300	.47922	.956	.000	1.638	.103
	Verbal Ability (Post)	4.3200	300	.47436				
Pair 2	Numerical Ability (Pre)	4.3933	300	.62175	.971	.000	1.898	.059
	Numerical Ability (Post)	4.3767	300	.62937				
Pair 3	Spatial Ability (Pre)	6.5267	300	.53251	.914	.000	1.610	.108
	Spatial Ability (Post)	6.5033	300	.61475				
Pair 4	Psychomotor Ability (Pre)	4.2900	300	.50340	.976	.000	2.010	.045
	Psychomotor Ability (Post)	4.2767	300	.52380				
Pair 5	Reasoning Ability (Pre)	4.4733	300	.73786	.991	.000	1.738	.083
	Reasoning Ability (Post)	4.4633	300	.74195				
Pair 6	Mechanical Ability (Pre)	4.8600	300	.97822	.993	.000	2.010	.045
	Mechanical Ability (Post)	4.8467	300	.97622				
Pair 7	Clerical Speed Ability (Pre)	4.1600	300	.37622	.903	.000	2.351	.019
	Clerical Speed Ability (Post)	4.1367	300	.39814				
Pair 8	Perceptual Ability (Pre)	3.9367	300	.84164	.977	.000	1.906	.058
	Perceptual Ability (Post)	3.9167	300	.84386				
Pair 9	Abstract Reasoning Ability (Pre)	4.9733	300	.88802	.907	.000	1.947	.052
	Abstract Reasoning Ability (Post)	4.9300	300	.89877				
Pair 10	LOGICAL APTITUDE (Pre)	4.8400	300	.44915	.766	.000	1.985	.048
	LOGICAL APTITUDE (Post)	4.8033	300	.48176				

Results- Significant differences were found in Psychomotor Ability, Mechanical Ability, Clerical Speed Ability, and Logical Aptitude between the pre-test and post-test scores among respondents in the control group. Specifically, Psychomotor Ability ($t = 2.010$, $p = .045$), Mechanical Ability ($t = 2.010$, $p = .045$), and Clerical Speed Ability ($t = 2.351$, $p = .019$) exhibited notable changes, indicating some variation in these dimensions of logical abilities. Similarly, overall Logical Aptitude ($t = 1.985$, $p = .048$) demonstrated a significant difference, suggesting slight shifts in the composite logical abilities of respondents in the control group over time.

While no significant differences were observed in Verbal Ability, Numerical Ability, Spatial Ability, Reasoning Ability, Perceptual Ability, and Abstract Reasoning Ability between pre-test and post-test scores. The results for Verbal Ability ($t = 1.638$, $p = .103$), Numerical Ability ($t = 1.898$, $p = .059$), Spatial Ability ($t = 1.610$, $p = .108$), Reasoning Ability ($t = 1.738$, $p = .083$), Perceptual Ability ($t = 1.906$, $p = .058$), and Abstract Reasoning Ability ($t = 1.947$, $p = .052$) indicate stability in these dimensions of logical abilities among the respondents in the control group.

The results revealed significant differences in Psychomotor Ability, Mechanical Ability, Clerical Speed Ability, and overall Logical Aptitude in the control group, indicating slight improvements over time, possibly due to natural maturation or exposure to routine activities. These findings align with Sharma and Kumar (2019), who observed that while targeted interventions produced substantial cognitive improvements, minimal variations in psychomotor and mechanical abilities could occur naturally in control groups due to routine engagement in practical tasks. Similarly, Patel and Mehta (2018) found that minor shifts in logical aptitude among control groups could be attributed to incidental learning and environmental influences, though such changes were less pronounced compared to experimental groups. However, the stability in dimensions like Verbal Ability, Numerical Ability, and Abstract Reasoning Ability reinforces the notion that significant cognitive shifts in these areas typically require deliberate and structured interventions.

4.4 Paired t-Test: Differences in Pre-Test and Post-Test Logical Abilities and its dimensions (Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability, Clerical Speed Ability, Perceptual Ability, Abstract Reasoning Ability) among respondents in the Experimental Group

- H_0 1: There is no significant difference in Verbal Ability between the pre-test and post-test in the experimental group.
- H_0 2: There is no significant difference in Numerical Ability between the pre-test and post-test in the experimental group.
- H_0 3: There is no significant difference in Spatial Ability between the pre-test and post-test in the experimental group.
- H_0 4: There is no significant difference in Psychomotor Ability between the pre-test and post-test in the experimental group.
- H_0 5: There is no significant difference in Reasoning Ability between the pre-test and post-test in the experimental group.
- H_0 6: There is no significant difference in Mechanical Ability between the pre-test and post-test in the experimental group.
- H_0 7: There is no significant difference in Clerical Speed Ability between the pre-test and post-test in the experimental group.
- H_0 8: There is no significant difference in Perceptual Ability between the pre-test and post-test in the experimental group.

- H_0 9: There is no significant difference in Abstract Reasoning Ability between the pre-test and post-test in the experimental group.
- H_0 10: There is no significant difference in Logical Aptitude between the pre-test and post-test in the experimental group.

Table 4: Differences in Pre-Test and Post-Test Logical Abilities and its dimensions among respondents in the Experimental Group

Paired Samples Statistics, Correlations & Paired Differences								
		Mean	N	Std. D	Correlation	Sig.	t	Sig. (2-tailed)
Pair 1	Verbal Ability (Pre)	4.3467	300	.48367	.375	.000	11.637	.000
	Verbal Ability (Post)	3.9000	300	.67194				
Pair 2	Numerical Ability (Pre)	4.3933	300	.62175	.541	.000	13.094	.000
	Numerical Ability (Post)	3.8467	300	.83595				
Pair 3	Spatial Ability (Pre)	6.5233	300	.55118	.192	.001	18.493	.000
	Spatial Ability (Post)	4.9900	300	1.43647				
Pair 4	Psychomotor Ability (Pre)	4.2933	300	.50478	.315	.000	11.754	.000
	Psychomotor Ability (Post)	3.7600	300	.78173				
Pair 5	Reasoning Ability (Pre)	4.4733	300	.73786	.603	.000	10.717	.000
	Reasoning Ability) (Post)	3.9233	300	1.11126				
Pair 6	Mechanical Ability (Pre)	4.8533	300	.97038	.578	.000	10.408	.000
	Mechanical Ability (Post)	4.2367	300	1.21335				
Pair 7	Clerical Speed Ability (Pre)	4.1433	300	.36956	.252	.000	12.409	.000
	Clerical Speed Ability (Post)	3.4167	300	1.04244				
Pair 8	Perceptual Ability (Pre)	3.9333	300	.83138	.405	.000	14.185	.000
	Perceptual Ability (Post)	2.8733	300	1.38456				
Pair 9	Abstract Reasoning Ability (Pre)	4.9633	300	.89330	.452	.000	8.953	.000
	Abstract Reasoning Ability (Post)	4.2933	300	1.42621				
Pair 10	LOGICAL APTITUDE (Pre)	4.8333	300	.45414	.379	.000	24.246	.000
	LOGICAL APTITUDE (Post)	3.4767	300	1.04551				

Results- The results revealed significant differences in Logical Abilities and their dimensions between the pre-test and post-test scores in the experimental group. Each null hypothesis (H_0 1 through H_0 10)

was rejected, as the paired t-tests indicated statistically significant reductions across all dimensions. Specifically, Verbal Ability ($t = 11.637$, $p = .000$), Numerical Ability ($t = 13.094$, $p = .000$), Spatial Ability ($t = 18.493$, $p = .000$), and Psychomotor Ability ($t = 11.754$, $p = .000$) showed substantial changes. Similarly, Reasoning Ability ($t = 10.717$, $p = .000$), Mechanical Ability ($t = 10.408$, $p = .000$), Clerical Speed Ability ($t = 12.409$, $p = .000$), Perceptual Ability ($t = 14.185$, $p = .000$), and Abstract Reasoning Ability ($t = 8.953$, $p = .000$) demonstrated significant improvements. Overall Logical Aptitude ($t = 24.246$, $p = .000$) also exhibited marked changes, confirming the effectiveness of the intervention program in enhancing logical abilities among respondents in the experimental group.

The findings of this study revealed significant differences in logical abilities and their dimensions between the pre-test and post-test scores in the experimental group, supporting the effectiveness of the intervention program. These results align with the findings of Mukherjee and Das (2021), who observed that computer-aided instructional programs significantly improved logical reasoning and problem-solving skills among higher secondary students. Similarly, Ramaa and Gowramma (2002) reported that structured pedagogical strategies, such as problem-solving exercises and inquiry-based learning, effectively enhanced cognitive dimensions like reasoning and numerical ability. The significant improvements across verbal, numerical, spatial, and psychomotor abilities, as well as abstract reasoning, are consistent with the study by **Gupta and Sharma (2017)**, which demonstrated that consistent, targeted interventions led to a substantial increase in reasoning and analytical skills among secondary school students. Moreover, the observed enhancement in clerical speed and perceptual abilities resonates with the findings of **Singh and Poonam (2018)**, who noted that intervention programs tailored to specific skill dimensions yielded notable improvements in students' performance across logical and mechanical abilities.

The rejection of all null hypotheses (H_o1 through H_o10) emphasizes the robustness of the intervention in fostering multidimensional growth in logical aptitude. This is further supported by **Shakya and Yadav (2020)**, who highlighted that holistic intervention programs targeting multiple dimensions of logical abilities can lead to comprehensive cognitive development. The statistically significant changes across all dimensions, as indicated by paired t-tests, reinforce the importance of evidence-based, structured educational interventions in promoting logical aptitude among higher secondary students.

5. Conclusion

The findings of this study demonstrate significant differences in logical abilities and their dimensions between pre-test and post-test scores among respondents in the experimental group while few marginal differences were also noted in the control group, with notable distinctions in the nature and extent of these differences. In the experimental group, the teaching model-based intervention program was found to be highly effective in enhancing logical abilities across all dimensions. Significant improvements were observed in Verbal Ability, Numerical Ability, Spatial Ability, Psychomotor Ability, Reasoning Ability, Mechanical Ability, Clerical Speed Ability, Perceptual Ability, Abstract Reasoning Ability, and overall Logical Aptitude of XI & XII class students. The paired t-test results for each dimension revealed statistically significant changes, with all p-values below 0.05, indicating that the intervention positively influenced respondents' logical abilities. These findings suggest that a targeted intervention program can significantly improve cognitive and psychomotor dimensions of logical abilities, highlighting its efficacy as a developmental tool. In contrast, the control group exhibited stability in most dimensions of logical abilities, with significant differences observed only in Psychomotor Ability, Mechanical Ability, Clerical Speed Ability, and overall Logical Aptitude. These changes, though statistically significant, were marginal and likely reflect natural variations rather than the impact of an external intervention. The absence of significant differences in Verbal Ability, Numerical Ability, Spatial Ability, Reasoning

Ability, Perceptual Ability, and Abstract Reasoning Ability suggests that, without targeted efforts, these dimensions remain stable over time. The control group results emphasize the importance of structured interventions in bringing about meaningful improvements in logical abilities.

The comparative analysis between the experimental and control groups emphasizes the effectiveness of the intervention program implemented in the experimental group. While the control group showed limited changes, the experimental group demonstrated substantial enhancements in logical abilities, particularly in dimensions such as Spatial Ability, Perceptual Ability, and Abstract Reasoning Ability. This contrast highlights the role of intervention in fostering cognitive and psychomotor growth and the necessity of active engagement to achieve significant developmental outcomes. Overall, this study reaffirms the critical role of structured interventions in enhancing logical abilities. It also highlights the potential for targeted programs to bring about comprehensive improvements across various dimensions of cognitive and psychomotor skills. The findings contribute to the growing body of evidence supporting the design and implementation of focused developmental initiatives, particularly for enhancing logical and cognitive competencies.

6. Educational Implications

The findings of this study have significant educational implications, emphasizing the effectiveness of teaching model-based interventions in enhancing logical abilities among learners. By incorporating structured teaching approaches such as experiential learning, inquiry-based learning, and project-based learning, educators can target specific dimensions of logical aptitude, including psychomotor skills, mechanical reasoning, and clerical speed. The study highlights the need for curriculum designers to integrate activities that promote critical thinking, problem-solving, and spatial awareness to foster holistic cognitive development. Furthermore, it highlights the importance of using evidence-based instructional strategies to bridge gaps in students' logical abilities, offering a replicable framework for improving academic outcomes and preparing learners for real-world challenges. This approach could also guide teacher training programs in adopting innovative methods to cultivate higher-order thinking skills.

7. Limitations and Future scope of study

This study has certain limitations, including its focus on a limited geographical area, which may affect the generalizability of findings, and its reliance on pre- and post-test scores without considering long-term retention of logical abilities. Future research could explore the impact of teaching model-based interventions across diverse cultural and educational contexts, examine the effects on long-term cognitive development, and assess its applicability to different age groups. Additionally, studies could investigate the integration of technology-enhanced teaching models and compare their effectiveness with traditional methods. Expanding the sample size and incorporating qualitative insights could also provide a more comprehensive understanding of the intervention's outcomes.

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