



# Identifying Scientific Reasoning Ability Among Secondary School Students

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**Abstract:** The instructional designs in schools are focused on supporting content knowledge but may not be sufficient to promote scientific reasoning ability among students, which is an important factor in improving student performance in science learning. The present study intended to identify the Scientific Reasoning Ability of Secondary School Students. In the present study, the descriptive survey method was used for the collection of data. The size of the sample was 100 students of 9th class from district Shimla of Himachal Pradesh, who were selected through Random Sampling Technique. To analyse the data, the Statistical techniques used in this study were Mean, Standard Deviation and 't'-test. The result of the study showed that among the five dimensions of scientific reasoning ability (i.e., Inductive reasoning, deductive reasoning, analogical reasoning, eclectic reasoning and classification as a reasoning), secondary school students have higher mean scores in Inductive reasoning, deductive reasoning and analogical reasoning, while low mean score were shown in eclectic reasoning and classification as a reasoning. Further, it was revealed that the boys and girls differ significantly in analogical and eclectic reasoning dimensions. Mean scores of boys were higher than girls in inductive and analogical reasoning dimension while, means scores of girls were higher than boys in deductive, eclectic and classification as a reasoning dimension of scientific reasoning ability. These findings point to the necessity of placing more focus on identifying scientific reasoning ability pattern among students so that scientific training as well as informal learning opportunities could be designed to improve scientific reasoning ability among students.

**Index Terms – Scientific Reasoning Ability, Secondary School Students.**

## 1. INTRODUCTION

Scientific literacy is now regarded as the primary goal for the development of twenty first century citizens. Scientific reasoning ability has been identified as an important factor in fostering student performance in science learning. Scientific reasoning entails activities such as hypothesis generation, testing, and revision, as well as reflection on the process of knowledge acquisition and change. Broadly defined, scientific reasoning covers the thinking abilities involved in inquiry, investigation, evidence evaluation, inference, and argumentation performed in the service of conceptual transformation or scientific understanding (Zimmerman, 2005). The first step in conducting a scientific inquiry is coming up with questions that motivate students to identify a problem and formulate a hypothesis. Next comes formulating plans, carrying out the study, drawing conclusions, and reporting the results. Forming plans and carrying out study scientifically generates excitement and curiosity among students, which is likely to motivate students to learn better. Despite its significance, studies acknowledge that students have difficulty posing questions, formulating hypothesis and finding out meaningful conclusions. Lawson (2004) and National Research Council (2012) mentioned that the development of students' scientific reasoning abilities is a major educational goal and a top priority in science and mathematics education. Scientific reason ability has received a lot of attention in science education because of its connection to the creation and revision of conceptions and hypotheses about the natural and social environment (Lawson, 2004, Zimmerman, 2007). Therefore,

fostering scientific reasoning is fundamental to nurturing scientific literacy and empowering critical thinkers. Equipping students with inquiry skills contributes to a society capable of addressing challenges and making evidence-based decisions.

## II. REVIEW OF LITERATURE

Scientific thinking includes general cognitive actions like induction, deduction, analogical reasoning, problem solving, and causal reasoning (Dunbar & Fugelsang, 2005). Scientific reasoning, which is defined as the application of thinking about scientific knowledge, it is argued that it can be developed through education (Adey & Csapo, 2012; Hogan & Fisherkeller, 2005). Jensen et. al (2017), Van & Csapó (2023) in their study found out that the learning scientific reasoning skills may be key to retention in science, technology, engineering, and mathematics (STEM). The results showed that there was a link between reasoning ability and high-level performance in final course grades. Fabby (2015) found that Students with higher scientific reasoning abilities performed well in solving concepts of different problem levels, while students with lower reasoning abilities struggled in solving problems that required higher conceptual understanding. Many science education researchers have reported that gender influences students' understanding and attitudes toward science. Joshua (2016) studied scientific reasoning of higher secondary school students and found that there was a significant difference in scientific reasoning among higher secondary students based on gender. Demirtas (2011) found that scientific thinking ability differs according to gender in the dimensions of correlational thinking and thinking with combinations. Girls were better in terms of correlational thinking and boys were better in thinking in combinations. While Piraksa et. al (2014) and Talib et. al (2018) found that the gender has no effect on students' scientific reasoning skills.

## III. NEED AND SIGNIFICANCE

To assist children become better science students and scientifically literate adults, there is a need and relevance for growing studies into developing scientific talents such as scientific reasoning ability, problem solving ability, and so on. To promote and establish such abilities in the science classroom, it is necessary to identify and assess students' scientific reasoning patterns and develop valid instructional tools that helps to develop their scientific reasoning ability. This view led researcher to take the study for identifying scientific reasoning ability pattern of the students, so that the various teaching methods and curriculum can be designed to develop these skills among students.

## IV. METHODOLOGY

### 1. Objectives of the study

To study and compare the Scientific Reasoning Ability of Girls and Boys of Secondary Schools with respect to following dimensions:

- a) Inductive Reasoning
- b) Deductive Reasoning
- c) Analogical Reasoning
- d) Eclectic Reasoning
- e) Classification as Reasoning

### 2. Hypothesis of the study

1. There will be no significance difference between the Scientific Reasoning Ability of Girls and Boys of Secondary Schools.

### 3. Delimitations of the study

1. The study was delimited to district Shimla of Himachal Pradesh only.
2. The study was delimited to 9<sup>th</sup> standard Secondary School Students only.

### 4. Research method

For conducting the present study, a descriptive survey method was used by the investigator to collect the data.

## 5. Variables of the study

For the present investigation, gender was taken as independent variables and Scientific Reasoning Ability was taken as dependent variables.

## 6. Population and Sampling

All the secondary school students of district Shimla constitute the population of the study. The investigator collected data from 100 secondary school students of 9th standard from different areas of District Shimla. Six schools were selected through random sampling technique. The sample of the students was drawn randomly.

## 7. Tools used for data collection

For collecting desired data for the present study, a scientific reasoning ability questionnaire prepared by Ramellind Kynta (2017) was used.

## 8. Statistical techniques

To analyse the data, the statistical measures such as Mean, S.D., and 't'-test were applied to the raw scores.

## V. ANALYSIS AND INTERPRETATIONS

**Objective 1: To study and compare the Scientific Reasoning Ability of Girls and Boys of Secondary Schools.**

In order to find out the Scientific Reasoning Ability of Girls and Boys of secondary Schools, the means, standard deviations and 't'-value of the scores are given below:

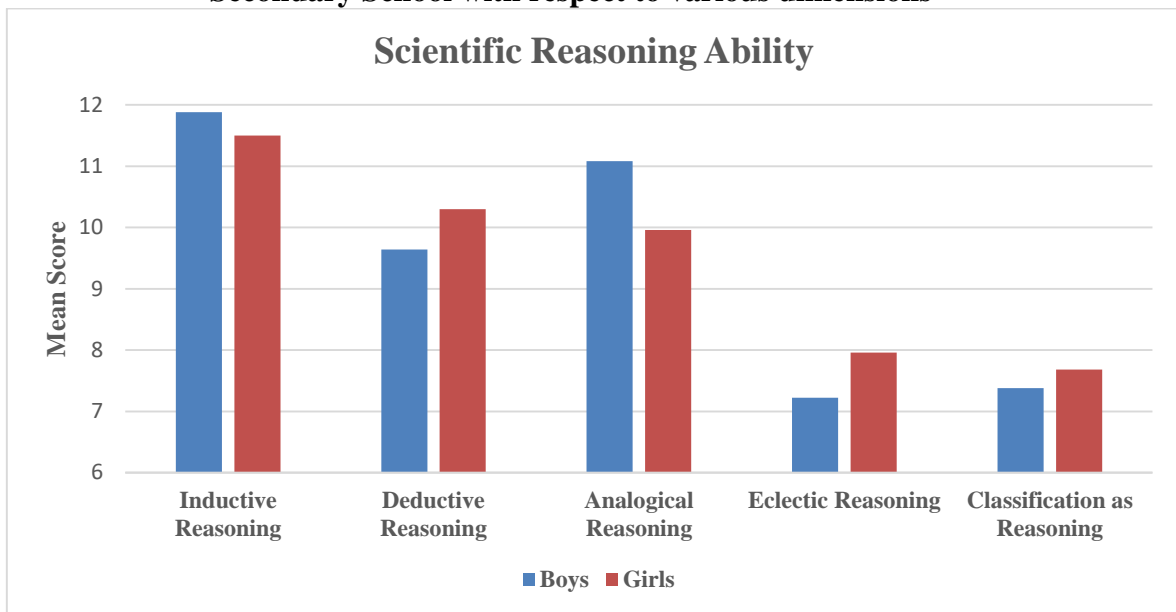
**Table 1.1 Showing the mean comparison on Scientific Reasoning Ability between Girls and Boys of Secondary School**

Dimensions	Group	Mean	S.D.	t-value	Level of significance
Inductive Reasoning	Boys	11.88	1.67	1.15	Non-significant
	Girls	11.5	1.63		
Deductive Reasoning	Boys	9.64	1.97	1.77	Non-significant
	Girls	10.3	1.74		
Analogical Reasoning	Boys	11.08	1.96	3.11	Significant at 0.01 level
	Girls	9.96	1.61		
Eclectic Reasoning	Boys	7.22	1.07	2.59	Significant at 0.05 level
	Girls	7.96	1.04		
Classification as Reasoning	Boys	7.38	2.06	0.85	Non-significant
	Girls	7.68	1.40		

\*Table value of 't' at 0.01 level is significance with df=98 is 2.63.

\*Table value of 't' at 0.05 level is significance with df=98 is 1.98.

**Graph 1.1 Showing the mean comparison on Scientific Reasoning Ability between Girls and Boys of Secondary School with respect to various dimensions**



From the table 1.1 it is clear that among the five dimensions of scientific reasoning ability (i.e., Inductive reasoning, deductive reasoning, analogical reasoning, eclectic reasoning and classification as a reasoning), secondary school students have higher mean scores in Inductive reasoning, deductive reasoning and analogical reasoning, while low mean score were shown in eclectic reasoning and classification as a reasoning. The table also reveals that among the five dimensions of scientific reasoning ability there is significant difference between mean scores of the girls and boys of secondary school in analogical reasoning at 0.01 level and eclectic reasoning at 0.05 level of significance. Further, the mean scores of boys were higher than girls in inductive and analogical reasoning dimension while, mean scores of girls were higher than boys in deductive, eclectic and classification as a reasoning dimension of scientific reasoning ability.

## VI CONCLUSION

The finding of the study reveals that pattern and gender differences in scientific reasoning ability of the secondary school students. Results revealed that secondary school students' scientific reasoning abilities vary across multiple dimensions. Students tend to have higher mean scores in inductive reasoning, deductive reasoning, and analogical reasoning, while eclectic reasoning and classification as reasoning have comparatively lower mean scores. Gender differences in scientific reasoning skills are also visible. Joshua (2016) and Demirtas (2011) also found the gender differences in their study. The results emphasize the importance of instructional designs that is not only focused on supporting content knowledge but it also should be sufficient to promote scientific skills among students and increasing their academic performance. Adey & Csapo (2012), Hogan & Fisherkeller (2005), Jensen et. al (2017) showed in their study that there is a link between reasoning ability and high-level performance in final of students. Considering the importance of reasoning to science education, it is important for teachers as well as educational organizations to help students foster their scientific skill and enhances their performances.

## VII EDUCATIONAL IMPLICATIONS

- 1. Dimensional Focus:** Educators should recognize students' varying strengths and limitations across multiple dimensions of scientific thinking. They can create teaching tactics that capitalize on students' strengths while simultaneously targeting areas of weakness in order to improve their overall scientific reasoning capabilities.
- 2. Promote Holistic Reasoning:** Because students performed better in inductive, deductive, and analogical reasoning, educators can add interdisciplinary activities and real-world problem-solving scenarios that encourage students to employ these reasoning abilities in tandem. This can assist overcome the theoretical-practical divide.
- 3. Targeting Weak Dimensions:** Because eclectic reasoning and classification as reasoning have lower mean scores, educators can construct targeted interventions to strengthen these areas. Students' thinking abilities can be strengthened through interactive exercises, case-based learning, and collaborative projects that challenge them to categorize and synthesize material.

4. **Gender-Specific Needs Assistance:** To overcome the identified gender inequalities, teachers might use instructional strategies that adapt to the various learning preferences of boys and girls. Encourage girls to participate actively in inductive and analogical reasoning, while providing boys with opportunity to improve their deductive and classification-based debates.
5. **Promote Critical Thinking:** Critical thinking skills are closely related to scientific reasoning ability. Educators should emphasize on encouraging critical thinking across all levels of reasoning. This can be done through discussions, debates, problem-solving tasks, and reflective assignments.

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