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Research Paper

A Study on the Relationship between Scientific Reasoning and Achievement in Chemistry of Secondary School Students

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ABSTRACT: *Reasoning in psychological perspective may be defined as set of mental processes used to derive inferences or conclusions from premises (Samarapungavan, 2009). Reasoning helps us to generate new knowledge and to organize existing knowledge making it more usable for future mental work. Reasoning therefore becomes central to many forms of thought such as scientific, critical, and creative thinking, argumentation, problem solving, and decision making. Reasoning is an inevitable part of the various aspects of academic inquiry. In this paper, the Investigators tried to find out the relationship between Scientific reasoning and Achievement in Chemistry of Secondary school students for total sample and for the subsample Gender. They also tried to find out whether there exists any significant difference in the Scientific reasoning and Achievement in Chemistry of Secondary school students based on their Gender. Proper statistical techniques were used to collect, standardize and Analyze the data.*

Keywords: - Scientific reasoning, Achievement in Chemistry, Secondary school students

I. INTRODUCTION

In literature, there are many definitions for Scientific Reasoning. From the science literacy perspective, Scientific reasoning includes the cognitive skills necessary to understand and evaluate scientific information, which often involve understanding and evaluating theoretical, statistical and causal hypotheses (Giere, Bickle & Mauldin, 2006; Hazen & Trefil, 1991). In a research point of view, Scientific reasoning broadly defined includes the thinking and reasoning skills involved in inquiry, experimentation, evidence evaluation, inference and argumentation that support the formation and modification of concepts and theories about the natural and social world (Zimmerman, 2005).

According to Middle States Commission on Higher Education (2002), scientific reasoning is a mode of thought that:

- Draws on systematic observation and description of phenomena
- Employs established facts, theories and methods to analyze such phenomena
- Draws inference and frames hypotheses consistent with that body of public knowledge and understanding
- Subjects explanations to empirical tests, including scrutiny of their declared and latent assumptions; and
- Allows the possibility of changes in explanations as a new evidence emerges

Scientific reasoning involves different components namely problem identification, Interpretation of results, making logical conclusions, deductive reasoning and inductive reasoning. A problem identification is built from an analysis of the situation. Exact identification of the problem requires proper scientific reasoning ability among the students. Interpretation of results obtained from data obtained must be scientific in the sense that the interpretations must have a clear scientific base and should be the result of proper scientific reasoning. The aim of evidence evaluation is to assess the degree to which a certain piece of evidence supports a claim or theory. What counts as evidence will differ both with respect to the epistemic mode in which scientific reasoning activity is realized and with respect to the domain under study (Shafto, Kemp, Bonawitz, Coley, & Tenenbaum, 2008).

In the case of inductive reasoning, a student may observe a series of events and try to discover a rule that governs them. Once a rule is discovered, students can extrapolate from the rule to formulate theories of the observed and yet to be observed phenomena. Inductive reasoning is the process in which it is believed that the premises of an argument support the truth of the conclusion. Deductive reasoning is an extremely important aspect of scientific thinking because it underlies a large component of how student conduct their experiments. Deductive reasoning or deduction consists of arguments where if the premises are assumed to be true, then it is

impossible for the conclusion to be false. Using deduction, there is a formulation of specific conclusion from a general truth (Lipton, 1998).

1.1 Need and Significance of the Study

Reasoning in psychological perspective may be defined as set of mental processes used to derive inferences or conclusions from premises (Samarapungavan, 2009). Reasoning helps us to generate new knowledge and to organize existing knowledge making it more usable for future mental work. Reasoning therefore becomes central to many forms of thought such as scientific, critical, and creative thinking, argumentation, problem solving, and decision making. Scientific reasoning assesses students' abilities in six dimensions including conservation of matter and volume, proportional reasoning, control of variables, probability reasoning, correlation reasoning and hypothetical-deductive reasoning (Lawson, 2000).

In the fast moving world, Education is also undergoing tremendous changes. Technology and Science are developed in such a manner that the practical Applications of Science in a systematic, logical and scientific manner has become more important than mere learning of Science content. For this reasoning power is a must. It should be developed in the minds of students from primary classes onwards. Students can explore in the field of Science and Technology only through the development of Scientific reasoning power. It includes the ability to identify problematic situations, making logical decisions or conclusions about any scientific process or phenomenon, Interpreting scientific events or scientific results and data, deductive and inductive reasoning. Through these processes of scientific reasoning, the knowledge acquired by the students may transform into a practical knowledge of the Science and which may help them to better understanding of the concepts in a systematic way. It will help students to store the informations constructively in their schemas which may ultimately lead to better Achievement in Science. Hence the Investigator decided to check the relationship between Scientific reasoning and Achievement in Chemistry.

1.2 Hypotheses of the Study

- There will be significant positive relationship between Scientific reasoning and Achievement in Chemistry of Secondary school students for the Total Sample and Subsample based on Gender
- There will be significant difference in the Scientific reasoning of Secondary school students based on Gender.
- There will be significant difference in the Achievement in Chemistry of Secondary school students based on Gender

1.3 Objectives of the Study

- To find out whether there exist any significant relationship between Scientific reasoning and Achievement in Chemistry of Secondary school students for the Total Sample and Subsample based on Gender
- To find out whether there exist any significant difference between the Scientific reasoning of Secondary school students based on Gender
- To find out whether there exist any significant difference between the Achievement in Chemistry of Secondary school students based on Gender

1.4 Population for the Study

Secondary school students studying in the schools run by General Education Department of Government of Kerala is selected as the population for the study.

1.5 Sample selected for the Study

The sample selected for the study consists of 176 secondary school students studying in standard IX from various schools of Kottayam District. Out of the 176 Secondary School students, 94 were Boys and 82 were Girls. The sample was selected using Stratified Random sampling Technique.

1.6 Tools used for the Study

1.6.1 Scientific Reasoning Test: - The Investigators prepared a Scientific reasoning Test based on the five dimensions namely Problem Identification, Interpretation of Results/Data, Making logical conclusions, Deductive reasoning and Inductive reasoning. The initial draft consisted of 70 items with a total of 75 Marks. After Standardization process, the number of items was reduced to 26 with a total mark of 45. Items with *t* value > 8.500 at .01 level were only considered for the final test. Reliability of Scientific reasoning test was ensured using Test – re test reliability. The Chronbach's α Coefficient for the whole test was found to be .994. The Chronbach's α Coefficient obtained for various components of Scientific Reasoning test are .943 for Problem Identification, .981 for Inductive Reasoning, .981 for Deductive Reasoning, .983 for Interpretation of results and .974 for Making Logical conclusions and Critical evaluations. Face validity, Content validity and Intrinsic

validity were used to validate the test. For the whole test the Intrinsic validity coefficient was found to be .996. The validity coefficients obtained for the components of Scientific reasoning are .948 for Problem Identification, .983 for Inductive Reasoning, .981 for Deductive Reasoning, .984 for Interpretation of Results and .976 for Making logical conclusions and Critical evaluations.

1.6.2 Achievement test in Chemistry: - An achievement test in Chemistry was prepared and standardized by the Investigator from selected units of Standard IX Chemistry text book namely 'Some Non metals in Nature' and 'The world of Carbon'. The draft test was prepared for 90 marks having multiple choice questions carrying one mark each. Proper weightage was given for content and level of questions. The test was prepared by giving weightage to five domains in the McCormack and Yager taxonomy of Educational objectives namely, Knowledge domain, Process domain, Creativity domain, Application domain and Attitude domain. After standardization 30 items having DI between 0.45 and 0.8 and with DP above 0.4 were selected for the final test. The reliability of the test was found to be 0.953 for the whole test using test-retest method. The Chronbach's Alpha obtained for the whole test was 0.973 and 0.880, 0.848, 0.902, 0.887 and 0.917 for the domains Knowledge, Process, Creativity, Application and Attitude respectively. Face validity, Content validity and Intrinsic validity were established for determining the validity of the Test. The Intrinsic validity was found out as 0.976.

1.7 Methodology used for the Study

The Investigators administered Scientific Reasoning Test and Achievement test in Chemistry among Secondary school students of the selected sample. The answer sheets were collected; tabulated and suitable statistical techniques were used for analyzing the data obtained.

1.8 Statistical Techniques used

- ✓ Descriptive Statistics
- ✓ Significance of difference between Means
- ✓ Call Pearson Product moment Correlation

II. ANALYSIS AND INTERPRETATION

2.1 Relationship between Scientific Reasoning and Achievement in Chemistry of Secondary School Students for the Total Sample and for the Subsample based on Gender

The Investigators collected the scores of students on Scientific Reasoning Test and Achievement test in Chemistry. The Mean and Standard Deviation obtained for the Total sample and Subsample Boys and Girls on Scientific Reasoning and Achievement in Chemistry were given in Table 1.

Table 1

Descriptive Statistics for the Total sample and Relevant Subsamples on Achievement in Chemistry and Scientific Reasoning

	Total Sample		Boys		Girls	
Variables	Mean	S.D	Mean	S.D	Mean	S.D
Achievement in Chemistry	13.37	5.92	16.11	6.4	16.67	5.41
Scientific Reasoning	24.31	11.23	25.50	10.91	22.95	11.5

Table 1 shows that the Mean scores obtained by Boys on variable Scientific Reasoning are slightly higher than Girls. This implies that Boys have more Scientific Reasoning than Girls.

The correlation between Scientific Reasoning and Achievement in Chemistry were found out for the Total Sample and the Subsample Gender using Pearson Product moment Correlation. The results obtained are given in Table 2.

Table 2

Correlation between Scientific Reasoning and Achievement in Chemistry for the Total Sample and Subsample Gender

No.	Variables Correlated	'r' value		
		Total Sample (N = 176)	Boys (N = 94)	Girls (N = 82)
1	Scientific Reasoning and Achievement in Chemistry	0.604^{**}	0.587^{**}	0.656^{**}

** - Significant at .01 level

Table 2 shows that the correlation coefficients obtained for the Total Sample, Boys and Girls are all positive. This reveals that there exists a significant positive correlation between Achievement in Chemistry and Scientific Reasoning for the Total sample and the subsamples Boys and Girls.

2.2 Comparison of Scientific Reasoning and Achievement in Chemistry of Secondary school students based on Subsample Gender

The Mean and Standard deviation were calculated for the Subsamples Boys and Girls. Significance of difference between the Mean Scores of Boys and Girls were found out for the variables Scientific Reasoning and Achievement in Chemistry. The results obtained were given in Table 3.

Table 3

Comparison of Boys and Girls on Scientific Reasoning and Achievement in Chemistry

Variables	Gender	N	Mean	S.D	t-value
Achievement in Chemistry	Boys	94	16.11	6.4	
					0.629
	Girls	82	16.67	5.41	
Scientific Reasoning	Boys	94	25.50	10.91	
					1.508
	Girls	82	22.95	11.5	

Table 3 shows there is no significant difference between the Boys and Girls on Achievement in Chemistry and Scientific Reasoning of Secondary school students. The Mean scores however shows that Girls are slightly higher than Boys on Achievement in Chemistry and Scientific Reasoning.

2.3 Major Findings of the Study

- ❖ There exists significant positive Correlation between Achievement in Chemistry and Scientific Reasoning of Secondary school students for the Total Sample and Subsample Gender
- ❖ There is no significant difference in Scientific Reasoning of Secondary school students based on Subsample Gender
- ❖ There is no significant difference on Achievement in Chemistry of Secondary school students based on Gender.

2.4 Educational Implications of the Study

- ✓ The study shows that Scientific reasoning and Achievement in Chemistry of Secondary School students are positively correlated. This means that the learning activities and written assignments in the classroom all should be designed in such a manner to arouse and promote Scientific reasoning in students. This will leads to learning the scientific concepts at a greater rate and thereby better achievement in the content area.
- ✓ The School curriculum should incorporate the teaching techniques and strategies that can promote scientific reasoning among students.
- ✓ The Science Teacher Education Curriculum should be restructured to include Innovative Instructional Strategies, Methods and Learning Models which can help the student teachers to practice and apply in regular classrooms to foster Scientific reasoning.
- ✓ The result which shows no significant difference between Boys and Girls in Scientific reasoning and Achievement in Chemistry is a merit of the present Educational system. It is a good sign that Gender disparity does not exist in the Achievement level and level of Scientific reasoning. But the Teaching-learning process must be made more strengthened by developing creative and efficient ways of Teaching Methods and Techniques to reduce the disparity based on gender to the minimum level possible.

III. CONCLUSION

Scientific reasoning is a must of Science Teaching – learning process. It will help students to think at a deeper level to analyze complex and abstract concepts of Science and to organize the Knowledge structure systematically into their cognitive structure or Schema. Scientific reasoning and Achievement in Science are related to each other. So it is the responsibility of the Teachers and Educational Administrators to provide ways which can promote Scientific reasoning among Secondary school students.

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REFERENCES

[1]. Rajamanickam, M (2001). Statistical methods in Psychological and Educational Research. New Delhi: Concept Publishing Company Pvt. Ltd.
[2]. Best, J.W., & Kahn, J.V. (2010). Research in education. New Delhi: Prentice hall of India.
[3]. Best, J.W., & Kahn, J.V. (2004). Research in education. New Delhi: Prentice hall of India.
[4]. Garrett, H. E. (2005). Statistics in Psychology and Education. New Delhi: Paragon International Publications.
[5]. Lawson, A. E (2000). "The development and validation of a classroom test of formal reasoning," Journal of Research in Science Teaching **15**(1), 11-24 (1978). Test used in study: Classroom Test of Scientific Reasoning revised ed.
[6]. Zimmerman, C (2005). The Development of Scientific Reasoning: What psychologists contribute to an Understanding of Elementary Science Learning. Paper commissioned by the National Academies of Science (National Research Council's Board of Science Education, Consensus Study on Learning Science, Kindergarten through Eighth Grade). http://www7.nationalacademies.org/bose/Corinne_Zimmerman_Final_Paper.pdf.
[7]. Lipton, P (1998). "Induction", Philosophy of Science: The Central Issues", 1st ed., W. W. Norton, New York, , pp. 412-425.
[8]. Samarapungavan, A (2009). Children's thoughts on the origin of species: A study of explanatory coherence. Cognitive Science, 21, 147-177.
[9]. Giere, R. N., Bickle, J., & Mauldin, R. F (2006). Understanding Scientific Reasoning, 5th edition, Belmont, CA: Thomson/Wadsworth.
[10]. Hazen, R. M., & Trefil, J. (1991). Science Matters: Achieving Scientific Literacy. New York: Anchor Books.