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A Study of Gender, Habitation and Logical Thinking in Relation to Achievement in Science

KEYWORDS: Logical thinking, Gender, Habitation, Achievement in Science

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ABSTRACT *The purpose of present study was to found out differences among low, average and high logical thinking on achievement in science for rural male, urban male, rural female and urban female students. Using simple random sampling technique 200 students were selected from 5 higher secondary school of Sagrur District. Logical Thinking Scale by Sujeet Kumar and Shikha Tiwari and Science Achievement Test (SAT) by Dr. R.D. Singh were used to measure logical thinking and achievement in science, respectively. Analysis of variance was used to analyse data. Results of this study show that significance difference exist among low, average and high logical thinking on achievement in science in favour of high logical thinking for all groups (rural male, urban male, rural female and urban female) and total sample. This study suggested that classroom teachers and teacher institution should develop logical thinking of their students.*

Introduction

We are living in era of science. Science is everywhere in the world. It is part of our daily lives. Science has provided great service to humankind. It has provided us many facilities related to different area of life (health, communication, transportation, entertainment, reading and learning etc.) that have made our lives very easy and comfortable. For example, electricity, train, tractor, bus, car, motorcycle, television, heater, cooker, airplane, computer, tablet, phone, medicine, various types of machines, rocket, fertilisers etc. are very useful for humankinds. According to DiChristina (2014) science is the engine of prosperity. It is a system for exploring and for innovation. It can fuel our nation's economic growth. It can form a path for our young people in a competitive global market place. And it can fire our imagination.

A knowledge and love of science is the right pathway for better quality of life. Science education is very important to the development of any nation in different areas of knowledge. Without science education development of technology is not possible. Development of engineering, medicine, architecture, etc. will not be possible without science education. Technology is the application of this scientific knowledge. Hence, science technology and development are proportional to each other. Development in the field of all area of knowledge is very essential for each individual of each country. For development sound knowledge of science and technology is essential. Without effective implementation of science and technology, no nation could grow. A nation who is not able to develop science and technology in this emerging scientific era would never be able to sustain the lives and may depend on other nations for their basic requirements. Therefore, development of science education is urgent need of any nation.

Science education mainly consist three subjects, namely biology, chemistry and physics. Science is knowledge about any system on the basis analysing and understanding facts through scientific approach. Science provides a solid conclusion on the basis of factual, repeatable, measurable and determinable results. It provides us with a logical, factual and generally rational explanation of the World around us. One of the most essential goals of science education is to develop students' logical thinking skills. Logical thinking is a reasoning skill to think logically and systematically. With formal logical thinking skills, a learner solves the problem or gives principals or rules by doing some abstraction and generalization. Logical thinking is considered important to understand concepts from elementary school to university level. Learner at formal operational stage (higher stage of logical thinking) can think logically about abstract concepts and test hypotheses systematically. Cohen (1980) stated that the person with higher ability of thinking function effectively in the society. Renner and Philips (1980) strongly believed that students should be given opportunities to develop their logical thinking abilities for intellectual development. Lawson (1985) also emphasize that schooling system is not meant for teaching of facts and concepts which are related to specific knowledge domain but more importantly to assist students in acquiring logical thinking skills. According to Shayer (1999) high abstract thinking levels do predict good achievement in mathematics and science.

Previous studies show that logical thinking is positively and significantly associated with achievement in science subjects. Lawson and Renner (1975) claimed that students with low formal reasoning face learning difficulties when they deal with concepts which require formal reasoning. Hence, it can be said that understanding formal concepts may be difficult for those students who have not developed formal reasoning ability (Williams & Cavallo, 1995). Wilson and Wilson (1984) pointed out that formal operational reasoning is determinants of students' success in science and mathematics advanced courses at secondary level. Chikkar (1985) investigated the relationship of reasoning abilities with achievement of concepts in life science and found a positive relationship between conceptual achievement in life sciences and reasoning ability. Bello (1993) reported that formal reasoning is positively related to sci-

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ence achievements. Shayer and Adey (1994) pointed out that operational reasoning abilities are significantly related to achievement. Johnson and Lawson (1998) investigated the effect of reasoning ability on biology achievement in expository and inquiry classes. They found significant positive correlation between reasoning ability and biology achievement in both of the classes. Danjuma (2005), Demide (2000), Krajcik and Hanet (1987), Oloyede (1998) and Sayre & Ball (1975) all agreed that formal reasoning is the strongest predictor of process science achievement. Lawson *et al*. (2000) also reported a significant relationship between conceptual knowledge and cognitive developmental level. Cepni, Ozsevgec and Cerrah (2004) was found significant relationship between reasoning ability and achievement in science. Bird (2010) was found that students at a formal operational stage perform significantly better in the general chemistry examination than students operating at lower levels. Oloyede (2012) was found a positive relationship between formal reasoning ability and chemistry achievement senior secondary students. Nnorom (2013) studied effect of reasoning skills on students achievement in Biology and found that students with high reasoning skills performed better in biology than the students who have low reasoning skills. Achor *et al.* (2015) was found that achievement of high and low reasoning ability level students significantly differed in favour of high ability students.

Sex and habitation are other variables that are also taken into account by many researchers to study achievement in science subjects. These studies are showin contradictory results. Some studies (Achor *et al.,* 2015, Atkinson, 2004; Dimitrov, 1999; Duguryil, 2004; Hupper *et al*., 2002; Nnorom, 2013; Ogbeba, 2009; Sungur & Tekkaya, 2003; Ugwu & Soyibo, 2004) indicated no significant difference between boys and girls in achievement in science subjects, while others reported significant gender differences (Cavallo *et al.*, 2004; Nkwo, Akubolola and Edinyang, 2008; Soyibo, 1999; Young & Fraser, 1994). Dimitrov (1999) revealed that there was no significant difference between girls and boys with respect to achievement in life sciences. Similarly, Ugwu and Soyibo (2004) reported no significant gender difference in Jamaican eighth-grade students' performance on the nutrition and plant reproduction concepts. Nnorom (2013) was found that gender does not have any effect on biology achievement. Achor *et al.* (2015) found that male and female basic science students exposed to content prior to instruction do not significantly differ in their achievement. On the other hand, results of the study carried out by Soyibo (1999) showed that girls performed significantly better on a test of errors in biological labelling. Young and Fraser (1994) revealed significant gender differences in biology achievement in favour of the boys. Moreover, Stark and Gray (1999) reported that girls performed at significantly higher levels on tasks where the content/context was drawn from the biological sciences and those written tasks assessing science skills. Boys, however, were found to be superior in the physical sciences. A similar finding was reported by Cavallo *et al.*, (2004). Nkwo, Akubolola and Edinyang (2008) found significant difference in performance of boys and girls in biology when exposed to student centred method. Mondal and Saha (2013) was found that male and female students differ significantly with regard to achievement in science subjects at secondary level. These studies are showing contradictory results related to sex and achievement in science subjects.

Ghosh, G.P. (1985) reveals that rural and urban students did not differ significantly on achievement in science. Mondal and Saha (2013) were found that (1) urban male & rural male students differ significantly in achievement in science at Secondary stages, (2) urban female & rural female students differ significantly in achievement in science at Secondary level. Agbaje and Awodun (2014) study revealed that there was statistical significant difference in the achievement mean scores of students in rural and urban school located areas. Mean of rural students was found higher than urban students.

It is clear from above review that results study of achievement in science in relation to sex and habitation produced contradictory results. But investigators were found lack of study of achievement in relation to logical thinking, separately for rural male, rural female, urban male and urban female. Therefore, there is need to find out the effect of logical thinking on students' achievement in science with controlling sex and habitation. The purpose of present study was to found out differences among low, average and high logical thinking students on achievement in science with controlling sex and habitation.

Objectives

Present study has been conducted with following objectives:

1. To study the difference among low, average and high logical thinking on achievement in science of rural male students of XII grade.
2. To study the difference among low, average and high logical thinking on achievement in science of urban male students of XII grade.
3. To study the difference among low, average and high logical thinking on achievement in science of rural female students of XII grade.
4. To study the difference among low, average and high logical thinking on achievement in science of urban female students of XII grade.
5. To study the difference among low, average and high logical thinking on achievement in science of XII grade.

Hypothesis

Objective wise null hypotheses were formed in following way:

1. There is no significant difference among low, average and high logical thinking on achievement in science of rural male students of XII grade.
2. There is no significant difference among low, average and high logical thinking on achievement in science of urban male students of XII grade.
3. There is no significant difference among low, average and high logical thinking on achievement in science of rural female students of XII grade.
4. There is no significant difference among low, average and high logical thinking on achievement in science of urban female students of XII grade.
5. There is no significant difference among low, average and high logical thinking on achievement in science of XII grade.

Methodology

Population and Sampling

The target population for the study comprised all the students of Senior Secondary School (grade XII) in Sangrur Disrtict of Punjab State, India. Using simple random sampling technique 200 students were selected from 5 higher secondary school of Sagrur District.

Tools used

Logical Thinking Scale prepared and standardized by Su-

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jeet Kumar and Shikha Tiwari was used to measure the logical thinking of higher secondary school students. Science Achievement Test (SAT) constructed and standardized by Dr. R.D. Singh was used to measure achievement in science of higher secondary school students.

Statistical Analysis
The data was analyzed using one-way analysis of variance.

Results
To find out differences among low, average and high logical thinking of higher secondary students on achievement in science analysis of variance was used. Descriptive statistics of low, average and high logical thinking students on achievement in science for rural male, urban male, rural female and urban female is given in Table-1.

Table-1
Descriptive statistics for one-way analysis of variance to find out differences of Gender, habitation and logical thinking on achievement in science.

Gender	Male	Female	Total				
Habitation	Rural	Urban	Rural	Urban			
Logical Thinking	Low	N	14	17	15	19	65
		Sum	475	610	534	684	2303
		Sum of Squares	16567	22714	19326	25120	83727
		Mean	33.929	35.882	35.600	36.000	35.431
		S.D.	5.890	7.184	4.748	5.249	5.724
	Average	N	15	18	18	13	64
		Sum	560	655	686	443	2344
		Sum of Squares	21336	24765	26530	15273	87904
		Mean	37.333	36.389	38.111	34.077	36.625
		S.D.	5.538	7.397	4.764	3.840	5.667
	High	N	21	15	17	18	71
		Sum	905	662	747	741	3055
		Sum of Squares	39921	30070	34013	30889	134893
		Mean	43.095	44.133	43.941	41.167	43.028
		S.D.	6.782	7.809	8.620	4.756	6.963
Total	N		50	50	50	50	200
	Sum		1940	1927	1967	1868	7702
	Sum of Squares		77824	77549	79869	71282	306524
	Mean		38.800	38.540	39.340	37.360	38.510
	S.D.		7.144	8.102	7.053	5.465	7.043

Results of analysis of variance for differences among low, average and high logical thinking students on achievement in science for different groups are depicted in Table-2.

Table-2
Summary of analysis of variance to find out impact of logical thinking on achievement in science for rural male, rural female, urban male and urban female students

Group	Source of Variation	Df	Sum of Squares	Mean sum of Square	F	p
Male Rural Students	Among Group	2	751.929	375.964	9.816	0.0003
	Within Group	47	1800.071	38.299		
	Total	49	2552.000			
Male Urban Students	Among Group	2	672.644	336.322	6.057	0.005
	Within Group	47	2609.776	55.527		
	Total	49	3282.420			
Female Rural Students	Among Group	2	596.901	298.451	7.421	0.002
	Within Group	47	1890.319	40.220		
	Total	49	2487.220			
Female Urban Students	Among Group	2	436.097	218.048	9.692	0.0003
	Within Group	47	1057.423	22.498		
	Total	49	1493.520			
Total Students	Among Group	2	2293.098	1146.549	29.615	0.0000
	Within Group	197	7626.882	38.715		
	Total	199	9919.980			

Table-2 shows that F value for difference among low, average and high logical thinking rural male students on achievement in science is 9.816. Probability of this F value is 0.0003 which is less than 0.01. This means that significant difference exist among low, average and high logical thinking rural male students on achievement in science in favour of high logical thinking. Therefore, null hypothesis that "There is no significant difference among low, average and high logical thinking on achievement in science of rural male students of XII grade" is rejected.

F value for difference among low, average and high logical thinking urban male students on achievement in science is 6.057. Probability of this F value is 0.005 which is less than 0.01. This means that significant difference exist among low, average and high logical thinking urban male students on achievement in science in favour of high logical thinking. Therefore, null hypothesis that "To study the difference among low, average and high logical thinking on achievement in science of urban male students of XII grade" is rejected.

F value for difference among low, average and high logical thinking rural female students on achievement in science is 7.421 and probability of this F value is 0.003, which is less than 0.01. This means that significant difference exist among low, average and high logical thinking rural female students on achievement in science in favour of high logical thinking. Therefore, null hypothesis that "There is no significant difference among low, average and high logical thinking on achievement in science of rural female students of XII grade" is rejected.

Obtained F value for difference among low, average and high logical thinking urban female students on achievement in science is 9.692 having probability 0.003, which is less than 0.01. This means that significant difference exist among low, average and high logical thinking urban fe-

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male students on achievement in science in favour of high logical thinking. Therefore, null hypothesis that "There is no significant difference among low, average and high logical thinking on achievement in science of urban female students of XII grade" is rejected.

Table-2 also shows that F value for difference among low, average and high logical thinking total students on achievement in science is 29.615 which is significant at 0.01 level. This result indicates that significant difference exist among low, average and high logical thinking for total students on achievement in science in favour of high logical thinking. Therefore, null hypothesis that "There is no significant difference among low, average and high logical thinking on achievement in science of XII grade" is rejected.

Discussion of Results

Results of this study show that significance difference exist among low, average and high logical thinking on achievement in science in favour of high logical thinking for all groups (rural male, urban male, rural female and urban female) and total sample. Results of this study indicating that logical thinking is guarantee for higher achievement in science subjects. Findings of present study support results of study conducted by Bello (1993), Bird (2010), Cepni, Ozsevgec and Cerrah (2004), Danjuma (2005), Demide (2000), Krajcik and Hanet (1987), Nnorom (2013), Oloyede (1998), Shayer and Adey (1994) and Sayre & Ball (1975).

Educational Implications

It is clear from this study and previous studies that logical thinking of students play significant role in their achievement in science subjects. Reason behind this is that students with low level of logical thinking would be expected to have difficulty in understanding concepts in science subjects and fail to achieve good marks. While students with higher logical thinking understand science concept in better way and they get higher marks in science subjects. The following recommendations were made by investigators:

1. The classroom teacher should provide knowledge of different aspect of logical thinking to their students. He or She regularly provides problems related to different level of logical thinking to their students. The classroom teacher should regularly check logical thinking of their students and provide feedback to develop their logical thinking.
2. Knowledge of logical thinking for teachers is essential. Therefore, this is responsibility of teacher training institutions that they develop logical thinking abilities in pupil-teachers.

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