



## Inductive Thinking in Mathematics of Secondary School Students

Dr Amir Zaman,  
Dr Nafees Bibi,  
Dr Imtiaz Ali,  
Dr Sheraz Khan

**Abstract**-Inductive and deductive thinking are two prime modes of thinking in every field and in mathematics as well. The objective of this study was to assess inductive thinking in mathematics and compare it across gender, location and sector wise of the schools. The study selected over 500 students for data collection randomly. The test consists of six inductive thinking items that was reasoning based. Test was properly validated before administering and reliability was calculated to make sure that test is up to the standard. Data was analyzed using t test and ANOVA. The analysis shows that there was significant difference between the mean score of urban and rural student where rural students scored better than urban students. On the other hand the mean difference in the case of gender and sector wise comparison was found insignificant.

**Key words:** inductive thinking, mathematics achievement, mathematical thinking

### I. INTRODUCTION

Deductive and inductive are the two modes of reasoning that are the most utilized examples of reasoning (Harry, 2002). Science is not quite the same as other order, at any rate at school level as in it sets up truth by deductive reasoning (Porteous, 1990). Reasoning is characterized as the procedure that "yields legitimate ends, which must be genuine given that their premises are valid" (Johnson-Laird, P.110). While Shatnawi (1982, p.10) characterized it as "showing up at a specific outcomes from obscure or expected standard". In deductive procedure realized articulations are utilized to reach a legitimate inference and along these lines it helps in deciphering and figuring guidelines, plans of activities and general standards. The two principal methods used to reach inductive conclusions are enumerative induction and eliminative induction (Hunter, 1998; Bochenski, 2012)). Enumerative induction is an inductive method in which a conclusion is constructed based upon the number of instances that support it the more supporting instances, the stronger the conclusion (Hodge et al, 2003). Eliminative induction, also called variative induction, is an inductive method in which a conclusion is constructed based on the variety of instances that support it (Hope et al, 2000). Moreover evaluation of information, move of information and decision among contending thoughts can be made utilizing deductive procedure because of its fact protection nature. Legitimacy of contentions doesn't change if new premises are added to a legitimate deductive contention. Deductive legitimacy is a win big or bust issue; rather than happening in degrees, a contention is absolutely legitimate or it is invalid. The ebb and flow inquire about has accepted the derivation as the utilization of a realized guideline to recognize the obscure the accompanying model from the real instrument can best show the origination. Beneath a thing is given for representation from genuine test for the investigation.

Inductive thinking is the way toward gathering obscure standards from data or perception. Expressed all the more essentially, it is the way toward making general ends from explicit data or perception. Polya (1964) characterized acceptance as the way toward finding general laws by the perception and mix of specific occasions. Enlistment happens in the wake of checking whether the general standard or speculation is valid for all cases as opposed to explicit cases from which it is inferred (Ma'moon, 2005). The analyst has separated enlistment from speculation based on its procedure. Enlistment can be demonstrated numerically utilizing the procedure of scientific acceptance as the illustrative method. It is illustrative thinking rather than conceivable thinking that finishes the inductive thinking (Polya, 1964). Making enlistment as a rule includes looking for explicit data, association or designs lastly broad ends or expectation. Furthermore it searches for any all in all or forecast when more data comes.

Inductive and deductive perspectives are two prime methods of reasoning. Major distinction in these two kinds of reasoning was conceptualized by Gurian, Henley and Trueman (2001). They presumed that young men will in general be deductive in their conceptualization, beginning from their thinking procedure much of the time from a general rule and applying it. They additionally will in general do deductive reasoning more rapidly than young ladies. This is the explanation that young men do well in

numerous decisions in educational accomplishment test. Young ladies on other hand will in general kindness inductive reasoning adding increasingly more to their base of conceptualization. More regularly than young men, young ladies start with explicit models and afterward construct their general hypothesis.

Relatively few explicit investigations are accessible talking about understudies' accomplishment in enlistment and derivation. The main significant examination discovered was that of Ma'moon (2005) in Jordan looking at numerical reasoning and arithmetic accomplishment of year 11 understudies. He regulated a trial of scientific speculation with 30 things which was intended to estimated six diverse angle utilizing images, speculation, reasoning, enlistment, geometrical verifications and sensible thoroughly considering an example of 468 understudies at grade 11. He reasoned that there was no noteworthy distinction between mean score for male and female understudies in enlistment and derivation sub scales. At the point when gender orientation and area were joined as free factors with the six parts of scientific reasoning and science accomplishment as reliant factors, females beat guys in Induction while in finding there was no huge distinction.

### Objective of the study

Objective of this study is to assess grade 9 students inductive thinking and compare them across gender, sector and location of the schools.

## II. RESEARCH METHODS

The study is survey in nature and a test was administered to grade 9 students to assess their inductive thinking.

### Tool

A test of inductive thinking was developed which consists of six task based items and the student were required to give reasoning for their correct options as well.

### Reliability of the Tests of Mathematical Thinking

Reliability of the test is important construct that should be ensured. Two form of the test should correlate highly if we are intended to use for accurate data Davidshofer, Kevin. Murphy, Charles. (2005). Reliability was also measured using the internal consistency method, usually associated with Cronbach's Alpha coefficients and its variants using statistical package for social science SPSS version 17.

### Scale Reliability of Induction

Mean score for items in induction scale ranged from 1.60 to 2.42 with overall mean of 2.41 and scale mean of 14.47 out 24. Item 4 was found to be the difficult item with mean score of 1.60.

**Table 1 Item Statistics for Induction sub scale**

	Mean	Std. Deviation	Cronbach's Alpha if Item Deleted
I1	2.16	1.47	.766
I2	2.42	1.29	.763
I3	1.72	1.47	.770
I4	1.60	1.52	.754
I5	2.30	1.35	.765
I6	1.86	1.45	.780
Induction	14.47	4.95	.747

This item required to apply the rule in the given instances to get subtraction of a fraction. Item 2 was the easiest item in the induction scale with mean score of 2.42. This item required to apply power rule in multiplication and was familiar question in the text of mathematics text book in grade 9.

### Gender Wise Comparison

Most of the schools were single gender with exception of private schools which were co-educational in nature. Male and female students' mean scores in test of inductive thinking were compared using t-test. Male students mean score was better than female students in however this mean difference was

not significant.

**Table 2 Gender wise Analysis of induction**

Scale	Male		Female		t-value	Sig.(2-tailed)	Effect size Cohen's d
	Mean	Std. deviation	Mean	Std. Deviation			
Induction	16.51	3.856	13.15	5.034	5.895	0.000**	0.599

\*Mean difference is significant at  $P < 0.05$

\*\*Mean difference is significant at  $P < 0.01$

To evaluate the amount of mean difference in each pair of mean scores effect size was calculated using Cohen's D effect size. Cohen's d value shows that effect was found to be medium effect size in case of, induction.

### Location Wise Comparison

Rural student was comparative higher than other sub section of the sample. To find the significance in the mean score sampled paired t-test was used comparing urban and rural students' mean scores in test of inductive thinking. The results are shown in table 2 indicating that urban students mean score was better than rural students in inductive thinking and t test shows that this result was significant.

**Table 3 Location wise Analysis of induction**

Scales	Urban		Rural		t-value	Sig. (2-tailed)	Effect size Cohen's D
	Mean	Std.Dev.	Mean	Std. Dev.			
Induction	14.62	4.637	14.91	4.939	0.503	.616	0.06

\*Mean difference is significant at  $P < 0.05$

\*\*Mean difference is significant at  $P < 0.01$

To further elaborates the amount of the difference Cohen's D effect size was also calculated and as the table shows a small effect size in induction (Cohen, 88).

### Sector wise Analysis

Private schools are growing in number and size in Pakistan and the comparative achievement is often debated. The table below shows their comparison in case of inductive thinking. The table shows that private schools student score well as compare to public school.

**Table 4 Sector wise Analysis of induction**

Scale	Public		Private		t-value	Sig.(2-tailed)	Effect size Cohen's d
	Mean	Std. deviation	Mean	Std. Deviation			
Induction	14.05	4.888	15.34	5.039	2.725	0.007**	0.26

\* Mean difference is significant at  $P < 0.05$

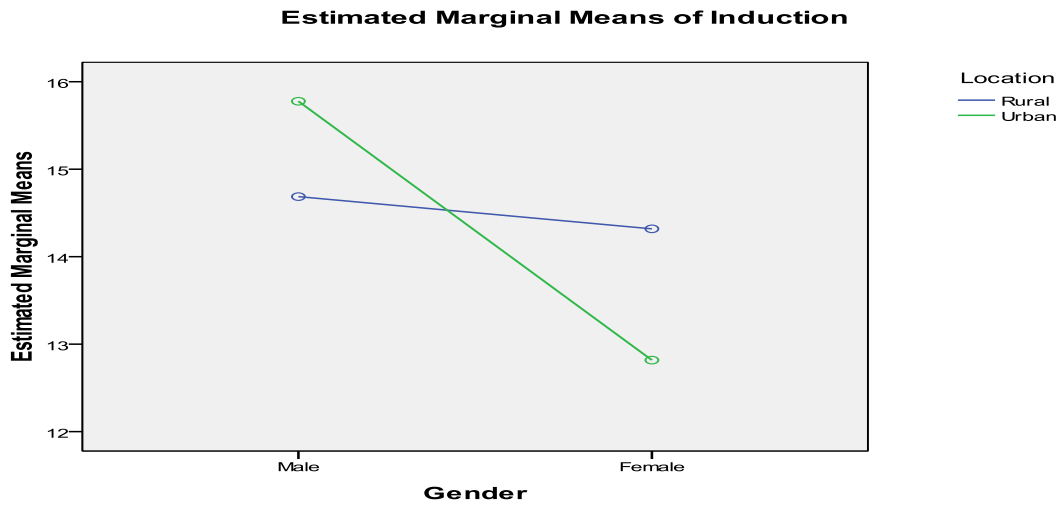
\*\* Mean difference is significant at  $P < 0.01$

Further to evaluate the mean difference Cohen's D effect size was used and its values shows that a small effect size in case of induction.

### Interaction Effect when Gender and Location are taken as Independent Variables

To find the interaction effect between gender and location, induction was entered in ANOVAs as independent variables and gender and location as independent variables.

**Figure 1 Interaction Graph of Gender and Location**

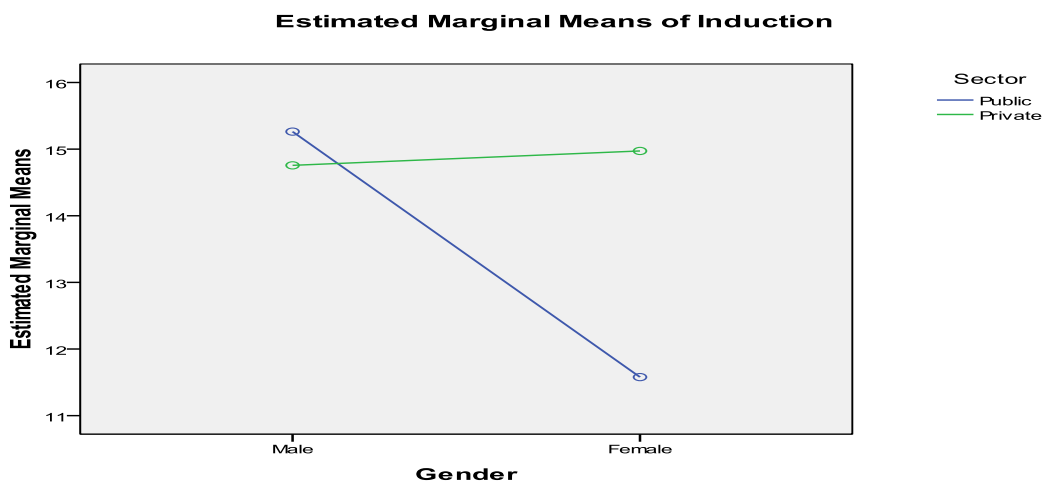


male in the urban schools were scoring better significantly than rural male in induction. In case of female students the result was not consistent and the urban girls were found better than rural girls.

**Interaction Effect when Sector and Gender are taken as Independent Variables**

To find the interaction effect between gender and school sector, score was entered in the multivariate analysis as dependent variables and gender and sector as independent variables.

**Figure 2 Interaction Graph of Gender and sector**



A result of this analysis is shown in graph which shows that there is significant interaction effect between gender and sector in induction. It follows from the above results that achievement of the students from different gender in different school sector was different.

**III. ANALYSIS AND DISCUSSION**

Gender and sector wise comparison in mean score of students shows that there is no significant difference between their scores. The possible reason of relative higher score by male students is the relatively high expectation of their parents for higher achievement and continuity of further education from male students and availability of coaching facilities in this male dominated and conservative society. Female students are disadvantaged in this respect due to male dominated society. Findings, furthermore, indicate that there was significant interaction effect between location and school sector. Rural students of private

school were doing better than urban students of public schools. Better score for urban students in private sectors in comparison to rural students of public school is consistent with t-test analysis and can be attributed to teachers' availability, effective supervision in private schools. Also rural students mostly comes from low income families and are spending most of the time helping their parents in daily life and thus have less time for study.

Similar study can be conducted on different level with new tools suitable for their level and also can be better conducted using tools that involve diagrammatic reasoning

#### REFERENCES

1. Bochenski (2012).. *The Methods of Contemporary Thought*. Springer Science & Business Media. pp. 108–09. ISBN 978-9401035781. Retrieved 5 June 2020.
2. Davidshofer, Kevin R. Murphy, Charles O. (2005). *Psychological testing : principles and applications* (6th ed.). Upper Saddle River, N.J.: Pearson/Prentice Hall. ISBN 0-13-189172-3.
3. Harry J. (2002). *Introduction to logic*. London/New York: Routledge, pp. 7-34.
4. Cohen, Jacob (1988). *Statistical Power Analysis for the Behavioral Sciences*. Routledge.
5. ISBN 978-1-134-74270-7.
6. Gurian M., Patricia H., Trueman T. (2001). *Boys and girls learn differently: a guide for teachers and parents* page 44-45 Google book
7. Hunter, Dan (September 1998). "No Wilderness of Single Instances: Inductive Inference in Law". *Journal of Legal Education*. 48 (3): 370–72.
8. Hodge, Jonathan; Hodge, Michael Jonathan Sessions; Radick, Gregory (2003). *The Cambridge Companion to Darwin*. Cambridge: Cambridge University Press. p. 174. ISBN 0-521-77197-8.
9. Hoppe, Rob; Dunn, William N (2000). *Knowledge, Power, and Participation in Environmental Policy Analysis*. Transaction Publishers. p. 419. ISBN 978-1-4128-2721-8.
10. Johnson R.B. and Anthony J. O. (2004). *Mixed Methods Research: A Research Paradigm*
11. *Whose Time Has Come*. *Educational Researcher*, 33(7) p. 19
12. Ma'moon M. (2005). *Mathematical Thinking and Mathematics Achievement in year 11 Student Jordan*.
13. Unpublished thesis. University of New Castle, Australia.
14. Pólya G. (1964). *Mathematics and Plausible Reasoning: Induction and analogy in mathematics*. Google books p.110.
15. Porteous, K. (1990), *What do Children Really Believe?*, *Educational Studies in Mathematics*, 21(6), 589-598.
16. Schum, David A. (2001). *The Evidential Foundations of Probabilistic Reasoning*. Evanston, Illinois: Northwestern University Press. p. 32. ISBN 0-8101-1821-1.
17. Shatnawi F. (1982). *Developing of Mathematical Thinking in Secondary level Students in Jordan*. Unpublished
18. *Research Master Thesis*. Irbid Yarmouke University