

# UNIVERSITY OF THE PUNJAB

**DR. ZAHID KARIM KHAN**  
**CONTROLLER OF EXAMINATIONS**  
**UNIVERSITY OF THE PUNJAB**  
Quaid-i-Azam Campus, Lahore-54590  
Pakistan



Tel: Off: +92-42-99231109  
+92-42-99231112  
Fax: +92-42-99231115  
E-mail: ce@pu.edu.pk

No. 3024 - Ph. D / 10

Dated 30 - 10 - 2010

**Dr. Michael Shayer,**

Professor of Applied Psychology,  
King's College, Cornwall House,  
Waterloo Road, London SE18WA,  
U.K.

Dear Sir,

Thank you for your E-Mail dated 30.09.2010 for accepting our request to act as an External Examiner to evaluate the thesis entitled "EFFECT OF INTERVENTION ON THE DEVELOPMENT OF COGNITIVE AND MATHEMATICAL ABILITIES AT ELEMENTARY LEVEL" for the Ph.D. Degree in Education.

I enclose a copy of the above thesis and request you to evaluate the thesis and to send your report at your early convenience indicating whether or not you recommend the award of Ph.D. Degree in this case. It may also be mentioned in the report whether or not the thesis is fit for publication both from the point of view of language and contents. The report be sent to me by name in a confidential registered sealed cover marked "Ph.D. Thesis Report".

Kindly acknowledge receipt.

Yours Sincerely,

  
(DR. ZAHID KARIM KHAN)

Encl: As above.

**EFFECT OF INTERVENTION ON THE DEVELOPMENT OF  
COGNITIVE AND MATHEMATICAL ABILITIES AT  
ELEMENTARY LEVEL**



**Submitted**

**By**

**Muhammad Abiodullah  
Dr. 2001-09**

**PhD**

**in**

**Education**

**INSTITUTE OF EDUCATION AND RESEARCH  
UNIVERSITY OF THE PUNJAB**

**Lahore  
May 2010**

**EFFECT OF INTERVENTION ON THE DEVELOPMENT OF  
COGNITIVE AND MATHEMATICAL ABILITIES AT  
ELEMENTARY LEVEL**

**A dissertation submitted to the University of the  
Punjab Lahore, for the degree of**

**PhD**

**in**

**Education**

**By**

**Muhammad Abiodullah  
Dr.2001-09**

**INSTITUTE OF EDUCATION AND RESEARCH  
UNIVERSITY OF THE PUNJAB  
Lahore  
May 2010**

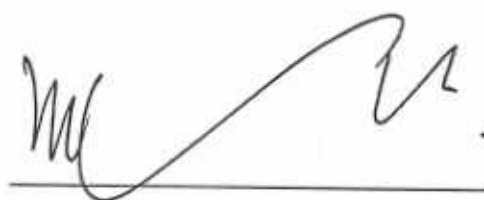
## Abstract

The study was conducted to find out the effect of intervention on development of cognitive and mathematical ability. The study was experimental in nature. Quasi experimental design was used for study. Before conducting the experiment a survey on seven schools of Lahore city was conducted by using Volume and Heaviness test and Thessoloniki Math test use to determine the existing level of Cognitive and mathematical ability of grade IV to VIII students. To conduct experiment 82 control group and 80 experiment group was selected from two private and public schools. For conduction of intervention thinking math lessons were taught to experiment group for a period of one and half year. Twenty 24 lessons was delivered fortnightly. Pre-test and Post-test consisted of Volume and Heaviness test and Thessoloniki Math test was used to get scores of students on their cognitive and mathematical ability.

The score of survey students on survey was analyzed through mean scores and level of ability determine on the basis of criteria developed by Shayer and Adhami.

The data of pre-test and post-test was used to calculate the mean, standard deviation and gain scores. The data of the study were analyzed using independent sample t-test to compare mean scores of pre-test and post test of both control and experiment groups. The pretest of the control and experimental groups show that there were no significant differences in mean scores of students of all schools except in one school whose pretest mean score of the control group was higher than the pre-test mean score of the experiment group. The post-test of the control and experiment groups show that there were significant differences in mean scores of students of all schools. The mean gain scores of the control group and mean gain score of the experimental group were compared by t-test. Their results were also significant for each school. In the light of these results it can be concluded that intervention has affect on the cognitive and mathematical ability of the students in experiment group. The effect of the intervention was measured in term of effect size. After analyzing the results, it was found that the intervention had affected the cognitive growth of the experimental subjects. To assess the effect of the intervention on students' cognitive and mathematical abilities. Residualised gain scores were also calculated. The results of residualised gain scores showed that the experiment groups performed better than the control groups. It is observed that the increased cognitive and mathematical ability of the students of the experiment groups is due to intervention.

Accepted by the faculty of Education, University of the Punjab, Lahore, in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Education.

A handwritten signature in black ink, consisting of stylized initials and a long horizontal stroke, positioned above a solid horizontal line.

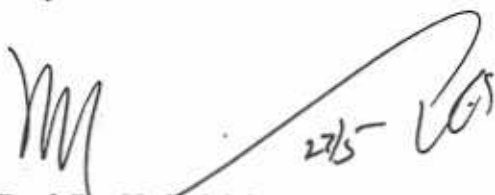
Supervisor

Prof. Dr. Hafiz Muhammad Iqbal

## CERTIFICATE FROM THE SUPERVISOR

This is to certify that the research work described in this thesis is the original work of the author carried out under my direct supervision. I have personally gone through all the data, results/materials reported in the manuscript and certify their correctness/authenticity.

I further certify that the material including this thesis has not been used in part or full in a manuscript already submitted or in the process of submission partial/complete fulfillment of the award of any other degree from any other institution. I also certify that the thesis has been prepared under my supervision according to prescribed format and endorse its evaluation for the award of PhD degree through the official procedure of the university.



27/5

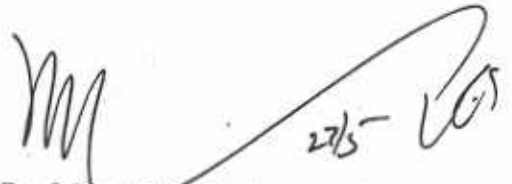
Prof. Dr. Hafiz Muhammad Iqbal

Supervisor

## CERTIFICATE FROM THE SUPERVISOR

This is to certify that the research work described in this thesis is the original work of the author carried out under my direct supervision. I have personally gone through all the data, results/materials reported in the manuscript and certify their correctness/authenticity.

I further certify that the material including this thesis has not been used in part or full in a manuscript already submitted or in the process of submission partial/complete fulfillment of the award of any other degree from any other institution. I also certify that the thesis has been prepared under my supervision according to prescribed format and endorse its evaluation for the award of PhD degree through the official procedure of the university.



27/5

Prof. Dr. Hafiz Muhammad Iqbal

Supervisor

## Table of Content

	Topic	Page
Abstract		i
Acknowledgement		ii
List of Content		iii
List of Tables		iv
List of Figures		v
Chapter I	INTRODUCTION	1
	Performance of Students in Mathematics	2
	Causes of Low Achievement	4
	Social Factors	5
	Cognitive Factors	5
	Need of the Study	7
	The Statement of the Problem	8
	Objectives of the Study	9
	Research Questions	9
	Significance of the Study	10
Chapter II	REVIEW OF LITERATURE	
	Cognitive Development	12
	Stages of Cognitive Development	12
	Sensorimotor Stage (Birth-2 Year)	14
	Preoperational Stage (2 To 7 Years)	14
	Concrete Operational Stage (7 To 11 Years)	15



Formal Operational Stage (11 To 16 Years)	17
Cognitive Ability	17
Theories of Cognitive Ability	20
Mathematical Ability	22
Importance of Mathematical Ability	25
Concept of Number	26
Sequence Words	27
Counting	28
Cardinal	28
Numerical Estimation and Approximation	29
Measure Words	29
Ordinal words	29
Non-Numerical Number Word Context	30
Arithmetic Operation	30
Fractions	31
Algebraic Equations	32
Development of Mathematical Ability	33
Learning by Inductive method	35
Limited Working Memory capacity	35
Developing Meta-cognitive Awareness and Control	36
Intervention	38
Intervention and its effect on Development of mathematical and Cognitive Abilities	40

	Thinking Skill Programs	42
	Heuristics	43
	Cognitive Operations	45
	The CAME Primary Project	48
	Research Plan	49
	Intervention Model	49
	Guidelines for selecting a Model for Intervention of Cognitive Development	51
	Basis for developing Intervention	54
Chapter III	METHOD AND PROCEDURE	58
	Research Design	58
	Subject Selection	59
	Population	59
	Sample	59
	Instruments of the Study	62
	Data Collection	63
	The Material: Thinking Maths Lessons	65
	Data Analysis	66
Chapter IV	DATA ANALYSIS AND INTERPRETATION	68
	Results of the Survey	69
	Results Related to Pre-test of Cognitive Ability	82
	Results Related to Post-test of Cognitive Ability	87
	Results of Pre-Test of Mathematical Ability	96

	Results of Post- Test of Mathematical Ability	101
Chapter V	<b>CONCLUSIONS DISCUSSION AND RECOMMENDATIONS</b>	109
	Conclusions	109
	Answers to the Research Questions	110
	Discussion	113
	Recommendations	115
	References	118
	Appendices	

## LIST OF TABLES

Table	Title	Page
2.1	Description of four benchmarks used in TIMSS 1999	41
2.2	Summary of Cognitive acceleration in Mathematics education projects	47
2.3	Piagetian reasoning levels in strands of mathematics activity	50
3.1	Distribution of Sampled Students from Seven Selected Schools	60
3.2	Distribution of the Sampled Students Selected from Four Schools	62
4.1	Comparison of Mean Scores of Students' Cognitive Ability of Different Grades	69
4.2	Comparison of Mean Scores of Students' Mathematical Ability of Different Grades	70
4.3	Correlation between Cognitive Ability Scores and Mathematical Ability Scores of Students	71
4.4	Effect of Gender on cognitive ability of students	72
4.5	Effect of Gender on Mathematical Ability of Students	74
4.6	Effect of Private and Public Sector on Cognitive Ability of Students	76
4.7	Effect of Private and Public Sector on Mathematical Ability of Students	78
4.8	Frequency and Percentage Distribution of Students in Different Cognitive Levels	80
4.9	Comparison of Mean Scores of Students' Cognitive Ability in Pre-Test of Control and Experiment Groups	82
4.10	Comparison of Cognitive Ability Mean Score of Pre-Test of Control and Experiment Group of Private and Public Schools	83
4.11	Comparison of Cognitive Ability Mean Score of Pre-Test of Control and Experiment Group of Urdu and English Medium Schools	84
4.12	Means and SDs of pre-test scores of the control and the experiment groups from four schools	85
4.13	Mean and SDs of Post-Test Scores of the Control and the Experiment Group	87

4.14	Means and SDs of Post-Test Scores of the Control and the Experiment Group from Public and Private Schools	88
4.15	Means and SDs of Post-Test Scores of the Control and the Experiment Group from Urdu and English Medium Schools	90
4.16	Means and SDs of post-test scores of the control and the experiment group	92
4.17	A Comparison of Mean Scores of students' cognitive ability in Pre-Test and Post-Test of the Control and the Experiment Group	94
4.18	Mean Residualised Gain Scores of Cognitive Ability of Experiment Group	95
4.19	Comparison of Mathematical Ability Mean Score in Pre-Test of Control and Experiment Group	96
4.20	Comparison of Mathematical Ability Mean Score of Pre-Test of Control and Experiment Group regarding private and public schools	97
4.21	Means and SDs of Pre-Test Scores of the Control and the Experiment Group from Urdu and English Medium Schools	98
4.22	Means and SDs Of Pre-Test Scores of the Control and the Experiment Group From Four Schools	100
4.23	Mean and SDs of Post-Test Scores of cognitive ability of the Control and the Experiment Groups	101
4.24	Means and SDs of Students' Mathematical Ability Scores in Post-Test of the Control and the Experiment Groups from Private and Public Schools	102
4.25	Means and SDs of Students' Mathematical Ability in Post-Test Scores of the Control and the Experiment Groups from Urdu and English Medium Schools	103
4.26	Means and SDs of Students' Mathematical Ability in Post-Test of the Control And the Experiment Groups from Four Schools	104
4.27	A Comparison of Mean Scores of students' Mathematical Ability in Pre-Test and Post-Test of the Control and the Experiment Groups from Four Schools	106
4.28	Mean residualised gain scores of mathematical ability of the experiment group	107

## List of Figures

Figure	Title	Page
3.1	Pre-test post-test control group design	58
3.2	Design of the Survey Sample	61
4.1	Line Graph of Mean Scores of Male and Female students of IV-VIII grades	73
4.2	Line graph of mathematical ability mean scores of male and female students of grades IV-VIII	75
4.3	Line graph of mean scores of private and public schools of grades IV-VIII	77
4.4	Line graph of mean scores of private and public schools of grades IV-VIII	79
4.5	: Bar graph of percentage distribution cognitive levels of students in IV-VIII	81
4.6	Bar graph of mean scores of pre-test of control and experiment groups of private and public schools	83
4.7	Bar graph of mean scores of pre-test of control and experiment groups on Urdu and English medium school	84
4.8	Bar graph of mean scores of students of cognitive ability of pre-test of control and experiment groups in different schools	86
4.9	Bar graph of mean scores of post-test of control and experiment groups of private schools and public schools	89
4.10	Bar graph of mean scores of post-test of control and experiment groups of Urdu and English medium schools	91
4.11	Bar graph of mean scores of post-test of control and experiment groups	93
4.12	Bar graph of mean scores of pre-test of control and experiment groups on private and public school basis	97
4.13	Bar graph of mean scores of pre-test of cognitive ability of control	99

	and experiment groups from Urdu and English medium schools	
4.14	Comparison of mean scores of mathematical ability of the control group and the experiment group of four schools in pre- test	100
4.15	Bar graph of mean scores of students' mathematical ability in post-test of control and experiment groups	102
4.16	A comparison of mean scores of students' mathematical ability in post test of the control group and the experiment group from Urdu and English medium	103
4.17	A Comparison of mathematical ability mean scores in post-test of control and experiment groups	105

## Acknowledgements

All acclamation and appreciation are for ALLAH Almighty who created the universe and bestowed mankind with knowledge and wisdom to search for its secrets. All praise be to the Holy prophet Muhammad (peace be upon Him), the city of knowledge.

I feel great pleasure and honour to express my heartiest gratitude to my supervisor Prof. Dr. Hafiz Muhammad Iqbal, of the Institute of Education and Research, University of the Punjab, for his valuable and expert guidance, scholarly criticism and sympathetic attitude towards the completion of this thesis. He always stretched hands of sincerity with a smiling face that brought me encouragement and immense enthusiasm.

I am highly indebted to Dr. Nasir Mahmood, Associate Professor of the Institute of Education and Research, University of the Punjab, for encouraging me to complete this dissertation and for his precious advice during the critical times that I faced during the development of this study.

Thanks are also due to the head teachers who allowed the researcher to conduct the study in their schools.

I dedicate this humble effort to my mother who always prayed for me.

Last but not the least, I am highly indebted to my affectionate father, elder brother and other family members especially my wife and children who remember me in their prayers and encouraged me throughout the span of the study.

I can forget at that time to my wife and children who care and help me during my studies.



# CHAPTER I

## INTRODUCTION

Mathematics plays an important role in the mental growth of an individual as well as the development of a nation. Advances in technology and information systems have altered the needs of future workers. Leaders in business and industry claim that future employees require more than conventional basic arithmetical skills that were once adequate for jobs requiring repetitive and routine tasks. Higher level of mathematical knowledge and skills are now needed for daily living and effective citizenship. We also need mathematical skills in decision making processes in financial and industrial arena. Society needs literate workers who are competent in technology, flexible and lifelong learners, and who can formulate and solve a variety of common and complex problems (English & Halford, 1995).

Mathematical skills are also required for daily functioning in today's society for example shopping, transportation, money exchange and food preparation. Use of mathematics makes it possible to make efficient and accurate decisions in our daily life problems regarding social, economic, religious, psychological, geographical, environmental, communication or transportation. Such problems are stated in words and their solutions need to convert words into mathematical language. Mathematical language consists of numbers and symbols. Applying the operations of mathematics on numbers and symbols we are able to get solutions. To get such solutions it is important that persons have good mathematical skills. Keeping in view the importance of mathematics in daily life, mathematics is being taught as compulsory subject right from grade one in schools throughout the world. Research conducted in different parts of the world reveals that rate of development of mathematical skills is not same in all children. Some children face more difficulty in the development of