

LANGUAGE IN INDIA
Strength for Today and Bright Hope for Tomorrow
Volume 11 : 6 June 2011
ISSN 1930-2940

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**A Relationship Study of Concept Formation Teaching Model
with Students' Academic Achievement**

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Abstract

The study aimed to investigate the effectiveness of concept formation teaching model on Class IX students' achievement. It was an experimental study in which concept formation teaching model was associated with academic achievement of IX class students. The objective of the study was to investigate the effects of "Concept Formation Teaching Model" on the teaching of Chemistry to Class IX. Data analysis reveals that concept formation teaching model had great effect on the achievement of the students. The experimental groups outscored significantly the control groups on post-test showing the supremacy of concept formation teaching model on traditional method. Hence the ultimate results of the study indicated that concept formation teaching model was more effective as compared to traditional method.

Key Words: Concepts, Concept Teaching, Concept formation, Direct Teaching, Concept Formation Teaching Model

1.1 Introduction

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Teaching is not telling or transferring the information to students; it is planning and guiding a student in such a way that he/she learns most. Teaching is a dynamic and well-planned process. Its objective is to acquire maximum learning experiences. In order to achieve this great objective, an almost infinite variety of teaching methods are present. There have been a number of methods devised from time to time to make the teaching of science real and effective. However, if a teacher's effort s is to produce desired results to improve the quality of instruction, there is a need to use appropriate teaching method that place more emphasis on thinking, understanding and learning through genuine interest.

At present, there is a need to explore such teaching methods which facilitates students' learning to maximum level. The responsibility of the teacher is to utilize students' time in effective learning and it is only possible when students' learning is based on thinking rather than memorizing, understanding rather than merely accumulating facts and learning through interest rather than coercion. For better learning and personality development, proper stimulation, direction and guidance is necessary. The principle aim of teaching is the total growth and development of the child and basic tools for achieving this principle are informality, freedom, encouragement on creative expression, life like situations in the classroom and provision of opportunities for developing initiative and curiosity among students.

Whatever the teaching method is to be used, the important thing is changing the child into an intelligent scientific thinker. The wise and efficient teacher utilizes all the students' capacities, abilities, habits, skills, knowledge and ideas etc. He/she can use any method that is more effective for developing the concepts. The effective teacher stimulates the thinking and reasoning power of the pupil for developing problem-solving ability and capacity of personal achievement to explore new ideas and concepts.

The science teacher must have the desire to teach his subject as effectively as possible for realizing the stipulated purposes of teaching science. One of the purposes of teaching Chemistry is to provide a base to explore new things. This exploration is possible when the students have clear concepts. Concept clarification is based on appropriate teaching method. A method is not merely a devise adopted for communicating certain items of information to students. It links the teacher and his pupil into an organic relationship with the constant mutual interaction. The quality of students' life may rise by applying good methods and bad methods may debase it. Good methods play a great role in the development of concepts.

Hence concepts must be formed properly at the initial stage. If concepts are not properly developed the knowledge remains vague and inadequate to cope with a problematic situation. So there is a need to explore other new teaching methods and models besides traditional methods for clarification of concepts. Therefore, the researcher decided to conduct research in this area.

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The method of teaching refers to the regular ways or orderly procedures used by the teacher in guiding the pupils in order to accomplish the aims of the learning situations. By method, in general is meant the process of reaching a definite end by a series of related acts which tend to secure that end. As applied to classroom teaching, method is a series of related and progressive acts performed by the teacher and the pupils to accomplish the general and specific aims of lesson. Teaching methods involve regular steps to guide the mental processes of the learner in mastering the subject matter being presented to him.

1.1.1 Concepts and Concept Teaching

A concept is an idea or understanding of what a thing is. It is ordered information about the properties of things and also related to other things.

According to Hudgins et al (1983), concepts are general ideas which summarize a large number of examples or cases that have some essential qualities or elements in common but may differ from one another in particular ways.

Concepts enhance the ability to learn subject matter content in a meaningful way. A learner who has a clearly delineated conceptual idea has much better opportunity to learn and remember particular information about it than one who must try to process and store incoming information without any conceptual hooks on which to hang all the details (Hudgins *et al.*, 1983).

It is generally accepted that students do not enter the classroom as a “blank slate”. When students enter into the classroom, they have already formed ideas on many topics and interpret the world around themselves and have their own individual present knowledge, beliefs and ways of thinking (Zirbel).

Concept teaching models have been developed primarily to teach key concepts that serve as foundations for student higher-level thinking and to provide a basis for mutual understanding and communication. Such models are not designed to teach large amounts of information to students. However, by learning and applying key concepts within a given subject, students are able to transfer specific learning to more general areas. In fact, without mutual understanding of certain key concepts, content learning in some subject areas is nearly impossible (Arends, 2007).

The main purpose of concept teaching is to learn new concepts. The learning of concepts and the development of higher level thinking skills of students including inductive reasoning, hypothesis formation, logical reasoning and concept building strategies are based on concept teaching. Concepts serve as the foundation for knowledge, increase complex conceptual understanding and facilitate social communication. In concept teaching, teacher- directed activities are used to construct,

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refine and apply the concepts by which students learn to classify, recognize members of a class, identify critical and non-critical attributes and define and label particular concepts.

Concept teaching approaches are process oriented which aimed at teaching students to think questions and discover rather than to solely memorize by encouraging their inductive thinking so as the students move from particular facts to generalization. Appropriate and solid concepts are constructed through the inventive act of concept formation.(http://www.sasked.gov.sk.ca/docs/policy/ince/section_3.html#concept_formation)

1.1.2 Concept Formation

In concept teaching, the process of construction of knowledge and organization of information into comprehensive and complex cognitive structure is involved. The term concept formation or concept learning is generally used by psychologists for the development of the ability to respond to common features of objects, events or ideas that have a common set of features.(<http://edutechwiki.unige.ch/en/Concept-Learning>)

Ausubel (1968) states that concept formation is characteristic of the pre-school child's inductive and spontaneous (untutored) acquisition of generic ideas from concrete-empirical experience. It is a type of discovery learning involving, at-least in primitive form, such underlying psychology processes as discriminative analysis, abstraction, differentiation, hypothesis generation and testing, and generalization.

Thus, in concept formation, the learner discovers relationships (the similarities within a class of objects) and gradually obtains a working concept through experience within the classroom or in real life situations (Thornburg, 1973).

Concept formation is the process of integrating features to form ideas by the recognition that some objects or events belong together while others do not. Once the objects or events have been grouped according to a particular categorization scheme, a label is given to the group. The end result of concept formation activities is the connections among the common characteristics of a concept. (http://www.sasked.gov.sk.ca/docs/policy/ince/section_3.html#concept_formation)

In concept formation, students are provided with data about a particular concept and they are encouraged to classify the data. This data may be generated by the teacher or by the students themselves.

For developing the concepts, educators and teachers use different approaches, methods and models, the researcher selected the direct teaching for developing concept formation teaching model.

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1.1.3 Direct Teaching

Direct instruction focuses on both “what” to teach (i.e., the design of the curriculum) and “how” to teach (i.e., specific teaching techniques). Specifically, it refers to teaching behaviours and organizational factors (i.e., the “how” to teach) that are associated with positive student learning outcomes (Gagnon and Maccini, 2007).

Direct teaching is a tool to form sound concepts. With direct teaching, teachers carefully explain what teachers must do to accomplish a task and then present a carefully structured lesson that is usually broken down into small, manageable steps.

Rosenshine and his colleagues (Rosenshine, 1988; Rosenshine and Steven, 1986) have identified six teaching functions based on the research on effective instruction (Woolfolk, 1998).

1. Daily Review. The review acts as an informal assessment to check whether students have the necessary prerequisite skills or if re-teaching of the content is required prior to the teaching of new lesson (Gagnon and Maccini, 2007).

2. New Material. Teachers begin by giving information to the students about objectives to be attained. New information is broken down into smaller bits and is covered at a brisk pace. Teachers illustrate main points with concrete examples. Teachers ask questions frequently to check for students understanding and make sure that students are ready for independent work using new skills and knowledge (Sadker and Sadker, 2003).

3. Guided Practice. The teacher uses the initial practice by walking the students through, step-by-step and giving feedback on their responses, then the teacher moves to guided practice in which students work independently under the supervision of teacher. Individual feedback is also given where needed. In it, teachers’ questioning, assessment of independent work and quiz and observation of a live performance may also be appropriate. Specific feedback is given as soon as possible after practice that focused only on desired behaviour.

4. Specific Feedback. Corrective feedback is provided immediately to reduce student errors.

5. Independent Practice. The teacher monitors the students’ performance and provides additional explanations or re-teaching as needed. Prior to performing the task with a higher level of accuracy and speed, students performed the task slowly with some errors (Gagnon and Maccini, 2007).

6. Weekly and Monthly Reviews. Weekly and monthly reviews are important for addressing maintenance of skills and for determining if re-teaching is necessary. It is recommended that teachers provide frequent reviews for assessing the adequacy of the pace of instruction (i.e., too fast or slow) (Gagnon and Maccini, 2007).

Arends (2007) says that direct teaching is specifically designed to promote student learning of well-structured factual knowledge that can be taught in a step by step fashion and to help students master the procedural knowledge required to perform simple and complex skill.

Direct teaching is a systematic instructional method that requires a masterful command of the subject by knowing more than the facts about content. Direct teaching is a systematic way of planning, communicating and delivering in the classroom. One does not become proficient at this, or any skill without practice and relevant feedback.

Direct teaching is particularly helpful for imparting new and complex information in small bits. It works well for development of concepts in more clear and easy way. The highly structured learning environment is set by the teacher in which students are careful listeners and keen observers.

1.1.4 Concept Formation Teaching Model

Concept formation teaching model follows a definite structure with specific steps to guide students toward achieving clearly defined instructional objectives. This model aims at clarification of misconceptions and development of new concepts by active involvement of students in questioning, discussion and activity. This model is helpful in changing a student's conceptions into valid and concrete conceptions by adding new knowledge to what is already there. In this model, students use their existing knowledge to construct the new one when the new concept is intelligible (knowing what it means), plausible (believing it to be true) and fruitful (finding it useful). By this model, the students become able to construct and build their own concepts after removing the misconceptions.

Steps of Concept Formation Teaching Model

Steps of concept formation teaching model are as under:

1.1.4.1 Instructional Objectives

Objectives of lesson plan of concept formation teaching model are based on Taxonomy of Educational Objectives to check three levels of cognitive domain i.e. knowledge, comprehension and application. These instructional objectives are comprehensive, consistent, attainable, suitable to subject matter, valid, clearly stated, measurable and testable, guided to action and evaluate-able. The purpose of stating the objective is to set the students' expectations of what they will learn.

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1.1.4.2 Previous Knowledge

The lesson is started with assessing the students' previous knowledge. It is checked by using some activity, reviewing previous work, conducting experiments, providing examples and questions by simple statements, moving around the room and voice inflation including a discussion about previously covered content. Connections are made between what is already known and what is to be learned. The purpose of assessing previous knowledge is to:

- a) determine students' existing ideas and conceptions;
- b) identify students' misconceptions;
- c) take measures to correct the students' misconceptions;
- d) construct new concepts on students' existing knowledge; and
- e) link new concepts with previous knowledge.

1.1.4.3 Presentation

The following points are kept in mind for presentation:

Statements: Concepts and principles are explained with the help of easy, clear and meaningful words. These concepts and principles are given by using inter-related, relevant and continuous statements and appropriate vocabulary. Vague words or phrases are not used.

Use of Board: Good, legible, neat, appropriate and adequate words of the contents are written on the board.

Getting Student's Attention: Pupils' attention is secured and maintained by varying stimuli like gesture, movement, changing interacting styles, deliberate silence and non-verbal cues.

Students Participation: Pupils' participation is encouraged by verbal and non verbal reinforcers (positive reinforcement and negative reinforcement) and the discussion about students' prior conceptions. Students are encouraged to participate in the class room, respond to the questions, give their own ideas and react to other ideas.

Question Technique: Appropriate questions i.e. well structured and well-stated questions are asked from the students to foster their participation in the lesson. Critical awareness about the concepts and their attributes is brought out by probing questions i.e. prompting, seeking further information, refocusing and redirection.

Management of Classroom: During the lesson, the teacher recognizes both attending and non-attending behaviour of the pupil. For this, attending behaviour is rewarded and

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non-attending behaviour is eliminated by giving directions to the students. The teacher uses the pupils' feeling and ideas to recognize pupils' attending and non-attending behaviours.

Presentation is based on motivational set and body of the lesson.

a) Motivational Set

A lesson is presented when students are emotionally and mentally prepared to digest new information. It deals with student's existing ideas and conceptions. Information given by the students during discussion and questioning is summarized in an organized manner by using examples, appropriate devices, techniques or activities to link previous knowledge to current lesson.

b) Body of the Lesson

To link previous knowledge with existing one, an overview of the new concepts is given as advance organizers. Prior to teaching, a large amount of meaningful material is presented in an efficient manner to utilize the students' prior knowledge to introduce the new concepts. Concepts and principles are explained with the help of activity, experiment if required and possible, explaining links, discussion and appropriate examples (simple, relevant to the content and up to the interest and mental level of students) through appropriate media i.e. teaching aids and use of student's ideas or responses for furthering the lesson. In this phase, both inductive and deductive methods are used. Logical sequence of concepts and skills are presented in categories in an organised manner i.e. simple to complex. Students get opportunities to elaborate new information by connecting new information to something already known and by looking for similarities and differences among concepts (guided discovery). Important points are stated several times in different ways during the presentation of information. Opportunities are provided to the students for repetition of learning. Schedules are also made for periodic review of previously learned concepts and skills.

1.1.4.4 Closure/Conclusions

Main concepts of the lesson are consolidated at the end of the lesson by the students. With the discussion of the students, present lesson is linked with the previous lesson and also with the next lesson. Students are encouraged to develop the summary and explanation for constructing and applying concepts. Opportunities are also provided to the students for applying present knowledge in the classroom and at home. It is meant to remind students about what the goals for instruction was.

1.1.4.5 Generalization

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Opportunities are provided for the establishment of certain formulas, principles or laws. Students are encouraged to draw the conclusions themselves. If students' generalization is incomplete or irrelevant, the teacher provides the guidance for clarifying the concepts.

1.1.4.6 Evaluation

Evaluation is done by checking pupils' progress towards the objectives of the lesson after regular intervals. The teacher diagnoses the pupils' difficulties in understanding a concept or a principle by step-by-step questioning and by under-taking suitable remedial measures. Teacher use specific corrective feedback as needed. Opportunities are provided to the students to repeat important concepts to evaluate students' mastery on that concept. Students are evaluated on specific concepts and their critical attributes, recognition about examples and non-examples, and evaluate example and non-example in terms of their critical attributes.

1.1.4.7 Home Task

Regular, relevant, short, challenging and innovative task about the topic according to the mental and interest level of the students is given to the students by explaining the way of working.

1.2 Experimental/Materials and Methods

1.2.1 Sample

An experiment was conducted on teaching Chemistry to Class IX students using the concept formation teaching model. The Principals three schools had permitted the researcher to conduct her research in their schools for three months. The students of these schools represent the population of typical Government High Schools of Pakistan i.e. large classes, spacious rooms, congenial atmosphere and learners having different socio-economic status, different educational background, intelligence, abilities and motivational level. One section of Class IX from each school was randomly selected.

A sample of 290 students of Class IX of three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject were selected for experiment. Out of 290 students of these three selected schools, 143 students of experimental groups were taught through concept formation teaching model and 147 students of control groups were taught through traditional method (Appendix A).

1.2.2 Design of the Study

The design of the study was the "Pretest-Posttest Nonequivalent-Groups Design".

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This design was selected due to the nature of the study and the study hypothesis. For the study, this design may be the only feasible one because the classes were used “as is”, so possible effects from reactive arrangement were minimized. The study was conducted in the natural settings of the schools.

The study design consisted of two groups: namely experimental group and control group. An achievement test was administered to experimental and control groups before and after the teaching as pre-test and post-test respectively. The experimental groups were taught through concept formation teaching model and control groups were taught through traditional method. The researcher repeated the experiment at the same time in three different schools of Rawalpindi city with the time difference of one hour to find out the effects of concept formation teaching model on Chemistry to Class IX.

1.2.3 Research Instrument

An achievement test was developed to check the effects of teaching Chemistry through concept formation teaching model on the basis of Bloom’s Taxonomy of Educational Objectives for measuring the knowledge, understanding and application level of Class IX students. It contained 100 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX published by the Punjab Textbook Board. 25 items were selected from each chapter.

For content validity of test, the table of specification was made on the basis of Bloom’s Taxonomy of Educational Objectives for measuring the knowledge, understanding and application level of Class IX students. The test was examined by experts of Chemistry subject and Education subject to check the appropriateness of items.

Before the collection of the data for the study, try-out of the study was conducted. An achievement test was administered to 30 students of Class IX of Government Islamia Boys High School No. 2 Rawalpindi to check the effects of teaching Chemistry by concept formation teaching model and traditional method on students’ achievement. All students completed the tests within the stipulated period of time. Tests were improved after try-out by using item analysis. Kuder–Richardson formula was used to test the reliability of whole test. Too easy and too difficult items were discarded on the basis of the results of the tests. Government Islamia Boys High School No. 2 Rawalpindi was not included in the final sample. The reliability of test was found to be .89.

Finally, it contained 80 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX published by the Punjab Textbook Board. 20 items were selected from each chapter (Appendix B).

This test was given to the experimental and control groups as pre-test and post-test to associate the students’ understanding of concepts at the beginning and the end of

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teaching after being treated through concept formation teaching model and traditional method.

The lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX published by the Punjab Textbook Board were developed on the format of direct instruction. The lesson plans were checked and approved by the experts.

1.2.4 Variables of the Study

The independent variables were two different types of instruction: concept formation teaching model and traditional method. The dependent variable was the academic achievement scores of the students in post-test. Controlled variables were time table and time duration of class. Uncontrolled variables were I. Q of students, their previous academic achievement, and prior knowledge of subject matter, socio-economic status, educational background, anxieties, interest and attitude.

1.2.5 Data Analysis

For calculating missing data in pre-test and post-test of experimental and control groups, following formula was used:

$$\sum (y_{ijk} - m - t_i - b_j) = 0 \quad (\text{Cochran and Cox, 2003})$$

From time to time certain observations are missing, through failure to record, gross error in recording or accidents. The omissions naturally affect the method of analysis. When certain observations are absent, the correct procedure is to write down the mathematical model *for all observations that are present* (Cochran and Cox, 2003).

Coefficient of correlation was calculated by Product-Moment Correlation method to determine the correlation between students' academic achievement test scores of experimental and control groups taught through concept formation teaching model and traditional method respectively (Gay, 2005). Significance was tested at .05 level as the criterion for the rejection of null hypotheses (appendix C). Predictive Analytics Software (PASW) was used for statistical analyses.

1.3 Results and Discussion

A positive relationship between concept formation and achievement has been found in several studies. For example, Carey, 2000; Sungur, Tekkaya and Geban, 2001; Alibali, Johnson and Seigler, 2001; Mikkila-Erdmann, 2001; Marsh, Kong and Hau, 2001; Gulcan, Hamide and Geban, 2004; Snead and Snead, 2004; Cetingul and Geban, 2005; Baser, 2006; Gardon, 2007; Canpolat, Pınarba, Bayrakeken and Geban, 2009; and Ozmen, Demircioglu and Demircioglu, 2009 who favoured this view that the conceptual

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change approaches was proved to be successful for the formation of scientific concepts. Similar finding is reported by this study that concept formation teaching model and students' academic achievement were positively related. The results also indicated that concept formation teaching model appeared to be favourable for the clarification of concepts for both lower and higher ability students.

The present study supports the findings of Mueen (1992) who summarized that in traditional method, the lesson is conducted mostly in lockstep (all students engaged or locked into the same activity), with the teacher in full command, standing before the students and very seldom moving from her place as cited by Khan (2008). According to him, the teachers only move in the classroom when the students are giving the test or when they are doing some work. Usually teachers read one paragraph or some lines and explain it without writing the concepts that need to be clarified on the board and without participation of all students. They point out the selected students who are high achievers and are very quick to give answers. So the remaining students are only passive learners. Students' participation is limited while the teachers play an active role. The teachers explain the exercises of each chapter orally or may even mark them on the book. Students have to reproduce their answers on their copies. So the understanding and clarification of the ideas and concepts are at the minimum level. The students hardly get a chance to write on the board or ask questions when they have any confusion. Teachers do not allow any communication between the students. Even they do not provide opportunities to the students to discuss in the classroom. They argue that due to communication and discussion, the classroom discipline would be at stake and the syllabus would not be covered. Teachers also avoid experiments. There is no concept of experiments or activities in the laboratory. The classroom environment is very rigid and strict. Students are punished severely when they do any wrong. Students' personality is destroyed and their creative thinking is sapped. Such a teaching plan reflects monopoly, boredom and fatigue for both teachers and students.

The findings of the present study also indicated that traditional method and students' academic achievement were also related but this relationship is not high. The reason for this low relationship is that students' learning was based only on rote-memorization. Students had to copy their concepts on papers in examination. Those students who reproduce the concepts as they were written in the books, considered as successful. There is no question about the understanding of concepts. In this way, students' creative thinking is destroyed. In such atmosphere, there is no room for bringing up of child. The main focus of the teachers was only to cover the syllabus without having this consideration whether the students grasped the concepts or not.

1.3.4 Conclusions

On the basis of findings, following conclusions were drawn:

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1. Concept formation teaching model and academic achievement of Class IX students in the subject of Chemistry were highly associated with each other.
2. The control groups who were taught through traditional method also performed well in post-test.

Acknowledgement:

I bow my head before Almighty Allah, the Most Merciful and Kind, who has given me the opportunity and skill of writing this thesis.

I extend my great appreciation to Dr. Muhammad Maqsd Alam Bukhari, my thesis advisor, for his valuable advice, scholarly guidance and dynamic supervision. Dr. Muhammad Maqsd Alam Bukhari has been instrumental in guiding this study from beginning to the very end.

I also express my thanks to the principals and students of Government Comprehensive Boys High School Rawalpindi, Government Comprehensive Girls Higher Secondary School Rawalpindi and Government M. C. Girls High School Rawalpindi who cooperated and participated in the study.

I am thankful from the core of my heart to my respected parents for all types of support required to me in all steps of education and training.

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Appendix A
Sample for Experiment

For conducting experiment			
Schools	Groups		
	Experimental Group	Controlled Group	
School I	53	55	
School II	48	50	
School III	42	42	
Total	143	147	290

Appendix B
Table of Specification for Achievement Test

Contents	Objectives			
	Knowledge	Understanding	Application	Total
Solution and Suspension (Ch.7, Class IX)	9	7	4	20
Electrochemistry (Ch.8, Class IX)	13	5	2	20
Acids, Bases and Salts (Ch.9, Class IX)	9	7	4	20
Chemical Energetics (Ch.10, Class IX)	9	5	6	20
Total number of items	40	24	16	80
Percent of Evaluation	50	30	20	100

(Appendix C)

Mean achievement Scores on Pre-test and Post-test

Groups	Schools	r
	School I	.94 (df=52)
Experimental Groups	School II	.96 (df=47)
	School III	.40 (df=41)

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	School I	.96 (df=54)
Control Groups	School II	.83 (df=49)
	School III	.97 (df=41)

$p < .05$ Table value of $r = .27$

Abbreviations

1. Ch. Chapter
2. df Degree of Freedom
3. r Pearson r
4. School I Government Comprehensive Boys High School Dhoke Kashmirian Rawalpindi
5. School II Government Comprehensive Girls Higher Secondary School Dhoke Kashmirian Rawalpindi
6. School III Government M. C. Girls High School Kali Tanki Rawalpindi

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