Mechanism of Mathematics Concepts Through Gagne's Taxonomy of Learning at Primary Level in Khyber Pakhtunkhwa

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By

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Abstract

A study was designed to apply the mechanism of concept formation through Gagne's Taxonomy of learning at primary level in Khyber Pakhtunkhawa. All students of government primary schools in Khyber Pakhtunkhawa constituted the population of the study. The study was delimited to the 5th class students studying mathematics in government primary schools. Sample of the study was taken as the students of 5th class studying in government primary school (Boys) PAF, Kohat. Sample students were divided in two groups i.e., experimental and control groups on the basis of Pre-Test by using pair sampling techniques. Pre-Test was used before the allocation of the groups i.e., experimental and control group for maintaining equality. A design "The Pre-test-Post-Test Equivalent-Group Design" was used to check the treatment effects for high and low levels of achievement. After suitable treatment data was collected through post-test. Problems faced by the students in mathematics were highlighted and appropriate suggestions were given to meet the future challenges.

***Keywords**:* Mechanism, Taxonomy, Mathematics, Equality, Design, Treatment, Suggestions

Introduction

Education is a lifelong investment in human resources development. The quality and quantity of educated manpower determine the strength of a nation. All developed and educated countries have recognized the needs of intimate relation of education of life and needs of the community. Education is a key factor in economic development and social transmission. Education is the principal instrument in awakening the child's professional training and helping him to adjust normally in the society. It is the investment made by the nation in its children for harvesting future crop in the form of a responsible and productive adult of the society. Education is a powerful catalyzing agent, which provides mental, physical, ideological and moral training to individuals, so as to enable them to have full consciousness of their mission, of their purpose in life and to equip them to achieve that purpose. It is an instrument for the spiritual development as well as the material fulfillment of human beings. Within the context of Islamic - perception, education is an instrument for developing the attitudes of individuals in accordance with the value of righteousness to help build a sound Islamic society (Govt. of Pakistan, 1998).

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Primary Education is the very basic of the educational pyramid and has the highest rate of return. Primary education is the most important and crucial phase of education as it aims at developing the intellectual base of the school going children. The entry age to primary education is ranging from four to eight years: similarly variation also exists in the duration of primary education, only three of the 217 countries provide 5 years of primary education and rest the entry age at 6 years. However, with the exception of three, all provide primary education from six to nine years. Looking it from another angle, 3 countries send children for five years or less, but except three, all start at age of six or more (Bhatti. e*t al*, 1986).

In Pakistan, provision of primary education is a fundamental responsibility of the state. The Public Sector has invested widely in education, both in urban as well as rural areas and in formal as well as non-formal institutions. The private sector also participates in extending education and has established formal schools mostly located in urban areas. Some NGOs and nonprofit organizations also offer primary schooling (Ahmed, 1989). Primary Education has been the top priority area in education sector, which is evident from the fact that on average half of the education budget/allocations have been earmarked for promotion of primary education. In Pakistan, the duration of primary education is five years, whereas medium of instruction at this stage is mother tongue of the child or the regional language. Co-education exists to a considerable extent in private primary school but it is discouraged in government school due to social compulsion. The present government has embarked upon a phased programmed for instruction of universal primary education by providing more school and teacher so as to raise the participation rate from 66% to 100% by 2015 (Govt of Pakistan, 2009).

Mathematics is the queen of all the sciences and arithmetic is the queen of mathematics. It importance has always been realized from the very beginning of civilization; Plato considers mathematics as the basis of judging ones mental capacity. In the present educational structure Elementary education plays a very crucial role. It is both a terminal stage for the majority of students and is also a significant determinant of quality of higher and professional education. Form both the cultural and materialistic point of view mathematics has held a very important place in the field of education (Arnold, 2003).

A large number of students today are extremely poor in their basic concepts (Agnihotri et al., 1994, pp. 86-87). One reason for this weakness in concept-based subjects is that concept formation relies on basic language and mathematical skills which in the initial stages, are helped by rote learning and algorithmic techniques. If the proficiency in language and mathematics is poor, it leads to a poor comprehension of text as well as mathematical statements. The present-day curriculum-builders have undermined the importance of algorithmic techniques and rote learning as a tool for gaining proficiency in language and basic mathematics. The students of today do not memorize multiplication tables and vocabulary as much as their elders used to do. These aspects are getting neglected when knowledge-based subjects such as social studies and science are introduced in lower classes where the student is inadequately prepared to handle them. For example, it is typical in Indian schools teaching in the English medium, to give word problems right from class 1. Elements

of set theory and number line concept are introduced in the kindergarten stage. The students struggle and waste a lot of time and effort. Concepts such as force and work are taught again and again starting from Class 4. The treatment is always partial be-cause the student has not learned the necessary tools. There have been some remarkable successes where dedicated teachers were involved (Agnihotri et al., 1994, pp. 137-146). But attempts to generalize them have not been effective.

Today instructional techniques based on constructivism as well as heuristic approaches are being advocated. But for some reason or other, the expected success has not been obtained. We have to understand the cognitive mechanism through mental reconstruction and heuristics work. The present paper focused on some aspects of the mechanism of concept formation and showed that if constructivist as well as heuristic approaches were to succeed, then they have to fulfill certain pre-requisites. The pre-requisites comprehended in terms of Robert Gagne's taxonomy that he described in his book 'The Conditions of Learning' (Gagne, 1970).

Review of Related Literature

Mathematics plays a prominent role in the fields of science, technology, industry, agriculture and business. Study of mathematics has been related with intellectual autonomy, effective opinion, aesthetic admiration, and innovative expression. Yet it allowed these objectives and opportunities to become dormant until the challenges of the modern world anxious as out of our satisfaction (Gall and Hicks, 1964).

Mathematics is as important to a country as feed is needed to young ones. As a vital device For understanding and to keep them in function of science and technology it works as a vital device, the discipline acts as the vital role of a initiate to the much desired technological and for the national development, which has turn into a very important in the development of the nations of the world. It has become an essential objective for the education of mathematics to facilitate the students to build up abilities to distinguish the relation between mathematics and the facts of life, and to recognize and realize the character of mathematics performing in the human life.

Robert Gagne in his book 'On the conditions of Learning', has given a taxonomy of learning types (Gagne, 1970 Chap.4). That he has arranged hierarchically.

Signal learning: This is a type of associative learning that has been initially studied by Pavlov who has called it conditioned reflex. A subject that responds in a certain way (R) to a stimulus S1 is given two stimuli (S1 and S2) simultaneously. After sufficient number of repetitions he learns to give the response (R) to S2 even in the absence of S1. Much of the learning that we do without giving conscious thought is of this type. Much of the initial learning of early childhood is signal learning.

Stimulus-response learning: This is another type of associative learning that has been called trial and error learning by Thorndike. Skinner has used the term operant learning for it. It involves some goal or objective that the subject attempts to achieve. The process is essentially a successive approximation process. The initial efforts are almost random. The subject modifies his approach in every attempt. Each successful attempt is remembered while failed attempts are forgotten. The success rate improves with more attempts. A good example is a child learning to walk. Initially he falls down often. But with more attempts he is able to master the skill.

Chaining: Chaining is the process of establishing a sequential connection of a set of stimulus-response pairs for the purpose of attaining a particular goal. For example, the opening of a lock involves a number of simpler steps connected in a sequence (locate the key-hole - insert the key - turn the key clockwise - watch for lever unlocking - take off the lock). Successful chaining requires prior learning of each component response. Algorithms are generally such chaining sequences.

Verbal Association: Human beings have the ability to encode and express knowledge through sound patterns. Verbal association here refers to the most elementary kind of verbal behavior - learning of verbal associations (object « name) and verbal sequences (chains of verbal associations).

Multiple Discrimination: *Learning* discrimination is the ability to distinguish between two or more stimulus objects or events. There are two different kinds of capabilities involved. The first is where the learner is able to make different responses to different members of a collection of stimulus events and objects. The second type involves the capability of the learner to respond in a single way to a collection of stimuli belonging to a single set. (This involves recognition of the defining rule for the set and responding accordingly.)

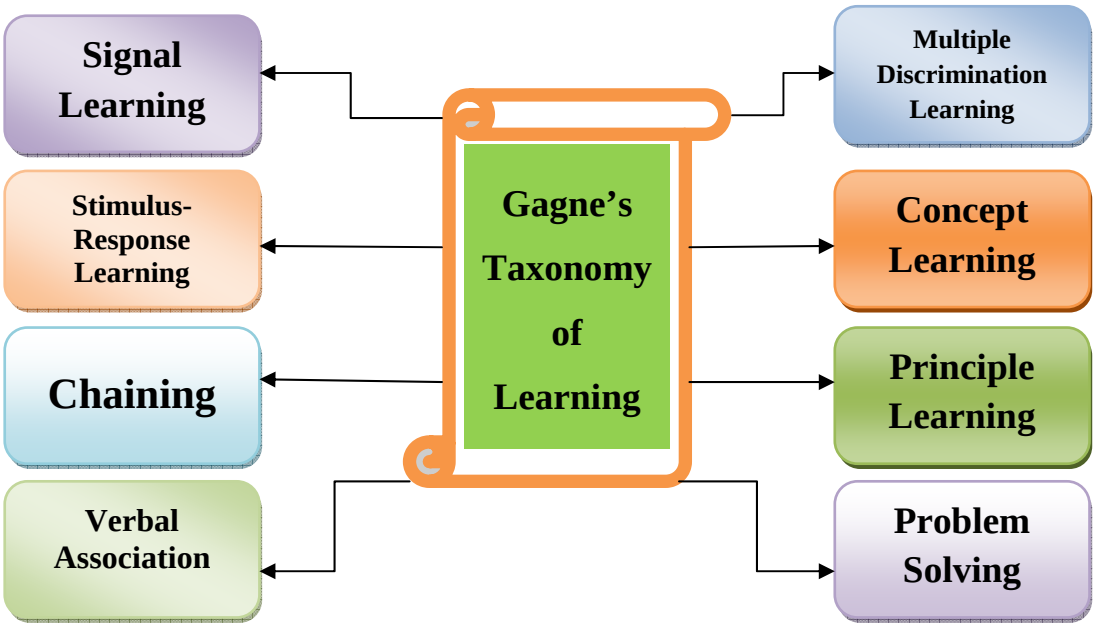
Concept learning: Concept learning involves discrimination and classification of objects**.** We will distinguish between two types of concept learning: concrete and abstract. Concrete concepts are those that are formed through direct observation. For example, consider the edge of a table, the edge of a razor blade and the edge of a cliff. It is possible to formulate a rule that defines an edge. But the concept of edge is formed more easily through direct observation of several examples. A learner can respond to a set of stimulus objects in two ways – one by distinguishing among them and the other by putting them into a class and responding to any instance of that class in the same way. Both these types are examples of concept learning. The significance of concept learning is that it frees the learner from the control by specific stimuli.

Principle (or rule) learning: Some concepts are not concrete. They are based on rules that involve other concepts. So they have to be learnt through definition. Definitions are statements that express rules for classifying, i.e. rules that are applicable to any instance of a particular class. Definitions are used for objects as well as for relations. A salient feature of principle learning is that the learner cannot acquire the concept through memorizing its statements verbatim unless he knows the referential meanings of the component concepts. For example, *2H2 + O2 = 2H2O* is meaningless unless you understand what the symbols *H2*, *O2*,

and *H2O* represent and are familiar with the mole concept. The concept formation process is cumulative. It weaves the different objects into a semantic web. Such a semantic web has been described by Novak, for example, as a concept chart (Novak, 1990) and by Gagne as a learning hierarchy (Gagne, 1970, p. 142).

Problem solving: Problem solving, here, refers to something more than classroom mathematical drills. Also referred to as heuristics (Polya, 1957), the process of problem solving is one in which the learner discovers a combination of previously learnt rules that can be applied to achieve a solution for a novel situation. The following sequence of events is typically involved in problem solving. (1) presentation of the problem, (2) definition of the problem, (3) formulation of hypothesis, (4) verification of hypothesis. The learning outcome of problem solving is a higher order rule that becomes a part of the student's repertory.

According to Gagne, cognition and concept formation is a multi-layered phenomenon, each layer consisting of a particular learning type. Signal learning, Stimulus-response learning, Chaining, Verbal Association and Multiple Discrimination Learning are all pre-requisites for the formation of concepts and the ability to solve problems. The process of concept formation involves all these eight processes. A very important point here is that if the learning has not been sufficiently accomplished at any level, then there are perceptible deterioration at all higher levels (Gagne and Wigand, 1970).



Research Methodology

Population

All students studying at government primary schools in Khyber Pakhtunkhawa were constituted population of the study.

Delimitation

A study was delimited to the students of 5th class of Government Primary school (Boys) PAF, Kohat. Research study was focused on subject of mathematics.

Sample

Sixty students of 5th class (Boys) government primary school, PAF, Kohat was taken as sample of the study.

Research instrument

In order to apply the mechanism of concept formation through Gagne's Taxonomy of learning at primary level in Khyber Pakhtunkhawa, a pre- test and post test was used for the collection of the data.

Validity and Reliability

Pre-test and Post-test were sent to the subject specialists for their content validity. Reliability of the post test was tested through pilot study on ten students and then applied on the sampled students after treatment. Split Half method (Even-Odd) was used to find the reliability of the test. Post test was divided into comparable halves by selecting odd items for one subtest and even items for the other subtest. Computed each participant's score on the two halves, and then correlated the two sets of the scores. The coefficient of reliability was determined with the help of Spearman Brown formula. Estimated reliability from the comparable values was found to be 0.80.

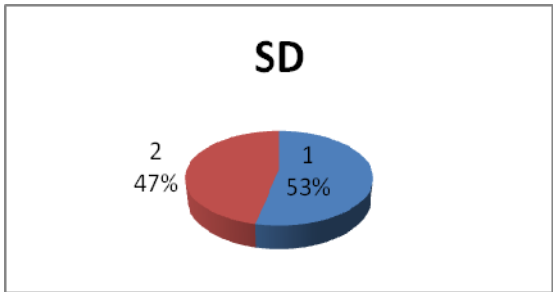
Results and Discussion

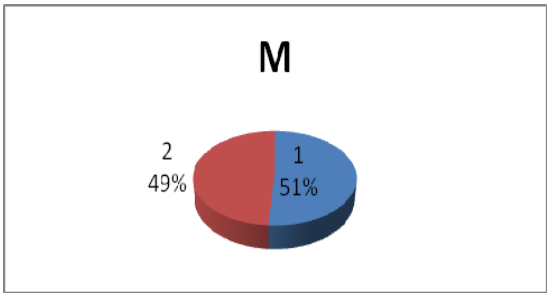
The study was conducted to explore teaching of mathematics by algorithmic techniques at primary level in the light of Gagne's perspectives in Khyber Pakhtunkhwa. This division was made on the basis of teacher made pre-test. The control group was taught by the teacher of that school and experimental group was taught by the researcher himself. Both groups were taught the two units of mathematics. The treatment was given for the four weeks to the students of fifth class in the subject of mathematics. After treatment a teacher made post test was administered to check whether they gained the concept of said subject. After twenty days same post test with minor readjustment of changing sequences as retention test was given to the student of the same class and then compared their output. Data is analyzed through different tables used in the following.

Table 1: Significance of difference between the mean scores of experimental and control groups on pre-test

Group	N	df	M	SD	SE_D	t-value
Experimental	30	29	55.67	12.67	3.38	0.64*
Control	30	29	53.50	11.08		

*Not Significant df=58 t-value at 0.05 level =2.04





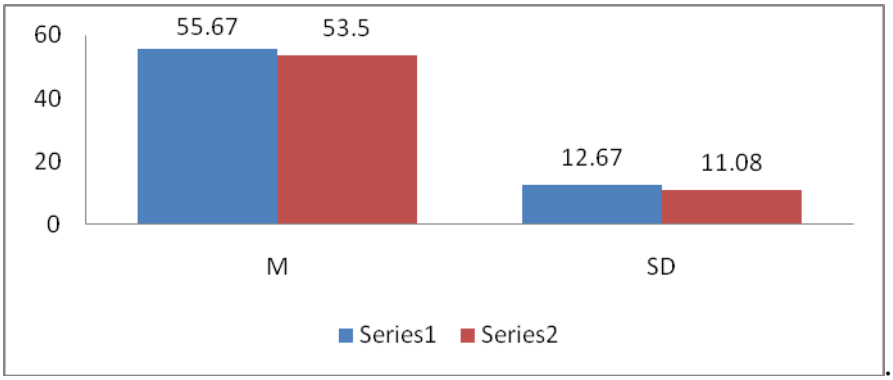
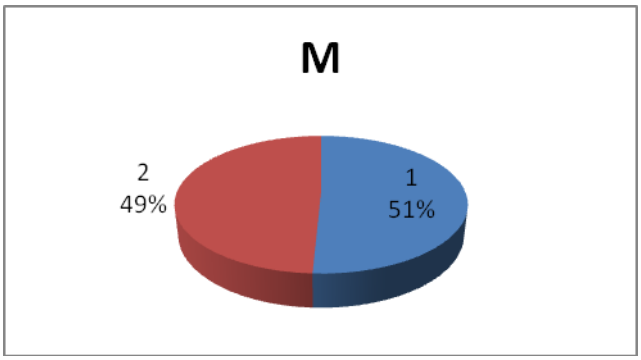


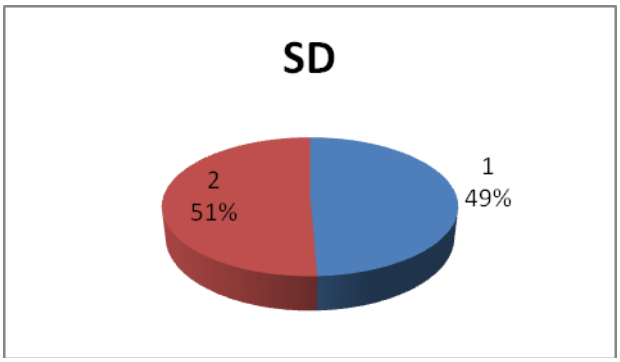
Table 1 indicates that mean scores of experimental group in pre-test were 55.67 and that of the control group was 53.5. The difference between two means was not statistically significant at 0.05 level. Hence, the null hypothesis, "There is no significance difference between the mean scores of experimental group and control group on pre-test" was accepted and both the groups could be treated as equal on the variable of pretest in the subject of mathematics.

Table 2: Significance of difference between the mean scores of high achievers of experimental and control groups on pretest

Group	N	df	M	SD	SE_D	t-value
Experimental	15	14	65.67	8.43	3.44	0.58*
Control	15	14	63.67	8.65		

*Not Significant df = 28 t value at 0.05 = 2.04





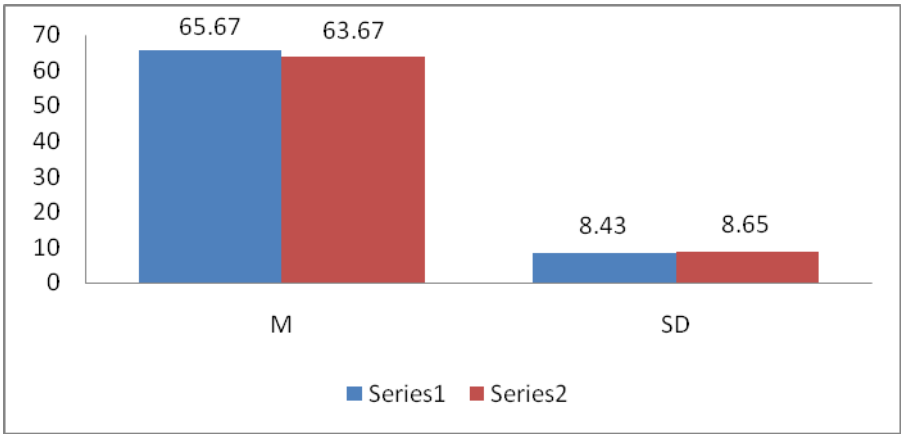
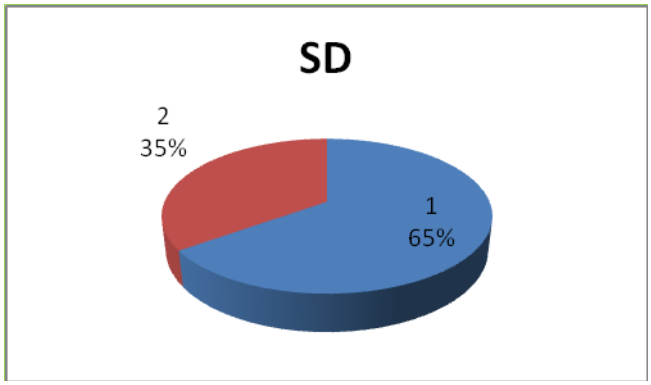


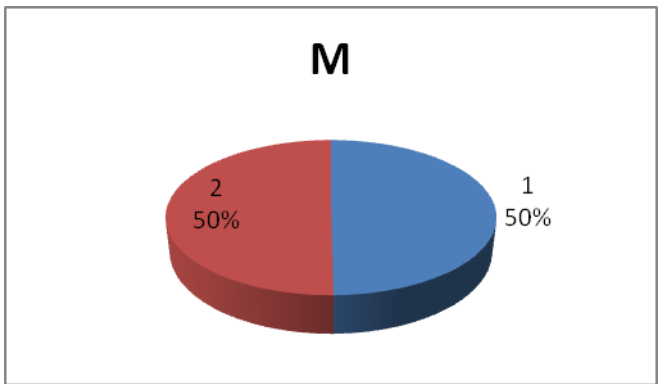
Table 2 reflects that there was no significance of difference between the mean scores of high achievers of experimental and control group on pretest. To obtained t value through calculation is 0.58 at 0.05 level, which is less than the, table value. Hence, the hypothesis, "There is no significance difference between the mean scores of high achievers of control group and experimental group on pre-test" was accepted. So, the high achievers of the both groups could be treated as equal.

Table 3: Significance of difference between the mean scores of low achievers of experimental and control groups on pretest

Group	N	df	M	SD	SE_D	t- value
Experimental	15	14	42.33	7.84	2.98	0.11*
Control	15	14	42.67	4.21		

*Not Significant df=28 t value at 0.05 = 2.14





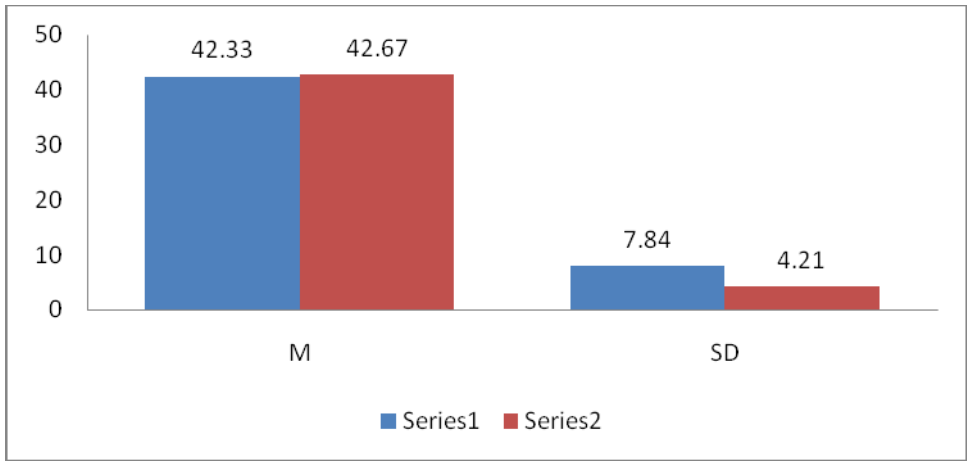


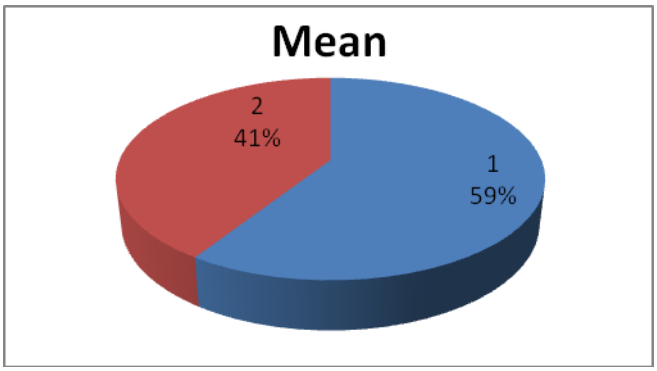
Table 3 reflects that there was no significance of difference between the mean scores of low achievers of experimental and control group on pretest. Hence, the hypothesis, "There is no significance difference between mean scores of low achievers of control group and experimental group on pre-test" was accepted. The calculated t- value is 0.11, which is less

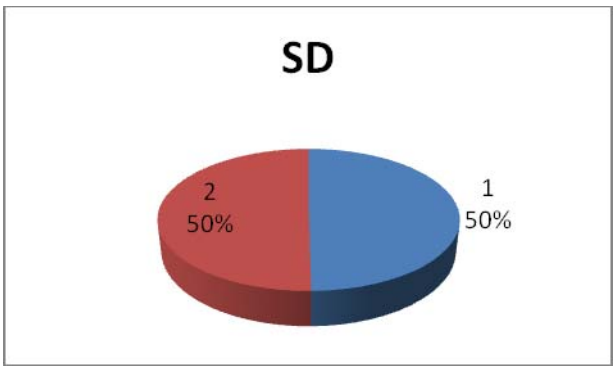
than the table value and is insignificant at 0.05 level. Hence, the both groups could be treated as equal

Table 4: Significance of difference between the mean scores of experimental and control groups on post-test

Group	N	df	Mean	SD	SE_D	t-value
Experimental	30	29	79	3.29	3.25	7.48*
Control	30	29	54.67	3.32		

*Significant df=58 t value at 0.05 = 2.04





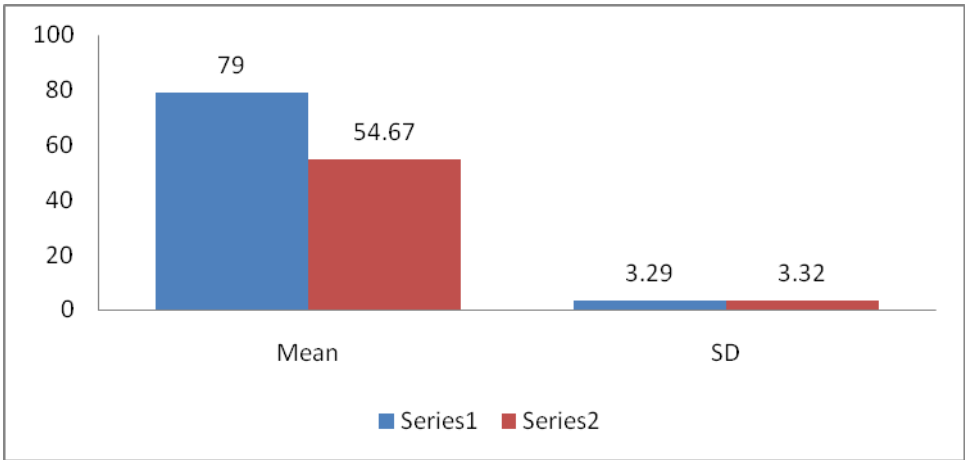
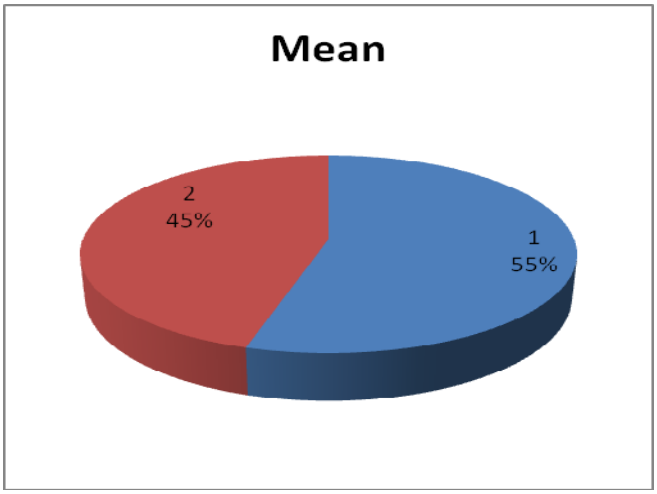


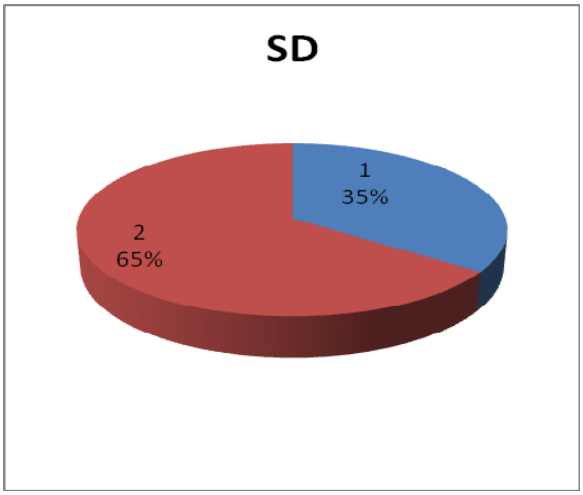
Table 4 reflects that difference between the mean scores on the post-test of the experimental group was 79 and the same of the control group was 54.67.The difference between the two means was found significant at 0.05 level in favor of the experimental group. Hence, the hypothesis, "there is no significance of difference between the mean scores of experimental and control groups on posttest," was rejected, in the light of the t-value obtained which is greater than the, table value at 0.05 level which is significant at 0.05 level. Hence, the hypothesis was rejected. It means students could learn effectively by the teaching of algorithmic techniques.

Table 5: Significance of difference between the mean scores of high achievers of experimental and control groups on posttest

Group	N	d f	Mean	SD	SE_D	t-value
Experimental	30	29	82.33	5.32	3.40	4.11*
Control	30	29	68.33	9.92		

*Significant df =58 t value at 0.05 = 2.14





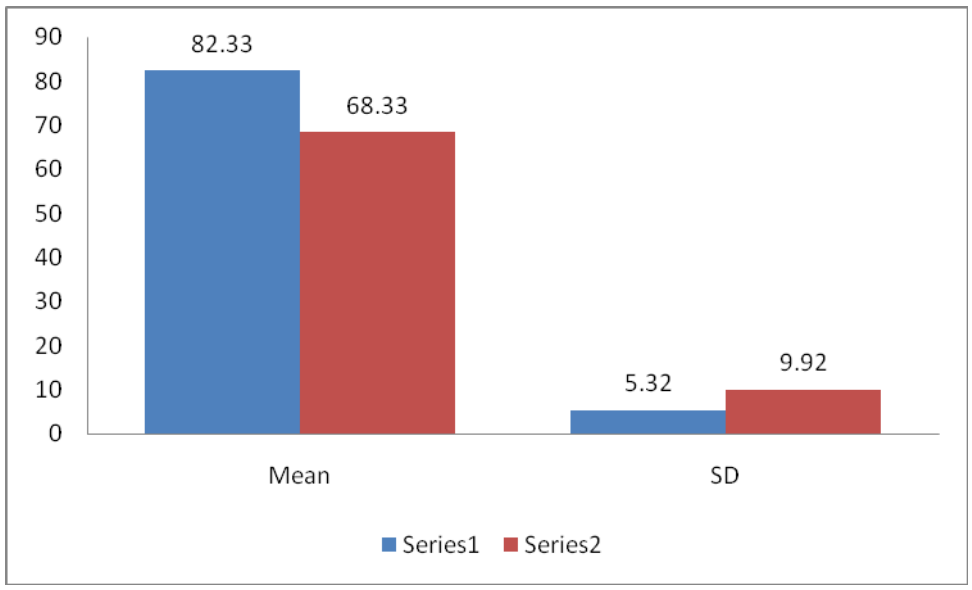
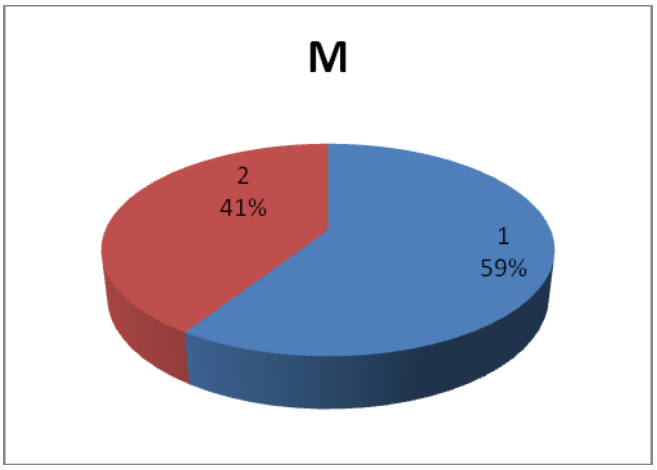


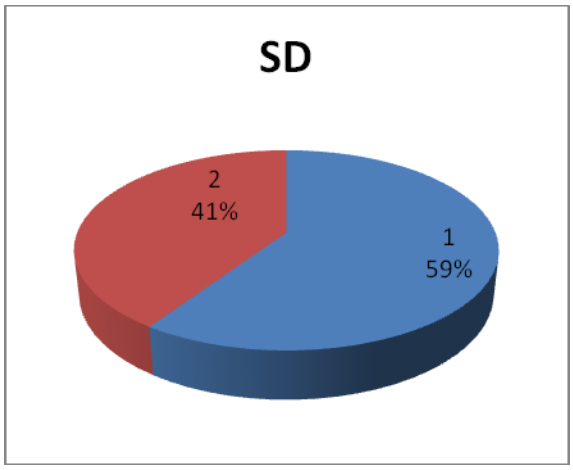
Table 5 shows that the difference between the mean scores of high achievers of experimental and control groups on post-test was statistically significant at 0.05 level in favor of the experimental group. The calculated value is 4.11, which is less than table value at 0.05 level. Hence, the hypothesis, "there is no significance of difference between the mean scores of high achievers in experimental and control groups on posttest," was rejected.

Table 6: Significance of difference between the mean scores of low achievers of experimental and control groups on post-test

Group	N	df	M	SD	SE_D	t-value
Experimental	30	29	65	4.47	0.74	7.02*
Control	30	29	45	3.05		

* Significant t value at 0.05 =2.04 df =58





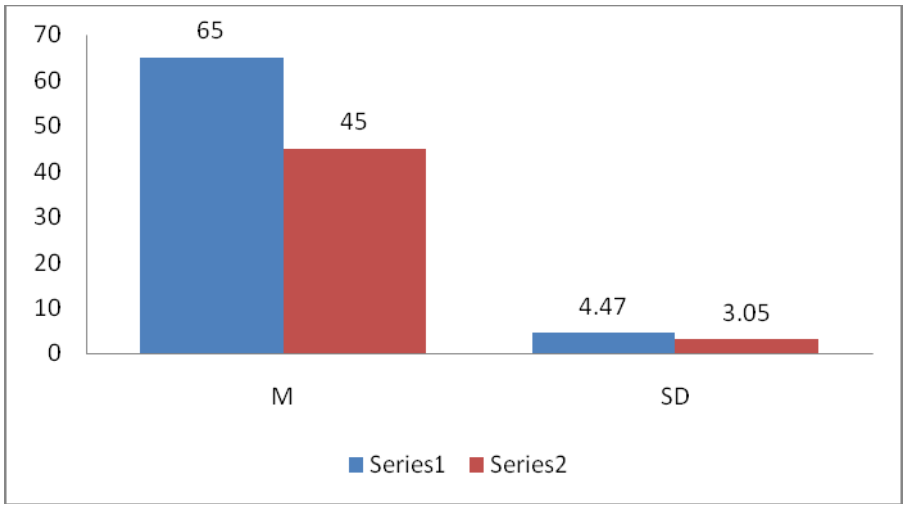


Table 6 indicates that the difference between 7.02 the mean scores of low achievers of experimental group and control group on post-test was not statistically significant at 0.05 level. The calculated t- value at 0.05 level is 7.02, which is higher than table value at same level. Hence, the hypothesis, "there is no significance of difference between the mean scores of low achievers of experimental and control group," was rejected. These results shows that low achievers had no interest in learning through algorithmic techniques.

Conclusions

From the above study, it is analyzed that;

1. There is a great role of Gagne's taxonomy in the academic achievement of students at primary level.
2. The concept of mathematics through Gagne' taxonomy can be made more effectively.
3. The students can retain the knowledge of mathematics for a longer time when taught through Gagne's Taxonomy.
4. There is no conceptual thinking into the curriculum of mathematics at primary level which provides the base for higher education.
5. There are no any advanced techniques and approaches which may help the students at the lateral stage.
6. There is no concept of associative learning as studied by the Pavlov.

Recommendations

Following recommendations are suggested in the light of above results;

1. It is suggested that more explanation of the concepts, opportunities for discussion, and encouragement may be provided for the advance learning.

2. It is recommended that grouping of the students should be made according to their abilities so that they may be taught with appropriate methodology.

3. Regional training should be given to the teachers for concept formation in the subject of mathematics according to the Gagne's Taxonomy.

4. Teachers should be given with different modern techniques of teaching through workshops and provision of courses.

5. There should be the approval of single curriculum for the whole country to survive in the country or to overcome the overlapping problems relating to the subject of mathematics.

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