

# The Use of Pre-lecture Assignments and Students' Cognitive Development in Mathematics at Secondary Level

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**Abstract** — The aim behind this study was to investigate the impact of pre-lecture on students' cognitive development in mathematics at secondary level. For this purpose twenty pre-lectures were prepared from grade 9<sup>th</sup> level mathematics textbook keeping in view the Gagne (1965) hierarchies, Blooms' Taxonomy (1956) and Johnstone et al (1994) information processing model. The whole sample (n=98) consisted of boys (n=43) and girls (n=56). The whole sample divided into with (n= 53) and without pre-lecture (n=45) groups. Before implementing research plan an attitude questionnaire was administered on the sample and by employing chi-square test no significant difference was found between the attitude of the sample with and without pre-lecture. To find out the effectiveness of pre-lectures and to in-depth the students concepts twenty post-tests were prepared keeping in view Blooms' taxonomy. The subjects of this study consisted of two secondary schools in Cantt/ Garrison setup Peshawar Pakistan. The data collection was continued through out the whole academic session 2011-12. The data analysis was made by using t-test at 5% level of significance. The results revealed as whole the students with pre-lecture performed significantly better than the students without pre-lecture. The findings outlined as pre-lecture helped in cognitive development of the students in mathematics.

**Index Terms** — Information Processing Model, Expert, Long term memory, Novice, Perception, Post-test, Pre-lecture,



## 1 Introduction

IN the process of learning mathematics the matter of readiness is an important factor for the acquisition of new mathematical concepts. According to Gagne (1965) mathematics is hierarchical in nature. Therefore an individual must learn lower capabilities before going to a higher one. The problem solving capability usually based on a series of underlying principles and concepts. For example to learn to multiply natural numbers would only be possible if a learner has already learnt several pre-requisites such as adding and counting and recognizing numerals and drawing

them with pencils (Gagne, 1965). Similarly to be able to solve quadratic equations by factorization method, it can be hypothesized that a learner must have acquired the capability to solve linear equations, to find squares and square roots (Orton, 2004). This behavioral perspective on learning mathematics is quite important but mere acquisition of sequential order in learning mathematics doesn't guarantee the thought processes of the learner. Knowledge.

Construction of knowledge in the mind of the learner successfully accomplished if a link is established between existing and coming ideas (Ausubel, 1963). Therefore we must concentrate what is already there in the mind of the learner, before introducing a new concept to the students. The new knowledge will be internalized in ordered, coherent and integrated form, if there is already relevant information in the mind of the learner (Ausubel, 1968). It means the prior experiences and knowledge have a controlling effect on future learning (Ried, 2008). In more depth the evidence of this process is detailed by predictive

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model of mathematics and science education as the “knowledge in the long term memory control the perception filter” (Johnstone et al., 1994). The filtration system works efficiently when anyone has the background knowledge in more integrated and coherent form.

There is a natural mechanism as we process information selectively. The selection process is accomplished in the light of what we have already in mind like knowledge, biases, prejudices and beliefs (Johnstone, 1997). This process is not only guiding us towards our important matters but also safeguard us from thousands of sensory information impinging constantly on our memory system. What happened if we would have allowing all information to our memory system? This would definitely be resulted in confusion or our nervous breakdown (Johnstone, 1997).

This background knowledge phenomenon is quite important and due to this we are stuck to what is important and ignore unimportant for further processing. An expert usually has vast interconnected background knowledge in his memory system, which provides him the facility to isolate a signal from noise (Zaman, 1998). On the other hand a novice finds it difficult to differentiate between the two.

In a classroom situation the expert and novice phenomenon comes to the surface, when to an on going topic some students readily pick relevant information whereas others fail to do so. This situation is occurred because of the difference of fertilization of the background knowledge in the long term memory of the students. In such state of confusion a teacher usually go back to clarify the underlying concepts first and then proceed to the main topic. On the other hand because of this, competent students of the class are suffered to a greater extent. Therefore to ensure the homogeneity in classroom and to smoothly integrate a new idea with the previous one, the mind preparation of the students is a necessary step in the process of learning. This strategy leads us towards the idea of pre learning.

Pre learning is a task oriented activity, in which the students complete the necessary work before coming to the lecture. The aim behind this activity is to initiate related information in the long term memory of the learner. On the basis of relatedness students are capable to pick relevant and ignore irrelevant information. This idea worked profoundly in the field of science education and remarkable improvements were recorded in the students’ understanding (Zaman 1996, 1998, Safdar 2002, 2007, Kolari & Ranne 2007). Similarly a range of other studies have also reported its positive impact on students’ understanding (Reid 2008).

The above cited literature indicates that pre-learning can help students to improve their understanding in mathematics. Following the same in this study a strategy of pre-lecture assignments were introduced followed by post-tests and the overall results recorded in this regard.

## 2 Statement of the Problem

Perception is a selective process and is considered to be first step in human processing and internalizing new information (Zaman, 1998). For a novice all the incoming information is important, whereas for an expert only a limited part of it because of his previous knowledge, prejudices, performances, likes and dislikes (Johnstone, 1997). In the context of learning mathematics, an expert is one being able to see deeper characteristics of a concept and look for specific information in a situation more quickly (Nickerson, 1985). Similarly “the richer the conceptual context in which one can embed a new fact, the more one can said to understand the fact” (Skemp, 1976, Nickerson, 1985). Consolidating the contextual knowledge in the long term memory of a learner is an important step for learning a new mathematical concept. Therefore this study intends to fertilize the background knowledge in the mind of the learner related to coming topic by employing pre-lecture assignments.

### 3 Experimental Design and Procedure

#### 3.1 Sample

For this study two schools (boy and girl) were randomly selected from the Cantt/Garrison setup Ministry of Defense Pakistan. In each school two sections at grade 9<sup>th</sup> level were randomly assigned as experimental (with pre-lecture) and control (without pre-lecture) groups. The total number of boys and girl students in experimental group was 22 and 31 whereas in control group 21 and 24 respectively. In this way the whole sample comprised on 98 students.

#### 3.2 Content of the study

For the present study twenty topics from grade 9<sup>th</sup> mathematics text book were selected keeping in view the topic selection criteria for Board examinations in the subject of mathematics by Federal Board of Intermediate & Secondary Education Islamabad. For this purpose five years previous papers were thoroughly screened out and finally the topics were selected. One of the benefits of this selection was that the focus concentrated on the main topics of various chapters. Secondly the selection of twenty topics didn't confine to one or two chapters but to a greater extent covered the main topics of the entire syllabus.

### 4 Procedure & Time Table of the Study

This study was continued in the above mentioned sampled schools for the whole academic session 2011-12. In one of the two sampled schools .i.e. in boys section the researcher himself implemented the research plan. For this purpose the researcher used to conduct two lectures on daily basis with grade 9<sup>th</sup> boys with and without pre-lecture. In the girl section there was only one female math teacher responsible to conduct the routine classes at grade 9<sup>th</sup> level. She was given two days training prior to implementation of research plan. The regional authority of the school was taken into confidence in this regard.

The whole sample was divided into with and without pre-lecture groups (experimental and control). To judge the difference in achievement of both groups in an

objective manner a twenty items attitude questionnaire was administered on the whole sample before implementing research plan. Despite criticism and disagreement the attitude questionnaire was developed on the pattern of Likert (1932) five point scale. For the reliability of the attitude scale internal consistency method was used.

The students in with pre-lecture group got instruction through pre-lecture (information processing model), whereas the students in without pre-lecture group got instruction through traditional teaching method. One week before the scheduled lectures each student in with pre-lecture group handed over pre-lectures. In the pre-lecture the students were guided to focus relevant ideas related to the coming topic. Besides this some preparatory problems were also given at the end of each pre-lecture. It was mandatory for students to solve these before coming to the scheduled lecture. On the delivery day of the scheduled lectures during the first five minutes of the lecture questions were raised about the preparatory work. After finding the satisfactory answers then progress was made to start the topic. The topic was detailed in accordance with the main headings of the pre-lecture.

On the alternate day of scheduled lecture each student in both groups got through a twenty minutes post-test. If any student remained absent on the test day then on the alternate day special arrangements were made such as to conduct lecture and post-test in library or any other free period.

### 5 Instruments

In this study three instruments were used for data collection. The first instrument used in this study before implementing the experimental plan was the attitude questionnaire, for the purpose to come to know about the attitude of the sample towards mathematics. The other instrument was pre-lectures handed over to the "with pre-

lecture" groups time to time in accordance with the scheduled syllabus to be taught. Similarly post-tests were conducted to both the groups in order to find out the effectiveness of the new methodology. The detail of each one is given below;

### 5.1 Attitude Scale

Keeping in view the importance of attitude as it affects the students' performance in any discipline and mathematics has no exception. Therefore an attitude questionnaire was developed on the pattern of Likert (1932) five points scale. The questionnaire was composed of 20 items. According to Sommer *et, al.* (1997), "an attitude scale should yield consistent results". Therefore to ensure about the reliability of the attitude questionnaire the first ten items were designed in the manner to point towards the positive aspects, whereas the other ten items pointing the same in negative form. The second part was constructed to check the consistency of the responses between the positive and negative statements of the attitude questionnaire.

### 5.2 Pre-lecture

According to Reid (2008), there is a vast difference between understanding and rote learning. Understanding is done when a link is established between existing and coming information in the mind of the learner. Moreover he views the process of understanding is achieved through underlying certain key determining stages as;

"How well a learner can focus on what is important for the task on hand

How well ideas can be linked in long term memory to make a meaningful whole"

Educationists and psychologists view the importance of previous knowledge as an important factor in achieving the above two underlying processes. This is because the humans are patterns seeker as new things are related into an existing system to make sense of it (Johnstone, 1997). The new idea is rejected when it doesn't make any sense. In other words the new idea is rejected

when there is no relevant information in the mind of the learner. The matter of acceptance and rejection is important and on the basis of this a hard line can be drawn between understanding and rote learning (Ausubel, 1968).

Keeping in view the importance of previous knowledge as to embed new mathematical idea into existing one, twenty pre-lectures were prepared from grade 9<sup>th</sup> mathematics text books keeping in view the Gagne (1965) hierarchies, Blooms' Taxonomy (1956) and Johnstone *et, al.* (1994) information processing model. To prepare the long term memory of the students in a broader way, pre-lectures were detailed in the manner as; what to achieve? How to achieve? Where to use the learned concept? Moreover the students were also instructed to read each step carefully given in the pre-lecture, consult the relevant portion of their text book, and solve the preparatory problems and to note any related query.

### 5.3 Post-test

Post-test provide and opportunity to the students to re-explore what they learnt during the lecture (Zaman, 1998). It also provides opportunity to the students to think critically about their performance. Post-test provides assistance to the students in interlinking the new learning to existing one in an enriched manner which pave the way towards "meaningful learning" (Ausubel *et al.*, 1968). Moreover by employing post-test the students can successfully draw conclusions and plan their own activities for future problem solving (Safdar, 2002). It can also be said that the results obtained through post-test provide information about the students seriousness towards pre-lecture preparation, their weaknesses in the topic area, background knowledge and the teacher own weaknesses regarding the lecture.

Keeping in view the above ideas twenty post-tests were prepared in relation to the approved text material taught to the sample. Each post-test used in this study comprised four objective type questions and two or three

short questions related to approved topics. These questions were prepared in accordance with cognitive domain of Bloom’s Taxonomy (1956). In each post-test efforts were made to set the questions in forty sixty ratio between lower and higher order cognitive levels of the cognitive domain. If possible efforts were made to relate the questions to daily life situations in order to check the students’ understanding in the core concept and their generalizing ability. A three months pilot study was conducted for the development of this tool in the session 2010-11. This was done to ensure about the reliability of this tool.

## 6 Results and Discussion

### 6.1 Phase 1: Attitude

An attempt was made to find out any significant difference between the attitude of the sample with and without pre-lecture. The analyses of the students’ responses to attitude questionnaire of the both groups are presented here. But before going to analyzing the students’ attitude, there must be some surety regarding the reliability of the attitude questionnaire. For this purpose the attitude questionnaire was developed in the manner as two statements measuring the same dimension in reciprocal form. For example if a student show agreement with the statement “I feel I have a good mathematical mind” and disagreement with “My mind is not good for math”, then this show consistency of responses.

There were total twenty items in which ten pointing towards positive aspects whereas the other ten to the same in negative form. By employing chi-square test, the results depicted stronger internal consistency between the two parts. Therefore the attitude questionnaire was working in a right direction and hence was safe to draw reliable results. In table 1 the strongly disagree and disagree level frequencies are combined as are the strongly agree and agree levels. This is because in actual form certain frequencies in disagree and strongly disagree cells fall below 5. This was done because

according to chi-square test rules the results are doubtful if one or more cells frequencies fall below 5.

TABLE 2  
 THE CHI-SQUARE TEST RESULTS AT (.05 LOS WITH DF 2) TO  
 THE RESPONSES OF THE SAMPLE WITH & WITHOUT PRE-  
 LECTURE

Students	Frequencies					$\chi^2_{cal}$	Results
	SA	A	N	D	SD		
with(53)		39	9	5		3.14	Ns
wout(45)		26	10	9			
with(53)		30	17	6		0.41	Ns
wout(45)		25	13	7			
with(53)		43	5	5		2.91	Ns
wout(45)		30	9	6			
with(53)		40	8	5		4.40	Ns
wout(45)		25	11	9			
with(53)		40	8	5		0.89	Ns
wout(45)		31	7	7			
with(53)		31	6	16		1.39	Ns
wout(45)		21	6	18			
with(53)		38	10	5		1.76	Ns
wout(45)		31	6	8			
with(53)		38	8	7		0.49	Ns
wout(45)		35	5	5			
with(53)		29	16	8		0.27	Ns
wout(45)		27	12	6			
with(53)		33	9	11		1.92	Ns
wout(45)		31	6	16			

*As whole the table shows for the responses of both groups to all statements, the chi-square calculated values are less than the chi-square tabulated value (5.99). By conventional criteria this indicates no significant difference between the responses of the sample with and without pre-lecture. Moreover the frequencies in agree column are by a huge margin greater than the frequencies in disagree column. Therefore, as a result it can be said that the students in both with*

and without pre-lecture groups have positive attitude towards mathematics.

### 6.2 Phase 2. The impact of pre-lecture on students' achievement

The results of this phase of study are detailed in two parts. The part one details the results of the sample with and without pre-lecture taken through experimental tool post-tests developed by the researcher. The part two compares the overall achievement of the both groups as obtained in Federal Board examination session 2011-12. This was done to check the reliability of the results taken through experimental tool post-tests.

#### 6.2.1 Part. 1: The Post-test Results:

The post-test mean scores made by the whole sample with and without pre-lecture have been analyzed and are presented here in the following table:

TABLE 2

THE t-test RESULTS OF THE POST-TEST MEAN SCORES OF THE SAMPLE WITH & WITHOUT PRE-LECTURE

Students	N	Means	SD	$t_{cal}$	$t_{tab}$	Results
with	53	5.42	1.04	9.36	1.98	Sig
without	45	3.29	1.20			

Level of Significance = .05, DF= 96

*The t-test was applied on the post-test mean scores of the sample with and without pre-lecture at 5% level of significance with degree of freedom 96. The t calculated value (1.98) is by a huge margin greater than the t tabulated value (9.36). Therefore as result it can be said that there is significant difference between the mean scores of the sample with and without pre-lecture. As whole the students (with pre-lecture) performed significantly better than the students (without pre-lecture) in post-test.*

#### 6.2.2 Part. 2: The post Board performance

Two students of the control group didn't appear in the Board examination therefore the results are confined to the mean scores of 43 students. Finally the sample restricted to 96.

TABLE 3

THE t-test RESULTS OF THE POST BOARD MEAN SCORES OF THE SAMPLE WITH & WITHOUT PRE-LECTURE

Students	N	Means	SD	$t_{cal}$	$t_{tab}$	Results
with	53	47.41	18.42	2.70	1.98	Sig
without	43	36.90	19.48			

Level of Significance = .05, DF= 94

*The t-test was applied on the mean scores of the sample with and without pre-lecture at 5% level of significance with degree of freedom 94. The t calculated value (2.70) appeared greater than the t tabulated value (1.98). Therefore as result it can be said that there is significant difference between the mean scores of the sample with and without pre-lecture. As whole the students (with pre-lecture) performed significantly better than the students (without pre-lecture) in Board examination.*

## 7 Conclusion

The results emerged from the study of the students' responses to the attitude questionnaire tend to confirm that as whole both groups had positive attitude towards mathematics. It further disclosed that the significant difference observed between the mean scores of the students with and without pre-lecture was due to the difference of the treatment and not because of the attitude of the students. The post-test and post Board results depicted that the pre-lecture students performed significantly better than the students without pre-lecture. As conclusion it can be said that pre-lecture helped in improving students understanding in mathematics.

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