Meaningful Learning and Rote Learning in Physics: A comparative Study in city Jhelum (Pakistan)

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Abstract

The work reported here is an empirical investigation to compare the students' achievement of the secondary school science students taught through meaningful learning approach and the rote learning approach in Pakistan. This experimental work was carried out on sixty-two science students for the period of one academic year in the physics classroom and laboratory. Two Experimenter's tools and the public examination conducted by the Educational Board were used to measure the achievement of the students in the physics theory and practical. It has been found in various significant indications that the Ausubelian approach of teaching physics has improved the performance of the students. The other significant factor in the learning process is the persistent increase in the standard deviations for the experimental group which suggests that not all students benefited equally. This gives rise to another area 'cognitive learning styles' that should be explored. The analysis of data revealed evidence for a major role of relevant cognitive structure in meaningful learning. The findings of this study provide qualified support to Ausubel's teaching approach of meaningful learning.

Key words

Meaningful learning, rote learning, learning style, cognitive structure

Introduction

It is universally acknowledged that any attempt at the improvement in the quality of science education ultimately depends on the quality of teaching and learning in the classrooms and laboratories. Literature on science education reflects that science education is the core area of any education system in the world and same is the situation in Pakistan. Science education provides us an opportunity to think critically, and unify the concepts of man's natural environment and apply these concepts to the control of the environment for man's benefit. Further, more it is a human enterprise, which requires man's best efforts to sustain it at an optimum level of productivity.

At secondary level, science education provides the students with opportunities to think critically, practice different teaching methods and develop scientific concepts, which facilitate the understanding of the physical environment. Effective classroom teaching in science requires advance thinking and proper planning. Certain points like objectives, content, teaching methods, teaching aids, evaluation techniques are required to be attended to properly in advance for achieving desired outcomes. A good teacher provides guidance for the learner. The guidance encourages the learner to do things that result in desired learning. Hence, it is said that teaching creates conditions, which encourage and stimulate learning.

In Pakistan, much teaching (which can be described as traditional) is based on teacher-centered, lecture presentations to students where the role of the learners is the recording of what the teacher says and its accurate memorization. Credit is given to the correct recall of as much as possible in formal tests and examinations. This approach does not occur in all countries and education systems but is a particular feature of much Pakistani education and in many other countries of the world.

Traditional teaching methods are fine for remembering sequences of objects but do not aid the learner in understanding the relationships between the objects. Meaningful learning, therefore, is personal, idiosyncratic and involves recognition of the links between concepts. In the traditional teaching the teachers' main focus is on memorization (rote learning). According to Vadidya, (1996), rote learning is not meaningful in the process of internalization. It is arbitrary and verbatim in nature. It stays close to the cognitive structure of the learner but do not get integrated there. Hence as a result the learner exhibits a non-successful learning set.

Both rote and meaningful learning may be achieved no matter what instructional strategy is used (Novak and Gowin, 1984). Either reception learning (passive listener with teacher-directed agenda) or discovery learning (active learning where the learner chooses information to be learned) may result in meaningful learning. Therefore, it is not necessarily how information is presented but how the new information is integrated into the old knowledge structure.

Basic sciences must include the mastery of concepts instead of mere memorization and the following of procedures. It must include an understanding of how to make the learning

material meaningful and to use the scientific equipments in the laboratory to arrive meaningfully at solutions to problems, to verify laws, principles.

In Pakistan, the curriculum wing, Ministry of Education sets standards for more emphasis on understanding of concepts, their logical arrangement, critical thinking and communication over recall of facts. In many fields such as mathematics and science it is still a matter of controversy as to whether rote memorization of facts is still necessary. Some educationists who are in favour of new standards are revisiting in response to sharp criticism from those who believe future generations should learn at least as much knowledge as previous generations have been taught, rather than just "how to think". It is countered that thinking skills alone will not be useful without a base of memorized facts.

Ausubel (1966) says that "Meaningful learning takes place if the learning task is related in a non-arbitrary and non-verbatim fashion to the learner's existing cognitive structure". Ausubel believes that "learning should progress deductively – from the general to the specific, and not inductively, as Bruner recommended (from specific to general).He supports the use of direct instructional methods (lecture), and argues that large bodies of knowledge are best obtained through this type of learning."

Direct instructional methods are much more than lecture. It can involve worksheets, textbooks, and websites as well as teaching with questioning. The key thing is that the instruction is directed by the teacher. This theory can help teachers as;

- We need to remember that inputs to learning are important.
- Learning materials should be well organized.
- New ideas and concepts must be potentially meaningful to the learner.

Anchoring new concepts into the learner's already existing cognitive structure will make the new concepts recallable.

Ausubel (1960), proposed his expository teaching model to encourage meaningful learning rather than rote reception learning. In his approach to learning, teacher presents material in the carefully organized sequenced and finished form. Students receive the most usable material in the most efficient way. It is most appropriate when we want to teach about the relationships among several concepts. Another consideration is the age of the students. This approach requires students to manipulate abstract ideas; this means expository teaching is more developmentally appropriate for students of elementary and secondary stages.

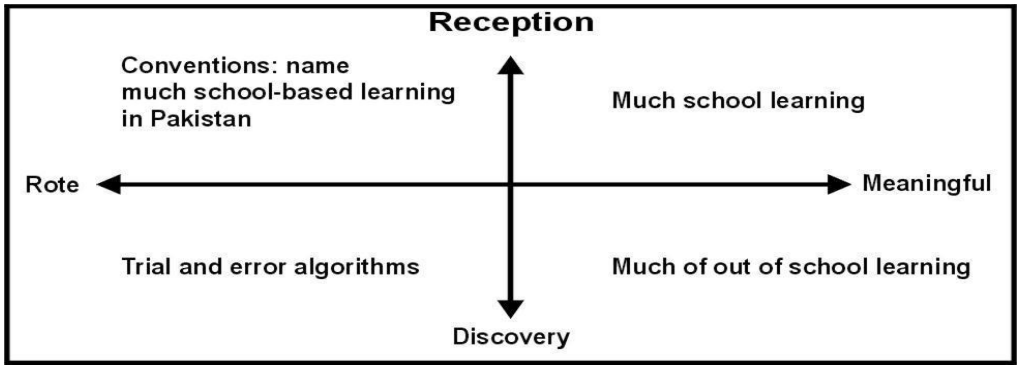
Traditional teaching methods view teaching as a management procedure involving controlling the stimuli to which students are exposed and rewards they receive for learning. Johnson, (1979) expresses the views that what can be directly observed is important, and through using environmental stimuli and rewards to condition students, anything can be learned. In the traditional teaching the teachers' main focus is on memorization (rote learning). According to Vadidya, (1996), rote learning is not meaningful in the process of internalization. It is arbitrary and verbatim in nature. It stays close to the cognitive structure of the learner but do not get integrated there. Hence as a result the learner exhibits a non-successful learning set.

The advocates of traditional methods argue that rote learning is the only way to learn material in a timely manner. For example, when learning the English alphabet, the vocabulary of a foreign (second or third) language, there is no inner structure or their inner complexity is too subtle to be learned explicitly in a short time.

Brevity is not always the case with rote learning. For example, many Muslims learn by heart and can recite the whole Holy Quran. Their ability to do so can be attributed, at least in some part, to having been assimilated by rote learning. Rote learning is prevalent in many religious schools throughout the world. For example, Jewish use this approach when teaching children Torah and Muslim Madrasas utilize it in teaching of Holy Quran. It is used in various degrees, and more so, although far from exclusively, at a younger age, the main purpose being to memorize and retain as much textual material as possible, to prepare a student for a more analytical learning in the future.

The great emphasis of Ausubel et al. (1968) was in their clear way of distinguishing from rote memorization from what they call meaningful learning. In addition, they separated these very clearly from the reception-discovery learning axis. The figure given below gives clearer picture which is derived from the work of Ausubel et al. (1968).

Figure1. Reception-discovery and meaningful-rote learning axis

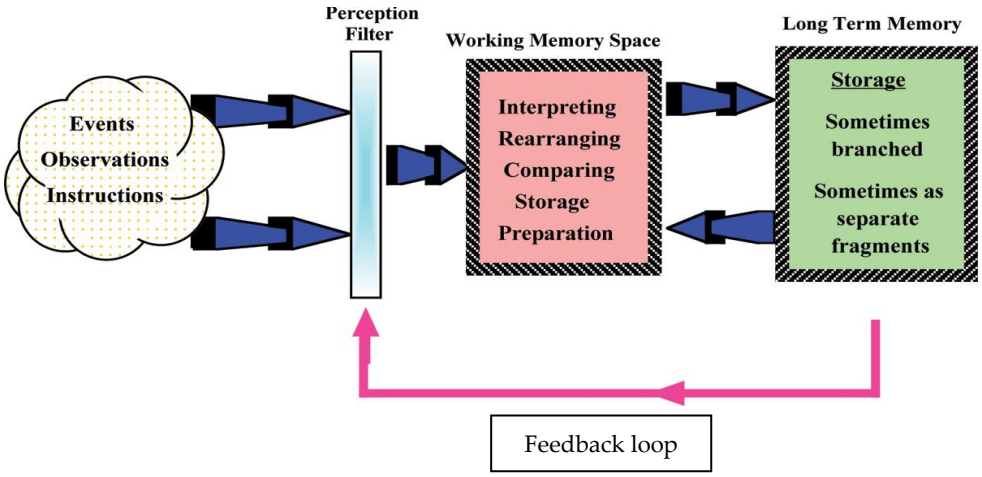


There are numerous ways by which school-learning can be characterized, for example:

- Teacher-centered: student-centered.
- Reception: discovery.
- Individual learning: group learning.
- Conceptual learning: skills learning.

According to cognitive psychologists, teaching and learning in the classroom depends on what the students have already in their minds', as well as on the learning context in which they find themselves. In the view of Johnson (1979), the information processing view divides learning into three phases: (i) attending to new information (ii) acquiring and retaining information, and (iii) retrieving information from memory and transferring it to new situation. The way that information is processed in learning has been summarized in the model presented by Johnstone, (1993). It represents the flow of the information through the memory system and the processing of such information. Such a model makes predictions about how input information is dealt within the human mind so that meaningful learning can take place.

Figure 2. Information Processing Model of Johnstone



In the above figure, the learner is seen to view new events, observations and instructions through a perception filter, which is influenced by what is already stored in the long-term memory. In this way, the learner selects and interprets new information in terms of what he/she already knows. The figure-2 also represents that previous knowledge affects new knowledge. It includes the ideas of Ausubel. Ausubel (1968) argues that: the most important single factor influencing learning is what the learner already knows.

Ausuble believes that information /scientific concept is learned more easily if it is organized and sequenced logically. Ausubel's theory (some time called expository teaching/deductive teaching) consists of three principles: (1) Concepts are meaningful only when the student can visualize them (i.e. it elicits an image in the "content of one's consciousness) and subsume them within a cognitive structure. (2) Always proceed from the most generic concepts to the most specific one. (3) Students' readiness; which include their current knowledge, stage of cognitive development, and predominant mode of intellectual functioning.

Meaningful learning approach found to be significantly superior to traditional method by Safdar (2010), Ausubel (1960), Anderson (1973), Alexander (1977), Schwartz (1979), Richardson (1986), Lewis (1987) and Siddiqui (1993) etc. On the other hand Ausubelian teaching method and traditional methods were found to be equally effective by Barren (1971), Moore (1973), Goodman (1977), Salman (1977), Carnes (1985). But in few cases Traditional teaching methods have been found superior to Ausubel's by a few investigators in terms of achievement like Tennyson (1986).

From the foregoing presentation of the studies, it may be seen that these studies have come up with contradictory results. It indicated that this area did not receive proper attention in Pakistan. In Pakistan, some efforts are being made to train the science teachers at elementary and secondary level to improve the teaching-learning process. The Federal and Provincial Education departments are conducting a series of teacher training programs in collaboration with CIDA, JICA, Ed-Link, GTZ etc. to improve the quality of science education in Pakistan. Present study leads to satisfy this need to some extent.

Methodology

The study was undertaken to compare the differential effects of teaching of physics through Ausubelian and traditional teaching methods on students' achievement. The research work was carried out for the period of one academic year in the physical science classrooms and lab.

Sixty-two science students were randomly selected as a sample for this study. The sample was then divided in to two equivalent groups on the basis of an achievement test of 50 marks from the 8th class science, published by Punjab Text Book Board, Lahore (Pakistan). The test was constructed, tried-out, improved and administered to the whole sample of 62 subjects. The researcher evaluated the answer sheets and the marks were arranged in the descending order. The sample was then divided into two equal matched groups on the basis of marks achieved by the students on even/odd basis.

The experimental group was taught by using Ausubel's teaching strategy of meaningful learning, five days per week that is from Monday to Friday in the physics classroom for the period of seventy minutes. At the same time the control group was taught by another science teacher having qualification B.Sc., B.Ed.

In the physics laboratory of Government Comprehensive School Jhelum the students came once per week for one and half an hour. The control group came on each Saturday from 8:30 to 10:00, and the experimental group came from 10:00 to 11:30 in the physical science laboratory for practical work.

The posttest only equivalent group design was used for this study. It involved two groups; experimental and control. The mean test scores of the experimental and control groups were subjected to a test of statistical significance (t-test).

Hypotheses

1. There is no significant difference between the achievement scores of the students in the subject of physics taught through Ausubelian and Traditional teaching method as measured by Experimenter's tool 1.
2. There is no significant difference between the achievement scores of the students in the subject of physics taught through Ausubelian and Traditional teaching method as measured by Experimenter's tool 2.
3. There is no significant difference between the achievement scores of the students in the subject of physics taught through Ausubelian and Traditional teaching method as measured in the secondary school certificate examination.
4. There is no relationship between the marks achieved by the students in the secondary school certificate examination conducted by the educational board and the attitude scale scores of the experimental and control group.

Variables

The teaching methods were used as treatment variables. The treatment variables consist of **Ausubelian teaching method** (the relationship of pre- knowledge and post-knowledge through comparisons and cross-referencing of new and old ideas to make the learning meaningful. It consists of three principles; (1) proceed from the most generic concepts to the most specific ones. (2) The concepts are meaningful only when the students can visualize them and subsume them in the cognitive structure. (3) Students readiness which includes current knowledge, stage of cognitive development, and predominant mode of intellectual functioning) and **Traditional teaching method (**the methods of instruction that tend heavily toward classroom lectures, book learning by rote, and memorization of facts, laws, principles, equations, etc. Recitation usually consists of repeating without questioning what the instructor or book stated. Knowledge periodically reinforced otherwise may forget).

. These variables were manipulated to study their comparative effectiveness. Attribute or organismic variables could not be altered by the experimenter though they had already been determined by the investigators. It was decided not to include these variables under study like, age, sex, race, and like variables. Best (1991), has agreed that such variables can be excluded from variables to be studied. The dependent variables or the criterions of the study were the achievement / performance and scientific attitude of the students. Situational variables like time, duration of treatment, teacher, subject to be taught, use of teaching aids, institutional variations, condition of instruction, sample size, language of instruction, and the like were controlled administratively and through selection of the sample; equating of time, equating the groups through equal treatment and likewise.

Tools of the Research Study (Construction, Validation, and Improvement)

Two Achievement Tests (i.e. Experimenter's tool I and Experimenter's tool II) were developed, each of 100 marks (theory 75 marks & practical 25 marks), keeping in view the contents of the study and the Bloom's Taxonomy of Educational objectives.

Test construction was made in four phases: (1) Planning Phase (2) Preparation Phase (3) Try-out Phase, and (4) Administration/evaluation Phase.

Planning Phase

The tests were planned keeping in view the concepts of validity, reliability and usability by answering the questions: What objectives are to be measured? What and how much content area (theoretical and practical) is covered? How much weightage in the test is given to each objective of the Blooms Taxonomy? How many types of test-items/problems/questions are to be included? How long my test will be? To answer these questions blue print (a two way chart /table of specification) for each test was prepared. While planning the tools, all the cognitive aspects (levels) of the educational objectives (Bloom's 1956) were taken into consideration.

Preparation Phase

Keeping in view the weightage given in the specification table, test-items/problems/questions (objective & subjective) were developed. The items/problems were taken from the content of the course and from everyday life. The language of the items/problems was kept very easy so that there should not be any difference in the understanding of the examiner, the teacher, the students and the researcher. Problems / test items were taken from the physics textbook published by Punjab Textbook Board Lahore, and from everyday life.

Try-out Phase

After getting feedback, the tests were improved through the selection, substitution and revision of test items/problems and by using the item analysis procedure. The item analysis was made by taking 30 percent of the students who scored the highest and 30 percent of students who scored the lowest marks. This was done to select the items, which discriminate the best among the low and high achievers. The difficulty level of each item was also calculated by using statistical procedure. Out of fifty-seven items, forty items (that is twenty for each test) were selected for the final form of the tests.

Administration phase

After the improvement of each tool, these were administered to the whole sample according to the schedule. The researcher evaluated the answer sheets, and the marks achieved by the students were kept in the record file of each student for further statistical procedures.

Validity and Reliability of the experimenter's tools

Although the tests were prepared on the basis of proper specification yet to ensure the content validity of the questions /test items, three professionals in the field of science education, assessed the bank of test questions for content validity.

The reliability / internal consistency of the Experimenter's Tools I & II was estimated by using formula KR-21, and was found to be 0.80 and 0.88.

The data collected through the experimenter's tools was then verified by the marks achieved by the students in the Secondary School Certificate examination, conducted by the Board of Intermediate and Secondary Education, Rawalpindi. After the declaration of the result of SSC examination, the result cards of the whole sample were taken from the in-charge school record for further statistical procedures.

Statistical Procedures

In this study, the researcher used the t-test for independent samples to determine whether there is probably a significant difference between the means of two samples (control and experimental groups).

Pearson correlation was used to determine the relationship between the scores achieved by the whole sample in the attitude scale and the marks achieved in the subject of physics in the

annual examination conducted by the board of Intermediate and Secondary Education, Rawalpindi.

Data analysis / Discussion

This study was conducted to compare the effectiveness of the two teaching strategies i.e. Ausubel's Teaching Strategy and Traditional Teaching Strategy. An experimental research design (posttest only control group design) was used to see the effectiveness of both the teaching methods. Sampled students were randomly assigned to treatment and control groups. Treatment group was taught through Ausubel teaching strategy while control group was taught through traditional teaching strategy. This experiment was conducted for a period of one year. At the end of the study (experiment) three measurements were observed through, (i) Experimenters Tools 1(ii) Experimenters Tools 2. (iii) Secondary School Certificate Examination "Physics"

Table 1. Data regarding achievement scores of students in the subject of Physics collected through Experimenter's research tool '1'.

Treatment	N	Mean	SD	t-value	*p*
Ausubelian Teaching Method (ATM)	31	46.8	17.5	2.91(59)	< .01
Traditional teaching Method (TTM)	30	35.2	13.1		

The t-test was applied to evaluate whether there was any significant difference between the achievement of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter's tool '1'. The result indicated that the mean concern for Ausuble's teaching strategy ($\underline{M}$ = 46.8, $\underline{SD}$ = 17.5) was significantly greater than the mean concern for Traditional teaching strategy ($\underline{M}$ = 35.2, $\underline{SD}$ = 13.1), $\underline{t}$ (59) = 2.91. As the mean score of the experimental Group (46.8) is greater than the mean score of control group (35.2), it indicates that the difference in the achievement and attitude is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis 1 stated above is rejected.

The findings of this study were consistent with the finding of Pandey (1986), Stenbrink (1970). On the other hand Ausubel's teaching Strategies (ATS) and Traditional teaching Strategies (TTS) were found equally effective by Feller (1973), Goodman (1977).

A clearer picture that emerged from Table 4.3 is presented in the form of bar diagram.

Figure 3. Data for the achievement scores of students in the subject of Physics collected through Experimenter's research tool '1'.

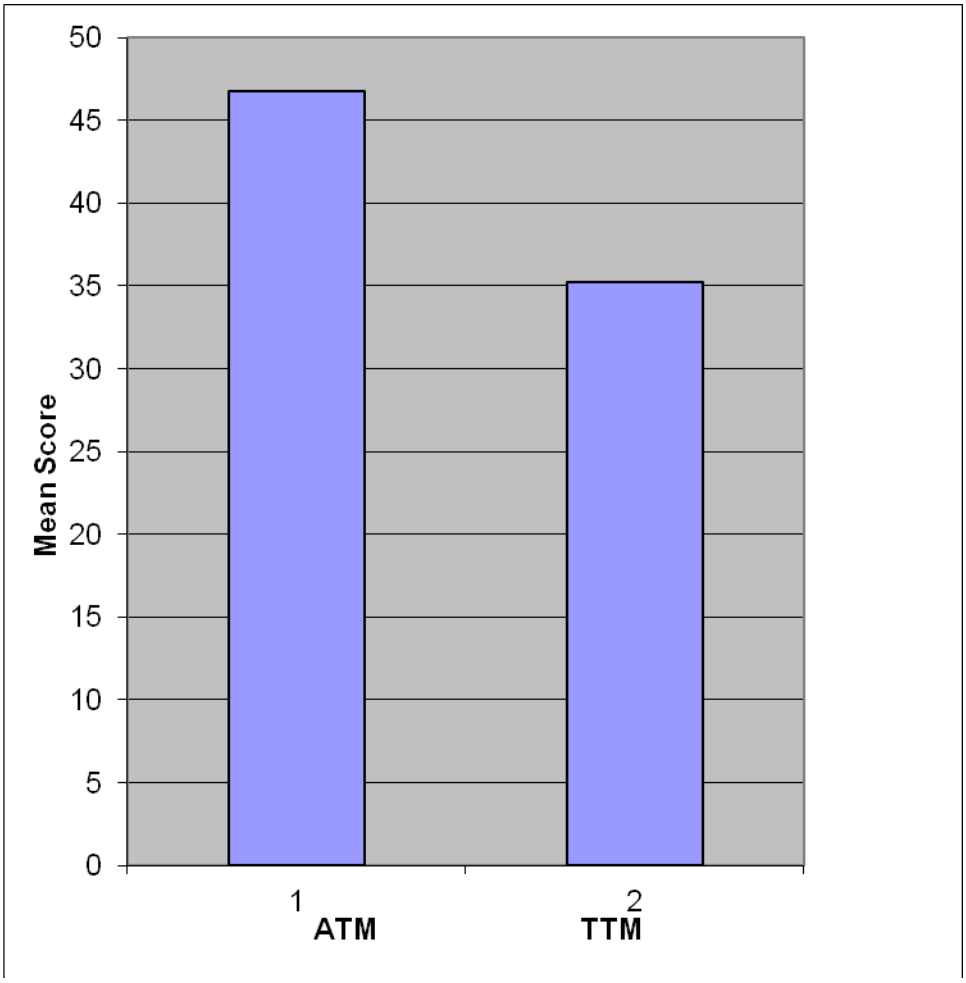


Table 2. Data regarding achievement scores of students in the subject of Physic collected through Experimenter's research tool '2'.

Treatment	N	Mean	SD	t-value	*p*
Ausubelian Teaching Method (ATM)	31	49.1	15.4	4.51	< .001
Traditional Teaching Method (TTM)	30	33.9	10.2		

The t-test was conducted to evaluate whether there was any significant difference between the achievement of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter's tool '2'. The result indicated that the mean concern for Ausuble's teaching strategy (M = 49.1, SD = 15.4) was significantly greater than the mean concern for Traditional teaching strategy (M = 33.9 SD = 10.2), t (59) = 4.51. It is indicated that students taught through Ausubel's teaching strategy performed better than the students taught through traditional teaching strategy.

Ausubel's teaching strategy had significant effect on active learning, achievement, and retention situation positively to traditional method and these effects were found in the research studies of Ausubel (1960), Ausubel and Fitzgerald (1963), Smith (1976), Johnson (1981), Novak (2001), Gupta (2004).

Table 3. Students' overall (theory and practical) achievement scores in the subject of physics as measured in the Secondary School Certificate (SSC) examination Annual 2005, when taught through ATS and TTS.

Treatment	N	Mean	SD	t-value	*p*
Ausubelian Teaching Method (ATM)	31	57.2	18.6	2.95(df=59)	< .01
Traditional Teaching Method (TTM)	30	44.4	15.1		

The result indicated that the mean concern for Ausuble's teaching strategy (M = 57.2, SD = 18.6) was significantly greater than the mean concern for Traditional teaching strategy (M = 44.4, SD = 15.1), t (59) = 2.95. Therefore, the hypothesis 3 stated above is rejected.

It is indicated that students taught through Ausubel's teaching strategy performed better than the students taught through traditional teaching strategy. The result of the study is consistent with the views of Ausubel (1960): specifically the importance of pre-learning, the linking of new ideas to previous knowledge.

Same results are evidenced by the research studies conducted by Rajoriya (1987), Lewis (1987), Ausubel & Gait (1968), Ausubel (1978), Siddiqui (1993), Novak (2001), who compared meaningful learning model /meaningful learning model with traditional methods for teaching and has been found that meaningful learning model facilitated significantly higher learning in comparison to traditional method. There are also a few studies like Tennyson (1986), which found traditional teaching strategy superior to Ausubel in terms of students' achievement. The study of Tennyson shows interesting result but this study was of shorter duration and covered very small content.

Table 4. Data regarding the correlation between the marks achieved by the experimental and control groups in the SSC Examination Annual 2005 and the attitude scale scores.

Group	Tool	Mean	SD	r	*p*
Experimental (N=31)	SSC Examination	57.2	18.6	0.667	<0.01
	Attitude Scale	115.2	15.2		
Control (N=30)	SSC Examination	44.4	15.4	0.145	>0.01
	Attitude Scale	102.7	15.1		

The Pearson correlation coefficient was calculated to find the relationship between the achievement scores and the scores in the attitude scale. The relationship is significant ($r = 0.667$ at $p = 0.01$) for the experimental group while insignificant for control group ($r = 0.145$ at $p = 0.01$). It can be seen that the high achievers showed more positive attitude and the low achievers showed least in the experimental group while in the control group the scores are scattered which resulted low correlation between the achievement and attitude scale scores.

Conclusion

In Pakistan, the traditional way of teaching in the science subjects at all levels at school relies heavily on the presentation of material in a lecture format, the students being required to record and then memories what is taught. This assumes that the educational process is built around the transfer of knowledge from the head of the teacher (with help from textbooks etc) to the heads of the young learners. It ignores the innate ability of learners to construct their own understandings. It leads to memories knowledge where ideas are not linked together, where most of what is learned is quickly forgotten simply because there are few links between ideas to enable the learner to recall after a period of time. It means that learners rarely can apply their knowledge in what is learned, is not really understood. Because the traditional method fails to work within the natural tendency of learners to seek to understand, then attitudes towards what is to be learned, the learning process and to education in general may well deteriorated, with long term consequences for future learning. The only advantage is that it allows the easy setting of examinations and tests,

these simply measuring the efficiency of recall for recognition. The whole process is a highly inconsistent way to educate. Indeed it can hardly be called education. There is, therefore, the huge need to re-think the whole process of teaching and learning in order to improve education.

It can be found from the tables 1, 2, and 3 that the Ausubelian teaching method help in improving the achievement of the students in the subject of physics. It was also found that the conceptual understanding of the students in the subject of physics was improved in favour of experimental group. This study seeks to contribute to this development by considering how the insights of Ausubel can be converted into effective and efficient instructional method, looking specifically at physics.

Table 4 shows that not only have the means risen but the marks are more spread in the experimental group. This implies that some students benefited more, while others benefited less by the use of Ausubel's Teaching Strategies. As the results are significant in favour of Ausubel's teaching strategies and showed high positive correlation, therefore, it is decided that Ausubel's teaching strategies helps not only to improve the achievement of the students but also helps to develop the scientific attitude. (Morgan, 1985, Zaman, 1996)

Hence, it is recommended that the traditional methods of teaching sciences (rote or parrot fashion learning should be replaced by more reliable teaching method that is Ausubelian teaching method .

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Appendix-A

Experimenter's Tool I for class X Physics

Max. Marks 75 Time 2 ½ hour
Name: _____ Roll No: _____

Note: Read the statements carefully and (√) the most suitable choice. (15)

1. Dr. Abdul-s-Salam was awarded Nobel Prize for his work on;

(a) Quantum theory (b) Corpuscular theory of light

(c) Grand unification theory (d) Theory of Relativity

2. What is the magnitude of the resultant force, when two forces of 3N & 4N are perpendicularly acting on a body?

(a) 7N (b) 12N

(c) 1N (d) 5N

3. A stone of mass 2kg falls from the top of a tower and reaches the ground in 4 seconds. How long will it take a stone of mass 4kg to fall to the ground from the top of the same tower?

(a) 2 seconds (b) 4 seconds

(c) 6seconds (d) 8 seconds

4. Equal forces applied on tennis and cricket balls of equal volumes, the acceleration in

(a) Plastic ball is greater than cricket (b) both balls is equal

(c) Plastic ball is less than cricket (d) none of a, b, c

5. If the uniform speed of a body moving in a circle is doubled, its centripetal force becomes;

(a) Twice (b) Three time

(c) Four time (d) Eight time

6. Which one is more elastic?

(a) Air (b) Water

(c) Steel (d) Rubber

7. A stone is dropped from a tower. It reaches the ground in 10 seconds. What is its velocity when it hits the ground?

(a) 1.00 m/s (b) 10.0 m/s

(c) 100 m/s (d) 1000 m/s

8. The output of a machine is always;

(a) Equal to input (b) Less than input

(c) Greater than input (d) Some time less some time greater

9. Torque is the product of;

(a) Force and displacement (b) Force and force arm

(c) Force and mass (d) force and acceleration

10. A simple pendulum is made of plastic ball (as a bob), filled with water and have a hole in it. During the oscillation, it's mass continuously decreasing. What will be the effect on the time-period of the pendulum?

(a) It will increase (b) It will decrease

(c) It will remain same (d) None of a, b, c.

11. The molecular theory of matter was experimentally tested by:

(a) Hooks (b) Archimedes

(c) Pascal (d) Brown

12. The unit of coefficient of friction is:

(a) Pascal (b) Joule

(c) None (d) Newton

13. The average speed of human being is:

(a) 2 km/s (b) 4 km/s

(c) 6 km/s (d) 8 km/s

14. What will be the work done, if a force of 100N acts on a body, making an angle of 45^0 with horizontal?

(a) 0.707 N (b) 7.07 N

(c) 100 N (d) 70.7 N

15. When water changes into ice, it:

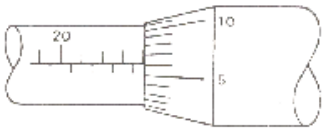
(a) Contracts (b) Expands

(c) Becomes dense (d) Volume decreases

Part B

Answer the following questions. (Give scientific reason where necessary) (30)

1. Why is a standard unit needed to measure a quantity correctly?
2. A stone of mass 5 kg thrown in the downward direction from a tower and reaches the surface of Earth in 5 seconds. How long a 10 kg stone will take to reach the Earth?
3. Why is the friction of rolling bodies less than that of sliding bodies?
4. Under what condition the sum of three vectors will be zero?
5. Can a moving body be in equilibrium?
6. Which vehicle has more danger of over turning on an inclined road? A Car or Tractor. Give its reason.
7. Why a cyclist bends himself towards the inner side of a curved path while taking turn with high speed?
8. How much power does a 50 kg athlete use by climbing 10 m high stairs in 10s?
9. How heavy stones were shifted from ground to a big height for the construction of Egyptian Pyramids (the first wonder of the world)?
10. A ship is mostly made of iron, but it floats on the sea surface, while a small needle sinks. Why?
11. Define the following terms: effort, load, mechanical advantage, and efficiency.
12. Differentiate between random error and a systematic error in the measurement of any physical quantity.
13. Can you explain why an inflated balloon shoots off when its air is released?
14. What is scientific method? Write its different stages.
15. Diagram shows the reading obtained for the diameter of a wire. If screwguage has no zero-error then calculate the diameter of the wire.



Part C

Q 1. (a Define friction. Also describe advantages and disadvantages of friction.
(b) In order to push a box of 50 kg mass on the floor, a force of 300 N is required. What will be the coefficient of friction existing between the box and the floor?

Q 2. (a) Define torque. What are the factors on which it depends?
(b) Calculate the mass of Earth by using Newton's Law of Gravitation.

Q 3. (a) Define the following: Stress, Strain, Surface Tension, Viscosity, and Pressure.
(b) Define Pascal's law and give its two applications in daily life.

Practical Examination

Max. Marks 25 Time 1 ½ hour

Name: _____ Roll No: _____

Note: Perform any one practical. **(20)**

A Find the volume of given cylinder with the help of vernier callipers & verify the volume by using measuring cylinder.

OR

Find the centre of gravity of a given meter rod. Find the weight of the given stone by using principal of lever.

B. Note book. (2)

C. Viva Voce. (3)