SUMMARY AND CONCLUSIONS

5.1. SUMMARY OF THE STUDY

The purposes of the present study were: (1) to determine the significance of differences in the Achievement of the students of Class IX (Just Promoted to Class X) in some achievement objective areas in General Physics; (2) to verify the established "Hierarchical" order of learning-objectives; (3) to find out the impact of Academic Motivation and Intelligence of the learners on their 'Achievement in General Physics'.

In the first chapter the investigator dealt with the concept of science as well as with the evolution of science-teaching at the Secondary level. There the investigator pointed out that the Science-teaching in West Bengal is devoid of observation, demonstration and experimentation. Science-teaching in West Bengal has little difference with the teaching of other subjects. The approach is bookish and cramming is the only method. In sections 1.2 and 1.3 of this chapter the investigator discussed the scope of General Physics in science and dealt with the objectives of science-teaching together with those of teaching - General Physics. He also pointed out that he selected the area of General Physics as delineated in the Physical Science Syllabus of Class IX. Other areas, such as Heat, Light were excluded because a survey of school progress showed that the progress differed from school to school.
In an unpublished Ph.D. Thesis, Ghosh (1985) selected only chemistry section of the Physical Science syllabus of Class-IX in West Bengal. Likewise the investigator selected General Physics portion from the syllabus of Class-IX, as this portion forms the foundation of the approach to the teaching-learning of Physical Science.

In section 1.5 the investigator dealt with the problems of Science Teaching. He stated why he preferred to test the cognitive areas only leaving out demonstration and identification or familiarity with scientific apparatus.

In section 1.6 he narrated the delimitations of the study within which this study was confined. He also discussed the significance of this study. He firmly believes that an Achievement Test like this can serve as a guide to the teachers, teaching Physical Science in Secondary Schools. The results, obtained through such an Achievement Test will serve as a feedback and facilitate in the identification of snags which stands in the way of an ideal and perfect teaching-learning situation in the different areas of achievement in Physical Science.

In 1.8 section the researcher discussed the assumptions taken by him for the formulation of the Hypotheses and afterwards he framed the Hypotheses for this study.
In the second chapter the investigator discussed the related studies, surveyed by him in relation to the ' Achievement Test' in different branches of science (Physics and Chemistry) framed for the determination of achievements in different areas of learning-outcome. He also made a survey of the impact of academic motivation upon the achievement of the students in General Physics.

At the end of Chapter-II the investigator defined the 'Terms' used by him in the context of his present study.

In the Third chapter the investigator developed and standardized an 'Achievement Test in General Physics'. In doing so, he selected the content units from the syllabus on Physical Science, as prescribed for Class-IX by West Bengal Board of Secondary Education.

He defined the objectives and their specifications in section 3.4, on the basis of which the test-items on the selected content-units of General Physics were framed.

The selected content units and their subunits, the respective Key-concepts of the subunits and the different specified objectives of teaching a content sub-unit were evaluated by the experts teaching physical science. Test items, prepared befitting to the specified objectives, were also
appraised to the experts. The developed original Test which comprised of one hundred and forty-six items was administered on four hundred forty-two Sample of students of Class-X (Just promoted from Class-IX) in thirteen schools, selected from different strata of the society. The answer sheets were evaluated and item-analysis of the Test was done as per procedure to determine the difficulty index \( (P) \) and discrimination index \( (D) \) of each item. On the basis of the determined indices of \( (P) \) and \( (D) \), thirteen items were rejected and thus the final Test comprised of one hundred and thirty-three items belonging to the four cognitive objective areas i.e. Knowledge - 33 items; Understanding - 43 items; Application - 24 items, and Skill - 33 items.

Two hundred students (one hundred boys and one hundred girls) were randomly selected from total Sample of 442 students with the help of table of random numbers and the scores of these randomly selected students were corrected following the result of "Item-analysis" of the Test, for statistical analysis.

The Final Test was re-administered on the randomly selected two hundred students, one month after the first administration of the 'Test' and the answer sheets were evaluated. Test-Retest coefficient of correlation was found to be 0.89 (significant at 0.01 level) and the coefficient of correlation as determined by split-half method with the help of Flannagan's formula was 0.95 which was significant at 0.01 level. This ensured the "Reliability" of the "Test".
In order to determine the validity of the Test, the Test-scores were correlated with those obtained by the students (randomized 200) in Physical Science in the last annual examination. The coefficient of correlation between the scores stated above, was found to be 0.68 (significant at 0.01 level). Thus the concurrent validity besides content validity of the "Test" was ensured.

After this the investigator set up a Norm for the 'Achievement Test in General Physics' by reducing the scores into T-scores.

The present researcher applied the Academic Motivation Test developed and standardized by Bhattacharyya (1980). The Test consisted of 42 items measuring 6 Dimensions. The test-retest reliability coefficient of correlation was 0.90 (p<.01). The Test possessed content validity.

Moreover, the present researcher administered Group Intelligence Test developed and standardized by Bhattacharyya (1982). The Test consisted of 72 items measuring 7 Dimensions. The test-retest reliability coefficient of the Test was 0.82. The Test possessed Construct Validity.

In the next part of the third chapter two kinds of test - (i) 'Group Intelligence Test' and the 'Academic Motivation Test', both designed and standardized by Bhattacharyya
(1982; 1980) were administered on the randomly selected two hundred students to find out their correlating influence on the achievement in General Physics.

In the first part of the Fourth Chapter various "Data" for Item-Analysis, Scores for Determination of reliability and validity of the Test were presented. Next the investigator dealt with the determination of means, standard deviations and other statistics of the scores obtained by the students (Total and randomized) in the Achievement Test in General Physics. On average percentage of scores in the four Cognitive Objective areas (Knowledge, Understanding, Application, Skill) of the randomized two hundred students (with break-up as Boys, Girls, High-achievers, Low-achievers and Middle-achievers) were found out and presented in "Bar-graph" to focus the differences of response patterns in different achievement areas and also to display the "Hierarchy-order" of different achievement objective areas. The distributions of the scores of the students in the 'Achievement Test in General Physics' were given.

The second part of the Fourth Chapter was devoted to finding out the significance of difference in the scores with the help of proportions of scores secured by the randomized two hundred students in each achievement objective area; afterwards Mann-Whitney U-Test was applied for the same purpose.
correct response

with the percentage of scores converted from the raw score of the individual student in each achievement objective area, since the distribution of the scores in 'Test' was not normal.

Mann-Whitney U-Test was also employed to find out the significance of difference between the scores secured by the High-achievers and the Low-achievers (as determined in consideration of their total scores in 'Achievement Test in General Physics') in (i) 'Group Intelligence Test', and (ii) 'Academic Motivation Test'.

This was employed to ensure the influence of 'Intelligence' and 'Academic Motivation' jointly on the academic achievement of the students.

In the last part of the Fourth Chapter Inter-correlation among the scores of students (randomized 200 in number) in the (i) 'Achievement Test in General Physics', (ii) 'Group Intelligence Test' and (iii) 'Academic Motivation Test' were calculated for finding out a 'Multiple Regression Equation' with the 'Achievement Test Scores' in General Physics as dependent variable and (i) Scores in 'Group Intelligence Test', (ii) those in 'Academic Motivation Test' as independent variables.
5.2. CONCLUSIONS

The present study undertaken by the investigator was a descriptive one. He developed and standardized an 'Achievement Test in General Physics'. The Distributions of the scores in this 'Test' were represented both in Tables and Graphically for different comparative studies.

The researcher administered a 'Group Intelligence Test' and an 'Academic Motivation Test' developed and standardized by Bhattacharyya (1982 and 1980 respectively) on two hundred students selected randomly from the total Sample (442). The scores in these two 'Tests' were also represented in Tables separately.

For testing the "Hypotheses" assumed, the data obtained from the (i) Achievement Test in General Physics, (ii) the Group Intelligence Test and (iii) the Academic Motivation Test were analysed in terms of proportions of correct responses followed by Mann-Whitney U-Test. Inter-correlation coefficients among the scores of the three 'Tests' were also calculated. After the analysis of the data the following conclusions were drawn:

(A) The percentage of total scores in the Cognitive Objective Area : 'Knowledge' for the randomized group (N = 200) was 60.12; percentage of total scores in the 'Understanding' area
for the randomized group \((N = 200)\) was 51.37; percentage of total scores in the 'Application' area for the same group of sample \((N = 200)\) was 54.79; and percentage of total scores in the 'Skill' area for the same randomized group \((N = 200)\) was 43.15 \(\text{Table No. 4(T23)}\).

Thus the first Hypothesis \((H_1)\) i.e. "Difference in performance in different Cognitive areas will come out" was supported by the results obtained. Hence this Hypothesis \((H_1)\) was retained.

It was also evident from the analysis that there were significant differences in the performance between (i) Knowledge and Understanding; (ii) Knowledge and Application; (iii) Knowledge and Skill; (iv) Understanding and Skill; and (v) Application and Skill. But regarding Understanding and Application, the difference in the performance was not prominent; as had been tested by the application of (i) a correct Response Proportion Difference Test \(\text{Table No. 4(T28)}\) and (ii) Mann-Whitney U-Test \(\text{Table No. 4(T32)}\).

The syllabus of General Physics of Class-IX (Appendix-I), as per curriculum prescribed by the West Bengal Board of Secondary Education, aimed at the fundamental concepts of different physical terms and events. Of the four cognitive areas, viz. Knowledge, Understanding, Application and Skill, Understanding
and Application were found to be so much inter-related and 
over-lapping that the difference in the results of performance 
in these two areas was found to be insignificant. Hence the 
practice in one area influenced the other.

The investigator adopted multistage sampling technique 
to have a 'Test of Significance' of the difference in the responses in different cognitive areas \( \text{Table No. 4(T26)} \).

From the Table of multistage sampling it was evident 
that the randomized sample \( (N = 50) \) at the second stage did not 
deviate from the Sample randomized \( (N = 200) \) at the First stage 
\( \text{Table No. 4(T26)} \).

Since the distribution of scores in the Achievement Test 
in General Physics was not normal, the investigator adopted Non-
parametric statistics (Mann-Whitney U-Test) for finding out the 
significance of differences.

(B) The educational objectives were framed by Bloom (1956) 
and were arranged in the 'Hierarchical order'.

He identified three major domains of 'Educational Obje-
catives' i.e. (i) Cognitive; (ii) Affective; and (iii) Psycho-motor. 
Later investigators broke up 'Cognition' into (a) Knowledge; (b) 
Understanding; (c) Application; (d) Skill etc.. These subdomains 
were arranged in the 'Hierarchical order'.
The investigator found this order in his investigation with certain modifications. Performance was highest in the 'Knowledge' area (60.12%). Next was the 'Application' area (54.79%). The third was the 'Understanding' area (51.37%). Last was the 'Skill' area (43.15%).

The 'Graphical' representation of percentage of responses in four different cognitive areas was shown in Figure No. 4(T23).

Thus the investigator found in his study that the performance in 'Application' area was slightly better than that in 'Understanding' area; but this difference was not found to be significant (Table No. 4(T32)).

According to Bloom et al (1956), after the 'Knowledge' aspect of cognitive learning the 'Understanding' aspect of cognitive learning followed, and the 'Application' aspect of cognitive learning followed the 'Knowledge' and 'Understanding' aspects.

But the investigator from his findings concluded that 'Understanding' and 'Application' areas were found to be interrelated and overlapping. This was evidently proved by the application of 'Significance Test' (Mann-Whitney U-Test) by the investigator.
Thus the 'Hierarchical Order' of cognitive objectives as determined by Bloom was modified by the investigator in the order: (i) Knowledge, (ii) Understanding and Application, (iii) Skill. The 'Understanding' and 'Application', though might be tested separately, would be ultimately a single cognitive domain as regards the findings of cognitive learning of General Physics of Class-IX. The Table No. 4(T23), also indicated the same information. When the group of Sample was broken up into Boys and Girls, and further subdivided into 'High', 'Middle', and 'Low' achiever groups, this same picture was also revealed.

Therefore, the second Hypothesis (Hg) that the cognitive objectives might be arranged in the 'Hierarchical Order' in respect of the performance of the students in General Physics was retained.

(C) The result showed that high-achievers were highly intelligent, but the low-achievers were mostly below average in intelligence.

At present the investigator substantiated the relative contributions of intelligence to academic achievement.

The results obtained indicated that there existed significant difference in intelligence of high and low achievers of the 'Achievement Test in General Physics', as determined by the application of Mann-Whitney U-TestTable No. 4(T38).
Thus the third Hypothesis (H₃), i.e. 'High and Low achievers, in respect of Total Scores in the Achievement Test in General Physics, do not significantly differ in Intelligence' was rejected.

(D) Academic achievement depended upon many factors. 'Achievement Motivation' was one of such factors. The investigator wanted to know the existence of correlation between the scores in the Academic Motivation Test and those in the Achievement Test in General Physics. For this purpose the investigator applied an 'Academic Motivation Test' (English version of the 'Academic Motivation Test' in Appendix - VIII) developed by Bhattacharyya (1980) and the Achievement Test in General Physics developed by the investigator.

'Achievement Test Scores' and the corresponding 'Academic Motivation Test Scores' of the students were shown in Table Nos. 4(T₃₅), 4(T₃₆) and 4(T₃₇). The result evidenced that there was high positive correlation between the scores in the 'Achievement Test in General Physics' and those in the 'Academic Motivation Test', since the coefficient of correlation was found to be 0.69 which was significant below 0.01 level (Scattergram of scores in Figure No. 3(F₃)).

Hence it was concluded that the highly motivated pupils would have high achievement scores.
Thus the fourth Hypothesis ($H_4$) that there would be no significant correlation between the scores in the Academic Motivation Test and the scores in Achievement Test in General Physics was rejected.

(E) The investigator wanted to study the influence of 'Academic Motivation' on the 'Achievement in General Physics' of different rank of the students, as specified on the basis of 'Achievement Test Scores in General Physics'. For this purpose the randomized group of students ($N = 200$) was broken up into High achiever group ($N_1 = 66$) and Low achiever group ($N_2 = 66$). The 33% students comprised the High achiever group, and 33% comprised the Low achiever group. The break-up was made according to the scores in 'Achievement Test in General Physics'. Their respective scores on 'Academic Motivation Test' were presented in Table Nos. 4(T$35$) and 4(T$37$) respectively. Mann-Whitney U-Test was employed to determine whether these two groups significantly differed in 'Academic Motivation Test Scores'.

The result showed $U = 3736$ and corresponding $Z$ value 7.09 which was significant beyond 0.001 level.

Therefore, the High-achiever group possessed high academic motivation and the Low-achiever group had low achievement motivation.
Thus the fifth Hypothesis (H₅) that there would be no significant difference in scores in 'Academic Motivation' between the High and Low achiever groups of students in respect of their scores in General Physics was rejected.

The investigator was thus assured that 'Academic Motivation' was responsible for the academic success in General Physics.

The present investigator, therefore, suggested that the teachers should foster motivation among the students through improvement of teaching-learning situations, school climate, parents' involvement and social atmosphere. It would mobilize extra energy, encourage initiativeness, develop ambition among the students.

5.3. LIMITATIONS OF THE STUDY

The investigator made an attempt to determine the extent of achievement in some basic units of General Physics from the Physical science syllabus, taught in Class-IX of Secondary schools in West Bengal. The extent of achievement was determined in four specific cognitive objectives of learning i.e. Knowledge, Understanding, Application and Skill to justify the differences of achievements in these four areas and to verify the established 'Hierarchical' order of learning objectives. He also identified some factors which influenced the achievement of the students in
General Physics. The study was a descriptive one, and the findings of the study were naturally based upon survey work.

The investigator tried his best to follow the standard methods and techniques for developing the "Tools" necessary for the study, administering them in appropriate time and appraising the outcome with the help of statistical measures he preferred. But still the study might have some limitations.

The investigator had to work under certain limitations which were stated below:

(i) The sample for the study was chosen from the three strata of the society - Urban, semi-urban, and rural. More analytical study could be possible if the sample be selected from more than three strata of the society, i.e. if the sample was chosen from socially backward (scheduled caste and tribe) strata of the society.

(ii) The sample in the present study consisted of four hundred forty-two students, of which two hundred forty-seven were boys and one hundred ninety-five were girls. For the standardization of the 'Achievement Test in General Physics' more students could have been chosen from different districts of this state. This would give more generality in the findings of the study. Moreover, the selected sample (Male and female)
was considered as a whole, since it was accepted by the investigator that the achievement of both the sexes: Male and Female, reading in the same class, in the Test in General Physics should be in conformity so far as the criteria of a particular class concerned.

(iii) The entire content of the Physical Science syllabus was not selected in this study since the syllabus is comprised of various disciplines of science and the (Test) would become enormously lengthy to administer and the analysis of the data, obtained therefrom would be a hard task on the part of the investigator. So he selected 'General Physics' portion from the physical science syllabus of Class-IX as the content area of this research work since he considered 'This content area' as the basis of all the disciplines of science and thought it to be judicious to perform his research work on the achievement in this specific content area.

(iv) Since there was limited scope for applying other methods, the investigator had to employ "test-retest" and split-half methods for finding reliability of the 'Achievement Test' developed by him.

(v) The 'Data', obtained from - (a) the Test, and (b) other Measures, were subjected to the following 'Statistical Treatment':

(1) The distribution being non-normal, parametric statistics were not employed, hence 'Non-parametric' statistics were adopted.
(2) "t" - test being not applicable, 'Mann-Whitney U-Test' was employed.

5.4. RECOMMENDATIONS

Learning is an active process experienced by the individual student. The competent teacher should provide effective teaching-learning situations and guide them when it is needed; but it should be remembered that it is the student who learns. The individual student learns in the same class according to his own rate of learning and learn differently at different times. The whole class does not move together at the same rate.

During the survey work the investigator in the present study gained some valuable experiences. Evaluation in science needed more attention with respect to the appraisal of right types of learning outcomes. These objectives were to be brought to the focus of student-learning. Conventional methods of teaching encouraged memorisation of scientific facts and information which was evident from the responses of the students to the 'Achievement in General Physics'.

Science teaching in the schools would not make the students scientists or researchers, but the school curriculum in science must develop 'Scientific Attitude' which would help the
individuals live in the society properly and help them solve day-to-day problems in life. The concepts which the students might learn would help them follow scientific courses of study in future.

The investigator suggested the following programmes of activities which would help the teachers of Physical Science to improve 'Teaching-Learning Situations' in schools for better achievement:

(i) **Correct attitude of the teacher**

The most important qualifications of a teacher are warmth and enthusiasm which cannot be ensured by "Teaching Machines". Hence the teacher should hold sympathetic attitudes towards the pupils. The teacher should be the source of inspiration and encouragement to the students and this is necessary to stimulate and motivate them in learning. The teacher should listen to the difficulties and problems of the students with much care and sympathy, and render all possible help in and outside the classroom in such a way that individual difference in the achievement in science among the students might be reduced as far as practicable. For this purpose the teacher should also develop special programmes in the teaching of science giving due importance to the 'Intelligence' factor of the students.
(ii) Selection of Methods, best suited to the Students' Difficulties

Individual differences in the achievement of the students made it clear that the students and shown differences in respect of the areas of disabilities in the learning of Physical Science. Hence a single method might not serve the purpose of all the students. In order to get maximum benefit, the teacher should select proper and befitting method or methods best suited to individual needs and nature of content. These methods should fulfil the very specific purpose of science-teaching in schools and develop ability in cause and effect relationship between the factual knowledge happening around the students.

(iii) Improved Physical Science Curriculum and Text Books

The existing school curriculum requires improvement. An ideal curriculum should aim at all-round development of the students. But the existing curriculum in Physical Science, placed undue stress on bookish knowledge and rote-learning. There is little scope for the development of specific objectives, i.e. Knowledge, Understanding, Application, Skill, Interest etc. fully.

In order to achieve all these specific objectives improved types of instructional materials are necessary. These instructional materials should be built up, following the
principles of individual differences, child growth and development. These materials should be enriched enough to supply the teachers with the right type of methods of instruction suitable for different topics in Physical Science, providing examples from the actual experiences of the students in their life situations.

In preparing the text books, the principles, as stated above should be followed. The text books in Physical Science should be written, based on content analysis (particularly on the analysis of the behavioural patterns) to help the teachers teach the subject properly. There should be provisions of suitably graded materials for the advanced students as well as the low-achievers in Physical Science.

Each text book in Physical Science should be supplemented by a "Teachers' Manual" in which divisions of content-topic into sub-topics and the corresponding behavioural changes as the learning outcomes should be written along with a detailed methods of teaching each topic i.e., how to introduce a new topic, how to present it successfully and how to evaluate the different aspects of achievement etc. Hence more innovations and researches are necessary in this field.
(iv) Preparation and Utilisation of "Scientific Kits"

'Scientific Kits' i.e. sets of content-unit-wise graded audio-visual aids would be very helpful in the teaching of Physical Science. These aids would also help the students to learn a content in Physical Science easily, creating interest and bringing about the cherished behavioural changes among the taughts, thus driving away the feeling of insecurity. These aids would help the teacher build up fundamental concepts of Physical Science on stronger bases. Therefore, large-scale production and utilisation of low-cost "Kits" should be encouraged.

(v) Creating interest in Physical Science

Interest of the students is the soul of learning. So the students should be motivated by bringing them directly to the environmental conditions where they lived. They could then interpret the problems and solve them to satisfy their own interest.

The first and greatest factor in creating interest is a sympathetic, well-informed, competent and inspiring teacher. Not all the devices in the world could bear the fruit of a continuing and enthusiastic student interest if they were grafted upon the dead slump of instruction in the hands of an incompetent and disinterested teacher. The teacher must have a deep and sound knowledge about the subject matter, so that he
might earn the confidence and respect of the students. Moreover, he must have an enthusiastic interest in his subject as well in its teaching. He must believe in its values and its contribution to the educational well-being of the students. In the opinion of the investigator, the teacher is the key figure in the creation of perfect teaching-learning situations in the schools adopting all the necessary measures (i.e. inspiration, motivation etc).

(vi) The Formation of Flexible Groups within the School

In the large schools, special coaching groups might be formed with the teachers of the school. These groups of teachers must diagnose the specific and major learning disabilities so far as learning of Physical Science is concerned, suggest outlines for the treatment and engage themselves in alleviating those disabilities of learning.

(vii) Courses for Training Teachers in Diagnostic and Preventive Methods

Additional training of the teachers is necessary for the proper use of diagnostic and preventive methods in teaching-learning situations. The investigator prescribed four-fold lines of activities -
(i) training in the development of the diagnostic tools in Physical Science;

(ii) training in the administration and evaluating diagnostic tools;

(iii) help in understanding the etiological factors, causing learning disabilities;

(iv) training in: the development of teaching units in different branches of Physical Science, Teachers' guides for those units and evaluation of various teaching methods adopted for the students suffering from learning disabilities in Physical Science.

REFERENCES