

CHAPTER : VII

SUMMARY, FINDINGS AND CONCLUSIONS.

7.1.: PROBLEM AND ITS CONTEXT:

Education in general and science education in particular are very essential for a meaningful national development programme. Though there were certain important contributions in the field of science by the Indians even during ancient period, it was only during the modern period with the conquest of the country by the British, modern science of the West was brought to India. After independence several Committees and Commissions at National level had looked into the various problems of education including that of science education and science textbooks especially at school level. The recent National Policy on Education (NPE- 1986) also reemphasized the need for total reorientation of science education programme at all levels and directed National Council of Educational Research and Training (NCERT), New Delhi to start publishing new textbooks for all school subjects upto Snr. Sec. level.

Physics, which is one of the basic branches of science, is a product as well as a process by its nature and structure. As pointed out in (p.15), studies such as, Hurd (1980), Ogunnanyi (1982), Menon (1986), Wood (1987), etc., are available to show that a textbook is very important in the teaching- learning process; to teach and hence to learn physics with the help of textbooks, physics textbooks should reflect the nature and structure of physics and at the same time take full care of pedagogical considerations at Snr. Sec. level.

NCERT was established by the Govt. of India in 1961; as a leading organisation especially in the field of school education, one of the major obligations of NCERT is to produce high quality, model textbooks, especially for the school programme following the syllabus of Central Board of Secondary Education (CBSE), Delhi.

7. 2.: RATIONALE FOR THE STUDY:

In any educational set-up, unavoidably, processes such as preparation, production, distribution, revision of textbooks, etc., are continuous; especially in science subjects, where knowledge is pouring in at a **fast** rate from all over the world, revisions followed by preparation of new editions or entirely new versions of textbooks are inevitable.

Based on the directives from the Govt. of India through NPE (1986) and Programme of Action (POA-1986), NCERT has brought out experimental editions of Snr. Sec. Sch. physics textbooks for Std. XI and Std. XII in the year 1988^{and 1989} respectively. The Director of NCERT in his Foreword and the Chairman of the Book-Writing Group in Physics in his Preface, have made an appeal to those who are consciously and seriously concerned with the improvement of Snr. Sec. physics curriculum, to come out with mature criticism (STD. XI, p. vii) of the material presented in the textbooks from the standpoint of the content as well as way of presentation; they have also consciously pointed out that because of constraints of time, these experimental editions have had to be brought out in some haste; and they have the plan to bring out the final versions of these experimental editions of the textbooks after receiving the feedback from various sources.

Based on the above facts, the investigator thought of embarking on this project, a rigorous evaluation of the present experimental editions of Snr. Sec. Sch. physics textbooks produced by NCERT, hoping that the findings of the study would be useful, as one of the sources of feedback to all those who are concerned with the revision exercise.

7.3. : STATEMENT OF THE PROBLEM:

An evaluation of the senior secondary school physics textbooks, produced by NCERT.

The above statement of the problem was further clarified by stating that the textbooks referred to are the present experimental editions of the physics textbooks produced and published by NCERT in 1988 and 1989 respectively for Std.XI and Std.XII mainly for senior secondary schools which are affiliated to CBSE, Delhi.

7.4. : OBJECTIVES OF THE STUDY:

The objectives of the present study were as given below:

- 1) To make a detailed study of content of the physics textbooks under study in terms of suitability of :
 - (a) Pre-text pages.
 - (b) Each chapter, in connection with the following areas:
 - (i) Introduction
 - (ii) Prerequisite/entry behaviour.
 - (iii) Content in each section.
 - (iv) Integrated science approach.
 - (v) References to scientists and history of science.
 - (c) Post-text pages.
- 2) To critically examine the physics textbooks as to their suitability to the development of the processes of inquiry.
- 3) To critically examine the communication strategies in the textbooks in terms of :
 - (a) Questioning strategies.
 - (b) Status of terms.
 - (c) Status of illustrations.

- 4) To make a detailed study of language aspects in the textbooks in terms of :
 - (a) Language specialities.
 - (b) Vocabularies.
 - (c) Major errors.
- 5) To study the following physical aspects of the textbooks: Type size, type face, size, print area, interline spacing, margins, paper, cover, ink & colour, strengthening of textual message, attraction, bulk and style of binding.
- 6) To make a detailed study of end-of-chapter exercises.
- 7) To study opinions of students, teachers and some experts regarding the suitability of the physics textbooks.
- 8) To carry out an overall evaluation of the textbooks on the basis of :
 - (a) Prescribed CBSE syllabus for Snr.Sec.Sch. physics course.
 - (b) Nature and structure of science in general and physics in particular.
 - (c) Goals and broad objectives of Education/science education in general and Snr. Sec. School physics curriculum in particular.

7.5. : DELIMITATIONS OF THE STUDY:

This study was delimited to the present physics textbooks for Std.XI and Std.XII of Indian Snr. Sec. Schools affiliated to CBSE, Delhi, produced and published by NCERT, New Delhi, based on the guidelines set by NPE (1986) and POA (1986); moreover practical physics through NCERT's Laboratory Manuals for the above classes were excluded *from* this investigation, as they require a separate study mainly to be performed in physics laboratory.

7.6: FRAMEWORK OF THE STUDY :

Textbook as a major curriculum material was first discussed briefly with the historical perspective based on its evolution in India and abroad, starting from the ancient period till the present; this was followed by a discussion on the superior position of textbook in instruction in general and science/physics instruction in particular, mainly based on studies such as Harmer & Yager (1981), Yore & Denning (1989), Goel & Sharma (1987) (pp.33-34), etc. The structure, function and major characteristics of textbooks in general and science/physics textbooks in particular were enumerated in order to begin developing the needed framework for the investigation and to get a general idea of the criteria to be set for evaluation of the chosen physics textbooks. The framework for the study was further strengthened by referring to the studies such as, Cohen et al (1983), Bojuwoye (1985), Wilson (1988), Osborne (1990), Pandey (1991), etc., (pp.39-40). In this connection special role of mathematics in physics, expected integrated science approach in physics and importance of history of science^{in physics} education were briefly touched. Product and process components of science were conceptualized based on the model adapted from Carin & Sund, 1970 (pp.52-62); the progress of science does not depend only on the accumulation of knowledge (product), but also on the emergence of processes of inquiry, the constituents of which are the development and cultivation of scientific attitude, scientific method and certain process skills.

Good communication strategies in science textbooks demand not only suitable language usage (English for Science and Technology - EST), but also appropriate questionings, positioning of technical terms and attractive but relevant illustrations through pictures, diagrams, graphs, tables, etc.; these were conceptualized on the basis of contributions mainly from Stevens (1969), Gee (1978), Sund & Throwbridge (1973), Galvia (1953), etc.

Mainly Hartley's (1990) contribution in the field of textbook design (pp.74-80) were found to be very useful in connection with physical aspects of textbooks. With regard to the strengthening of message in textbook design, von Restorff's (1933) studies and her isolation effects (or von Restorff effect) and a recent study by Panda (1990) (pp.79-80) were found useful to further conceptualize the expected physical aspects of the textbooks. Analysis of end-of-chapter exercises was conceptualized by specially referring to taxonomy of educational objectives (Bloom, et al, 1956, pp. 80-81), especially in the cognitive and affective domains.

On the whole, some 108 references were ^{examined} from conceptual articles, studies, etc., to develop the framework of this study consisting of the following major dimensions: content, process aspects, communication strategies, language, physical aspects and end-of-chapter exercises.

7.7: REVIEW OF THE RELATED, PREVIOUS RESEARCHES :

By keeping in mind the above developed framework of the study, a thorough search was carried out among the numerous research studies available in India and abroad, during the past two decades. Among the studies abroad, the investigator has chosen to include in this report, only some 23 studies during the period from 1984-1991; this does not mean that studies were not available earlier; they have not been referred to as they are somewhat similar to the studies after 1984. Similarly at the Indian scene, only some 27 studies have been referred to, which were carried out during the period from 1971-1991. Recommendations made by UNESCO at the international level and by NCERT at the national level have helped a lot to the textbook research workers. Though most of the studies being at doctoral level, are complete in many respects, some of them treated only some specific aspects of textbook, such as content

conceptualization, questioning styles, end-of-chapter exercises, language, etc. Most of the studies were carried out for existing textbooks, sometimes with a comparative outlook with the previous textbooks or textbooks related to some other parallel curriculum, to enable the textbook agencies to revise their editions after using for some years; but the investigator believes that the ideal timing for a textbook research is immediately after getting the experimental edition of the new textbook (as in the case of present investigation), before bringing out the final revised version which is likely to be used for a few more years and by all those schools to whom it is concerned (because ^{an} experimental edition, strictly speaking, should be implemented in a limited but representative sample of the concerned schools; but in the case of present experimental editions of the physics textbooks under study, surprisingly, they were implemented throughout the country).

As discussed in Ch.III (pp.120-123) in addition to NCERT's concrete recommendations, mainly the following reviewed studies have been found useful for the present investigation: To analyse the actual academic content (product aspects) studies such as Walwalkar (1971), Joshi (1972), Gopalkrishnan (1977), Lalithamma (1981), Roy (1986), Chiang-soong (1987) - some of these studies were useful for other dimensions also; to analyse the process skills, studies such as, Menon (1986), Hehr (1988); to deal with the communication strategies (questioning status of technical terms, illustrations), investigations by Leonard & Lowery (1984) and Shepardson, Pizzini (1991)-; for language aspects mainly studies by Mukhopadhyay (1983) and Strube (1989); for physical aspects, studies by Singh (1984) and Hartley (1990); for analysing end-of-chapter exercises along with Bloom's taxonomy of educational objectives, studies by Vaghamare (1971) and Ponkshe (1972) were useful; and also to study opinions of teachers, students and experts as well as to carry out overall evaluation, some of the above mentioned studies were found to be useful.

7.8. : METHODOLOGY :

Based on the overview of the above mentioned numerous articles and research studies available in the field, it was decided to make use of content analysis as the main research technique for objective No.1-6 & No.8 and questionnaires, opinionnaire and interview for Objective No.7.

7.8.1: METHODOLOGY USING CONTENT ANALYSIS:

FOR OBJECTIVE No.1-6 & 8:

Any document has 'content' in it, if it can be represented by an organized set of statements or propositions, /suggestions, explanations, etc. In any communication process like the one between the learners and a textbook, content occupies the central position; communication content is full of experiences and its causes and effects are very much varied; hence it is very difficult to have a single system of substantive categories to describe it; however a scientific method has been developed to describe various aspects of communication content in a summary fashion and this method is referred to^{as} 'content analysis' (pp.131-132); as Fox (1969) puts it, it is a procedure for the categorisation of verbal or behavioural data for the purpose of classification, summarisation and tabulation.

In this investigation, content analyses of the physics textbooks have been carried out at manifest as well as latent level; as discussed in p.135, at the former level this has been done by keeping in mind certain sets of criteria for each objective/sub-objective while evaluating the exact content of the textbooks (with nothing added to the textual transcription or with nothing assumed about it); as such some criteria were developed for the concerned 7 Objectives and their Sub-Objectives mainly based on the information available from the previous works. Content analysis at latent level has

/which may include definitions, facts, principles,

been carried out by making an attempt to code or decode the inner or indirect meaning of the textual transcription or its underlying dynamics; mainly for this 2nd level of analysis as well as for fixing certain criteria for the 1st level analysis, the investigator's background and several years of experience in teaching physics as well as education courses at various levels by making use of different textbooks in India and abroad, were also useful.

For Objective No.1-6 & 8, methodology consisted of the following:

- (a) MAIN SOURCES OF DATA: All the pages of the two physics textbooks under study and the selected portions mainly from the following documents: NPE (1986), POA (1986), CBSE Syllabus (1987,1991,1993); report of the Education Committees and Commissions at National level earlier to 1986, were also referred to some extent wherever needed.
- (b) CRITERIA FOR EVALUATION: As discussed earlier/^{several} criteria for evaluation were set based on the information obtained from earlier studies, NCERT's guidelines and the investigator's background and experience in the field of teaching-learning process (for the above 7 Objectives along with their Sub-Objectives, pp.138-161).
- (c) TOOLS, COLLECTION AND ANALYSES OF DATA: Information sheets were developed by the investigator to enter, classify and to summarise the data obtained through rigorous content analyses under objectives No.1-6 & 8 and their Sub-Objectives using various criteria set for the evaluation; because of the nature of data obtained, in some cases it was not possible to enter all the details in the developed 'Information sheets'; in such cases, the methods of presenting brief statements as such, were used; mainly based

on the data entered in rows and columns of tabular 'Information Sheets' and other data in statement forms, analyses and interpretations were made in terms of positive aspects and inadequacies by reflecting the analyses at manifest and latent level.

7.8.2: METHODOLOGY FOR OBJECTIVE NO.7:

In the case of Objective No.7, i.e., to study opinions of students, teachers and some experts regarding the suitability of the physics textbooks under study, the methodology consisted of the following:

(a) SOURCES OF DATA :

Students of Std.XI and Std.XII in Indian Snr. Sec. School affiliated to CBSE, Delhi and their physics teachers were the main sources of data, in the form of ^{their} opinions regarding the use of the present physics textbooks under study.

(b) SAMPLE :

Snr. Sec. Schools affiliated to the CBSE in the western region of India, i.e., in the states of Maharashtra, Gujarat and Rajasthan were chosen; among 108 such schools in all, as most of the schools are under Kendriya Vidyalaya Sangathan (KVS), New Delhi ^{and the public sectors,} the sample was likely to be the cross-section of different regions of the country and likely to have very much mixed SES groups, urban and rural locations and coeducational status. Among the students only two students (one average and one above-average) from each section of Std.XI and Std.XII were chosen in each school by the physics teachers to respond to students' questionnaires. In the case of teachers all the physics post-graduate teachers (normally only ^{one} in each school) were chosen to respond to teachers' questionnaire. In the case of experts to give their opinions, the sample consisted of 5 experts - four from the Dept. of Physics of the M.S. University of Baroda with several years of research and teaching

experience at undergraduate as well as post-graduate level and who had the opportunity to make use of the physics textbooks under study in certain occasions; the fifth one is Snr. physics teacher with a doctorate degree in the area of physics education and Vice-Principal for several years in a Snr. Sec. School at Baroda where the present NCERT physics textbooks are used.

(c) TOOLS:

In the case of students and teachers separate restricted type response (YES/NO/UNDECIDED) questionnaires were constructed

by the investigator; but provisions were made to get additional responses from the respondents wherever needed. To collect experts' opinions, an opinionnaire was developed which was followed up using a semi-structured type of interview.

(d) COLLECTION OF DATA:

After getting permission mainly from the CBSE to carry out the study in the schools affiliated to them, questionnaires for teachers and students were posted to the concerned Principals of the chosen schools; in the case of a few schools in Gujarat (around Baroda) and in Maharashtra (around Bombay) the investigator personally contacted the principals and administered the questionnaires. Attempts were made to get response from larger number of schools by sending additional postal reminders or personal visits/telephone calls, in a few cases, wherever possible. In the case of experts, opinionnaires were supplied to them personally by the investigator; after a convenient time-gap, during which they made an attempt to respond to the opinionnaire, three semi-structured interviews were held separately with them mainly to further discuss issues related to their responses.

(e) DATA ANALYSES :

In the case of students' and teachers' questionnaires, restricted responses of YES(Y), NO(N) & UNDECIDED (U) were analysed by first finding their frequencies followed by the calculation of average rating scores for each items ; based on the three criteria set (pp. 146-147) for interpretation of the average rating scores, the combined responses of the groups for each item, were classified into YES (Favourable), No (Unfavourable) and UNDECIDED (Uncertain) categories. In the case of unrestricted/additional responses given by teachers and students as well as in the case of experts' opinions their analyses were done by carefully going through them and by classifying (wherever possible) the relevant views of the majority into the seven aspects of the textbooks (as represented by Objective No. 1-6 & 8); and their presentations were made as far as possible in terms of positive aspects and inadequacies of the textbooks under study.

7.9. : MAJOR FINDINGS :

What follows is an enumeration of the major findings, in terms of positive aspects and inadequacies for the major dimensions of this investigation :

7.9.1: POSITIVE ASPECTS :

(a) REGARDING PRE-TEXT PAGES (i.e., PAGES BEFORE THE BEGINNING OF THE FIRST CHAPTER) :

- (1) Foreword and Prefaces for the textbooks are well written.

- (b) REGARDING CONTENT (PRODUCT ASPECTS) OF THE TEXTBOOKS:
- (2) Introductions for almost all the chapters are found to be related to science/physics from previous classes and previous chapter/s within the textbooks.
 - (3) If the development of chapters one after the other within the textbooks are considered, it appears that there are no problems for the learners [with respect to prerequisites/entry behaviours from the readings of previous chapter/s while entering into the readings of the subsequent chapter/s.
 - (4) Within the chapters, the detailed analyses of write-up of the content in different sections show that in Std.XI and Std.XII textbooks respectively (i) 54% and 47% of the sections appear to be clear in write-up; (ii) 36% and 41% of the sections appear to be somewhat clear in write-up; (iii) 14% and 7% of the sections seem to be very much exciting; (iv) 27% and 17% of the sections seem to be interesting; (v) 20% and 50% of the sections seem to be somewhat interesting; (vi) 61% and 63% of the sections do not seem difficult for students; (vii) for 5% of the sections in both the textbooks additional positive remarks/appreciations have been made by the investigator (Table No. 5.3 (p.2) Col. 9. pp.203-216).
 - (5) All chapters in both the textbooks contain references to physicists/scientists, the maximum (47) being in Chap.12 of Std.XII.
 - (6) All the chapters in Std.XI textbook contain atleast one specific and direct reference to history of physics.
 - (7) There are a few references to the history and philosophy of science during ancient Indian period, in the textbooks.

- (c) REGARDING COMMUNICATION STRATEGIES (STATUS OF QUESTIONS, FIGURES, TABLES & TECHNICAL TERMS) :

In the textbooks for Std.XI and Std.XII respectively :

- (8) 79% and 80% of the questions present, are higher order questions.
- (9) 92% and 96% of the identified technical terms are defined or their meanings are given.
- (10)
 - (i) 94% and 98% of the figures/diagrams present are relevant;
 - (ii) 39% in both are adequate;
 - (iii) 58% in both are somewhat adequate.
- (11) Almost all the Tables present in both the textbooks are relevant; and 74% and 29% of them are adequate.

- (d) REGARDING LANGUAGE USED IN THE TEXTBOOKS :

- (12) The vocabularies used in both the textbooks appear to be not so difficult at Snr. Sec. level (though some students didn't agree to this).
- (13) Most of the chapters in both the textbooks do not seem to have any serious language error.

- (e) REGARDING END-OF-CHAPTER EXERCISES :

- (14) Answers given to the numerical problems at the end of the textbooks agree with the answers obtained by the investigator in the case of most of the problems, except, of course, some discrepancies mainly in decimal places in the case of of a few problems.

In the textbooks for Std.XI and Std.XII respectively,

- (15) 11% and 25% of the end-of-chapter exercises are starred (i.e., mainly meant for above-average students).
- (16) 64% and 73% of the end-of-chapter exercises are mathematical problems, which are very relevant to the nature and structure of physics.
- (17) 68% and 73% of the end-of-chapter exercises are related to application and other higher order objectives.
- (f) REGARDING PHYSICAL ASPECTS:
 - (18) The sizes of the textbooks are more or less suitable; in the case of printing of the main textual content in both the textbooks, the print area, interline spacing, type size and type face are all within the acceptable standards.
- (g) REGARDING THE OPINIONS OF STUDENTS, TEACHERS AND EXPERTS:
 - (i) BASED ON THE RESPONSES FOR THE QUESTIONNAIRES/ OPINIONNAIRE :
 - (19) Students' Average Rating Scores (A.R.S : Section, Table No.5-20 pp.369-371) for the concerned item in the questionnaire show that they liked the questions in the textbook chapters.
 - (20) Among the teachers, their A.R.Ss for the concerned items in the questionnaire show that they are satisfied with the accuracy of the content in the textbooks and they agree that the starred problems in the end-of-chapter exercises would be really challenging even for bright students (Table No.5-21 pp.388-391).

- (21) Out of five experts, three of them specifically agreed that the information given in the textbooks are accurate and up-to-date; and illustrations are adequate in number.

(ii) BASED ON ADDITIONAL COMMENTS GIVEN BY STUDENTS,
TEACHERS AND EXPERTS :

These comments may not be always reflecting the opinions of majority of the respondents involved in this investigation; however, some of the following comments made by them, are likely to add to give a better picture of the overall evaluation of the textbooks.

- (22) A few students have stated that some of the questions/problems are explained well with the help of suitable diagrams; certain details about physicists along with their photographs are very helpful in getting general knowledge in the field of physics; and among the end-of-chapter exercises, questions related to the giving of scientific reasons are very interesting.
- (23) (Teachers' additional comments: NIL as positive aspect)
Experts' additional comments (written as well as through interviews): The textbooks contain good graphical illustrations, several discussions on historical developments as well as latest/future applications, ample quantitative data from material science and good end-of-chapter exercises.

7.9.2: INADEQUACIES :

(a) REGARDING PRE-TEXT PAGES :

- (1) The cover pages of the textbooks are not very attractive and not durable.

- (2) Among the pre-text pages, 'A Note for Teachers' does not contain all that the teachers need to make use of the textbooks effectively, especially when a separate 'Teachers' Guide' is yet to be made available.
 - (3) Based on the information available in the pre-text pages, practising Snr. Sec. Sch. physics teachers were not given suitable opportunity to have involvement in the preparation of textbooks; moreover, review workshops for these two experimental editions of the textbooks with some 874 pages were held just for 5-7 days involving a very few practising physics teachers and that too drawn from a very few important cities only.
- (b) REGARDING CONTENT (PRODUCT ASPECTS) OF THE TEXTBOOKS:
- (4) Just a 3-page write-up has been termed as Ch.1, 'Introduction' in Std.XI textbook; though it contains a few useful basic informations/concepts, it appears to be lacking in many respects as a general introduction to the course work in physics at Std.XI and Std.XII levels; in this chapter, introduction to basic Units such as Mechanics, Heat, Light, Sound, Electricity, etc., are missing.
 - (5) A short write-up on calculus in the beginning of Std.XI textbook is insufficient to enable the learners to digest several chapters of physics using this major area of higher mathematics.
 - (6) Within the chapters the detailed analyses of the write-up of the content in different sections show that, in Std.XI and Std.XII textbooks, respectively:
 - (i) 12% and 8% of the sections seem to be very difficult/above the learners' level.
 - (ii) 2% and 5% of the sections seem to be unnecessary (partly/fully).
 - (iii) 8% and 16% of the sections require more explanations for certain terms/concepts.

- (iv) 12% and 14% of the sections have additional criticism (Table No.5.3(1.2) Col.9, pp. 203-216)
- (7) Every section does not contain solved example and some of them are not of suitable nature.
- (8) In both the textbooks, there are very few references made to other related disciplines such as, chemistry, biology, geology, astronomy, medical science, engg/technology, etc., to support integrated science approach.
- (c) REGARDING THE POST-TEXT PAGES (i.e., PAGES AFTER THE LAST PAGE OF THE LAST CHAPTER) :
 - (9) Epilogue at the end of Std.XII textbook does not seem to appeal much.
 - (10) Index for the terms used in the textbook for Std.XII - Part.I is missing.
 - (11) Glossary of important terms is not given in both the textbooks.
 - (12) Bibliography in both the textbooks does not contain any reference to books written by Indian authors.
 - (13) Corrigendum or Errata is missing in both the textbooks (though there is a need for the same.)
- (d) REGARDING SCIENTIFIC PROCESSES OF INQUIRY (PROCESS ASPECTS):
 - (14) Though there are a few content presentations in some chapters, which might help to develop the process aspects of physics (i.e., the dimensions of scientific attitude, scientific method and scientific process skills), it seems that they are somewhat neglected in the overall presentation of content in both the textbooks.

(e) REGARDING COMMUNICATION STRATEGIES :

- (15) Number of activity-oriented questions are very low (XI: 13% ; XII: 7%) in both the textbooks.
- (16) Some 41% and 60% of the identified technical terms are not found in the Index of Std.XI and Std.XII textbooks respectively.
- (17) About 60% of the figures/diagrams in both the textbooks are not fully adequate; figures/diagrams and photographs are printed only in black and white.
- (18) About 26 % and 71% of the Tables in Std.XI and Std.XII respectively are not fully adequate.

(f)- REGARDING LANGUAGE USED :

- (19) Language specialities such as analogies, idioms, phrases, etc., are very few (5 & 12) in both the textbooks.
- (20) There are certain technical terms in physics which are originated from Greek, Latin and even Arabic languages; only in some cases, the textbooks have given their original meanings.
- (21) There are some Greek, Latin and Sanskrit words/symbols used in the textbooks, for which a note on 'how to read' them is missing; in most of the cases, these have not been printed in italics or atleast with inverted commas.

(f) REGARDING END_OF_CHAPTER EXERCISES :

In the textbooks for Std.XI and Std.XII respectively:

- (22) Only 2% and 1% of the exercises are activity-oriented problems.
- (23) Only 27% and 7% of the exercises, seem challenging/interesting. (In the case of starred exercises only 40% and 8%).

- (24) Only 12% and 6% of the exercises seem to be helpful to develop process aspects of physics.
- (25) 20% and 32% of the exercises seem to be beyond the level of students/very difficult.
- (26) 6% and 4% of the exercises seem to be not directly related to the chapter/previous chapters.

(g) REGARDING PHYSICAL ASPECTS :

- (27) The printing of solved examples, starred portions, footnotes and end-of-chapter exercises is below the standard due to poor reproduction and unsuitable type face; these are very tiresome even to adult reader's eyes and hence irritating^{or} distracting sometimes.
- (28) Gutter and fore-edge margins are below the standard in both the textbooks.
- (29) The qualities of the paper and ink used for the production of the textbooks are below standard.
- (30) The printing of the photographs and other diagrams are not good due to their poor reproduction.
- (31) No underlinings, boxes and/or colours are used throughout both the textbooks for strengthening the textual message or to produce isolation effects for better retention, even in the case of important formulae, theories, laws, thrilling facts, etc.

(h) REGARDING THE OPINIONS OF STUDENTS, TEACHERS AND EXPERTS:

h.(i) BASED ON THE RESPONSES FROM THE QUESTIONNAIRES/
OPINIONNAIRE :

- (32) Students of both the classes found certain topics in the textbooks which looked very difficult for most of them (Negative Average Rating Scores:- A.R.Ss: Table No.5-20, p.369). High A.R.Ss for both the groups (Table No.5-20, p.371) suggest that majority of the students have used other physics textbooks for their studies instead of the present NCERT physics textbooks.
- (33) The opinions of the teachers very clearly indicated (Table No.21, p.388) that the knowledge of mathematics from the previous classes is not enough for the students to understand physics discussed in the textbooks; they indicated (Table No.21, p.388) that the concepts and facts given in the textbooks are not easy to understand for the students.
- (34) Experts have indicated that the concepts and facts given in the textbooks are not easy to understand for students; the textbooks would not help the students to get training in the scientific method; the examples worked out in the textbooks are not very useful in solving the problems at the end of the chapters; end-of-chapter exercises do not contain enough activities and questions; and they are not at all satisfied with the physical aspects of the textbooks.
- (ii) BASED ON ADDITIONAL COMMENTS GIVEN BY STUDENTS, TEACHERS AND EXPERTS : (As pointed earlier (p.516) the following additional comments may not be always of majority of the respondents) :
- (35) Students and teachers have indicated several difficult topics, which by and large agree with the findings by the investigator; some of them expressed their difficulties

about mathematical treatment in the textbooks, the solving of starred problems, status of certain terms, physical aspects, etc.; they have also felt that the present physics textbooks are not of much ^{use} as far as preparations for the present day examinations are concerned; most of the students have stated that they make use of other textbooks and guides (by private publishers) (they have indicated some 25 such books- as given in pp.382-383); and some of the teachers have also stated that they generally do not make use of the present NCERT physics textbooks.

- (36) Some experts have opined that the present physics textbooks would not help the students to get high marks in examinations; they have bitterly criticised the lack of co-ordination of physics with mathematics, with overemphasis on use of calculus; they have felt that starred portions are too difficult even for good students because of high level mathematics; the authors are very ambitious in introducing difficult topics such as 'General Theory of Relativity' at Snr. Sec. level, without developing proper background; and some of the experts felt that the authors who prepared the textual matters in the chapters seem to be different from those who prepared the end-of-chapters exercises.

(1) REGARDING THE OVERALL SUITABILITY OF THE TEXTBOOKS (IN TERMS OF SYLLABUS, AIMS AND OBJECTIVES, ETC.):

- (37) The two physics textbooks for Std. XI and Std. XII written in 1988 and 1989 respectively do not reflect much on CBSE-1987 syllabus but incidentally more on CBSE-1993 syllabus.
- (38) Based on the overall evaluation of the physics textbooks under study in terms of nature and structure of science in general and physics in particular, it is found that the position is somewhat disappointing especially because of the inadequate help available in the text for the development of process aspects of scientific inquiry (i.e., scien-

tific attitude, scientific method and process skills); this inadequacy has indirectly affected the fulfillment of national goals and broad objectives of education/science education in general.

- (39) Out of the 5 broad Objectives of Snr. Sec. Sch. physics curriculum (as mentioned in CBSE - 1991 & 1993 syllabi-Appendix:G & H), the first 4 Objectives are relevant for this study; and it appears that the present physics textbooks under study may not fully achieve these 4 Objectives; but the 3rd Objective, i.e., "to strengthen his (students') foundations for further study of physics" seems to be better achievable mainly in the case of above-average students, provided they get proper attention especially in the mathematics department and they are willing to pursue a career in physics rather than in other professional courses.

7.10 CONCLUSIONS :

Based on the detailed findings reported in Ch.V (which have been summarised above) and their discussion in Ch.VI the following are the conclusions alongwith a few implications wherever needed:

- (1) The experimental editions of the physics textbooks for Std.XI and Std.XII published by NCERT in 1988 and 1989 respectively, contain strong academic content in physics; though their content seem to be high with reference to CBSE - 1987 syllabus, the revised CBSE-1993 syllabus by and large gets reflected well in the textbooks; but these textbooks may not fully reflect on the Objectives mentioned in the CBSE-1993 syllabus for Snr. Sec. physics. However the high level content along with starred portions and end-of-chapter starred exercises in these textbooks are likely to help atleast some above-average students who would like to choose a career in physics in the

near future, provided they get sufficient help in higher mathematics in appropriate period. Though most of the sections in most of the chapters in both the textbooks are by and large well-written chapterwise, it is very difficult to note even a single chapter which seems perfect in all respects. One can easily notice a lot of effort was being used to provide variety of end-of-chapter exercises in these textbooks; they consist of a large number of exercises/mathematical problems related to application and other higher order objectives; but many of the problems require good background in mathematics and some of the starred problems seem to be difficult even for above-average students.

(2) Regarding communication strategies used in the textbooks, there are large number of higher order questions, relevant and adequate figures, tables, etc.; most of the technical terms have been suitably placed; language-wise the vocabularies used seem to be suitable for Snr. Sec. level but language specialises, such as, analogies, idioms, etc., have not been used to the satisfactory level; ~~these~~ language specialities can make an interesting and easily understandable presentation of certain difficult concepts in physics. ~~And the~~ physical aspects of the textbooks have been very much neglected in the process of production.

(3) In these two physics textbooks under study though the product or content aspects of physics are by and large well taken care of, the process aspects (in terms of scientific attitude, scientific method and process skills) have been somewhat neglected due to reasons such as lack of sufficient pedagogical considerations in terms of organisation and presentation of the content and the decision of the concerned authorities to separate theory and practice (i.e. to publish the Laboratory Manuals containing activities ^{and} experiments separately from

these textbooks); hence the nature and structure of science/physics as well as the aims and objectives of Education/Science Education at Snr. Sec. level do not seem to be taken care of fully. Integrated science approach is not very strong in the treatment of the content; there could have been more stress on scientific temper and areas such as physics behind Environmental Education through certain relevant/additional chapters to take care of the National as well as global objectives of Education, so as to reflect clearly on some of the major recommendations of NPE (1986) (based on which these new textbooks have been produced).

(4) The major problems related to the content or the product aspects of physics in these textbooks is the assumption that a few pages of brief write-up on calculus (even if followed by a few hours of instruction) in the beginning of Std.XI would be enough for the learners to digest anything and everything in physics! Because, as at present calculus is presented/taught in Std.XII mathematics textbook/course; moreover there are students at Snr. Sec. level who are allowed to take physics as one of the four subjects without taking mathematics; this is where, in the interest of such students either CBSE has to rectify this administrative error or there should be provisions for additional simplified versions of the physics textbooks by avoiding higher mathematical treatment wherever possible. On the whole, there is strong need for greater co-operation^{and} co-ordination between physics and mathematics programme, if the concerned textbooks are to be properly utilised by students.

(5) In general, sampled students and teachers as groups have shown their uncertainties regarding various aspects of the suitability of these physics textbooks; but several individuals among them have expressed deep dissatisfaction about their physics textbooks. Being experimental editions, there could

have been try-out of the prepared materials using the students and teachers of a representative sample of the Snr. Sec. schools, instead of rushing to write, publish and distribute these textbooks throughout the country at a stretch. Practising Snr. Sec. physics teachers were not made to play their due role in the writing work, though some of them from just a few cities were involved in the review of the write-up, but for a short period. The opinions of the experts regarding the overall suitability of the textbooks, by and large agree with that of the investigator as well as of teachers and students. On the whole in the interest of the Snr. Sec. students, there is a strong need for bringing out the revised versions of these experimental editions of the physics textbooks at the earliest by taking into consideration all the available feedback from various sources.

7.11 SUGGESTIONS FOR FURTHER STUDIES:

In connection with this investigation, due to the influence and implications of various articles/studies reviewed, methodology developed and the numerous findings obtained, the investigator would like to suggest a few topics for further study; some of them are to strengthen the present study, so as to enable the textbook agencies to get more and better feedback from various sources and these are to be embarked upon as early as possible; and some other studies are of academic as well as professional interest only. The following are some of the possible topics for the above :

1. In this study, opinions of students and teachers were collected only from the Snr. Sec. Schools in the western region of India; similar efforts could be made in the other three regions as well as in other countries where CBSE affiliated Snr. Sec. Schools make use of the present physics textbooks.

2. To improve physics programme only textbook evaluation is not sufficient; there is a need to have a thorough investigation of the present Snr. Sec. Sch. physics curriculum in terms of the major aspects such as personnel, availability of laboratory ~~dx~~ and other audio-visual facilities, the examination system, etc., and also similar investigations are needed in the case of other science subjects and mathematics at Snr. Sec. as well as Sec. Sch. level, for the purpose of better co-ordination and co-operation.

3. Based on the opinions of ^{the} students and the teachers obtained in this study, comparatively higher popularity of several textbooks and guides produced by private (Indian) publishers has been very well revealed; in fact in the interest of the policy of Nationalisation of textbooks, it is worth to carry out a comparative study of some these textbooks (though not the guides) with the present NCERT physics textbooks; similarly various State Board Physics textbooks can be compared with NCERT textbooks.

4. It will be of some academic interest in the developing field of textbook research to carry out the following comparative studies :

- (i) A comparison between NCERT's old physics textbooks in use upto 1987 with the present experimental editions produced in 1988/89.
- (ii) A comparative study of the Indian physics textbooks at Snr. Sec. level with textbooks in one of the highly developed countries in Asia, i.e., Japan or in America (i.e., U.S.A./Canada). These types of studies in comparative Education are likely to yield several interesting information for better development; no doubt curriculum and hence textbooks depend

on the culture and needs of a particular nation; but in a field like physics, perhaps certain similarities and hence adaptabilities are quite possible.

- (iii) A comparative study of the Indian physics textbooks at Snr. Sec. level with that of our neighbouring developing countries such as Sri Lanka, Bangladesh, Pakistan or other developing countries in Africa, such as Nigeria, Kenya, etc. These comparative studies might be useful to strengthen our Cultural and Educational Exchange Programme in other developing countries.