

CHAPTER : VI

DISCUSSION

In the previous chapter, data collected from the rigorous content analyses of two physics textbooks under study on the basis of first 6 Objectives, have been analysed and interpreted to arrive at a number of positive aspects as well as inadequacies for the textbooks. Seventh objective was on corroborative evidences for the whole investigation from a sample of students (above-average as well as average) and practising teachers, in the CBSE affiliated Snr. Sec. schools from western region of India and experts (mainly from the Physics Department of the M.S. University of Baroda); the data obtained using questionnaires, opinionnaire as well as semi-structured interviews, have been analysed and interpreted to obtain several findings. Through the last objective of this investigation, an attempt has been made to give an overall picture of the status of the present physics textbooks under study based on almost all the findings from the earlier objectives.

It may be recalled here that any process of evaluation has to consider the qualitative and quantitative measurements as well as value judgements; the case of the present evaluative study of the textbooks, by its very nature, is basically qualitative; in the previous chapters, several findings reflecting the positive aspects as well as inadequacies were based on certain criteria for evaluation which were discussed in Ch. IV on 'Methodology'. These criteria were fixed mainly based on the available research findings in the field as well as on the basis of experience of the investigator in the use of physics textbooks at various levels in India and abroad.

In this chapter, first, the issues arising out of the findings of the study will be discussed. This will be followed by some of the salient features of the general and controversial issues raised by corroborative evidences from sampled students, teachers and experts; and finally there will be discussion on methodological as well as other relevant and important issues arising out of the process of the overall evaluation of the present Snr. Sec. physics textbooks under study.

6.1. : REGARDING ISSUES ARISING OUT OF THE FINDINGS OF THE STUDY :

This will be discussed based on certain major themes identified during the study, which are related to the findings; ^{this} section starts with the theme on pre-text pages. It is worth recalling here the national as well as international status of the publisher of the present physics textbooks under study i.e., NCERT; this body is ^{of the important} one /academic advisors to the Ministry of Human Resource Development (HRD) of the Govt. of India. They have the international recognition from world bodies such as UNESCO, UNICEF, UNDP, etc. Production of exemplar curriculuar materials such as school textbooks for the Nation is one of the major tasks of NCERT. As discussed in Ch.I, 1.6, (p.16) sometimes in 1990 some history and Snr. Sec. physics textbooks produced by NCERT have attracted the attention of Japanese and Americans respectively. One of the NCERT¹ brochures published during 1990 states that an American publisher has evinced interest for bringing out an American edition of NCERT's Snr. Sec. Sch. physics textbooks. At times the investigator begins to wonder: "What is it that an American publisher found so special about our Indian Snr. Sec. physics textbooks?" Perhaps on the first sight, he must have overlooked the physical aspects of these textbooks and might have looked at the content aspects more seriously;

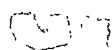
because, after all, he might be sure of taking care of the physical aspects in his own country which is highly advanced in the printing technology too. Normally the publishers are very critical because they mean serious business. In the U.S.A., the well-known PSSC physics textbooks were published, which were very popular during 1960s and later NCERT published the same based on the American collaboration; now it is surprising the reverse process is likely to take place - our textbook authors have to be congratulated ! No doubt contentwise our present textbooks are of high standard and with latest information; perhaps the causes of the puzzle are apparent lack of understanding of pedagogical considerations on the part of the authors with respect to the over-dose of depth, background and ways of presentations in the textbooks and of course again the physical aspects; the former is caused because, though NCERT is a professional body and a National education leader, it depended too much on pure physicists especially from some of the top level Universities/Higher Education Institutions and Research Bodies, rather than on practising physics teachers and educationists. There is no dearth of pedagogues in the country and there are several of Snr. Sec. Schools, which are well reputed having highly experienced physics teachers with higher qualifications such as M.Ed., M.Phil, Ph.D. in Physics/Education. Vogel (1951)² emphasizes that the important factors of the textbook writing are the experience of authors regarding teaching the subject about which he is writing, higher qualifications, specialization in preparing the manuscripts, etc.

6.1.1: ISSUES BASED ON THE FINDINGS FROM THE PRE-TEXT PAGES:

Careful content analyses of the pre-text pages revealed several important information about the personnel involved in the whole project of textbooks preparation; the Chairman of

the Book-writing group in Physics was a Vice Chancellor of one of the major Universities in India and one of the members was a Principal of NCERT's RCE - perhaps the book producers had put much burden on these two, normally too busy chief executives, by engaging them to write school textbooks; instead, recently retired but competent professors could have been engaged; other members of the Book-writing Group for these Snr. Sec. school physics books were top level physicists from Universities as well as Research Institutes; and of course the programme co-ordinator was from NCERT. Among the members of the Advisory Committee only one was a practising teacher, as a representative of Indian Association of Physics Teachers (IAPT); in fact there could have been more representation from IAPT in this important task of writing textbooks. Of course, for Review Workshops, a few practising teachers were invited, but just for 5-7 days and that too mainly from Delhi and a few other important cities only; within such a short period, what type of review could be done? Based on the list of authors and other members involved in the whole process of textbook writing and reviewing, it is very clear that very few practising Snr. Sec. physics teachers and physics teacher educators were involved in the whole exercise. Though NCERT mainly consists of top level professional educationists, it is very difficult to appreciate their wisdom as well as that of Govt. of India, Ministry of HRD in depending too much mainly on pure physicists to write a textbook at Snr. Sec. level which is at a very important and crucial transition stage, academically and psychologically; if these adolescent students get frustrated at this level, in the long run it would affect or even afflict the number of personnel available in the discipline of physics as well as in other technical professions/vocations. No doubt, the author-physicists are highly placed ones, but it appears from the content presentation, that they may not be having enough

teaching experience at Snr. Sec. level; but due to them, textbooks should not become the cause of frustration for our younger generation; we need them as advisors but not necessarily as textbook writers at Snr. Sec. level.



The very first impression of the books based on the cover pages is somewhat disappointing; though the printers guided by the artists and the author-physicists made an attempt to give a picture of micro and cosmo world together on the cover of the Std.XI textbook, somehow, this doesn't appeal much academically as well as aesthetically; moreover the theme is not that fitting one as there is only one chapter on astronomy and that too at the end of Std.XII. And the very same cover picture is given on both the parts of the textbook. In the case of Std.XII textbook (in both the parts- the same one), the astronomical photograph printed on the cover pages, does not appeal at all in any way; moreover the cover pages are thin and not even laminated nor the bindings of the books are handy. One thing very special that has to be appreciated about NCERT publication is that they indicate Indian Calender months and years (e.g., 'Jyaistha', 1910- Std.XI textbook: 2nd pre-text page) in addition to that of Western Calender (i.e., June, 1988); this reflects 'Indianness' or national identity, which is one of the National goals of Education.

Foreword and Preface are very well presented with high sounding and pedagogical terms by the Director of NCERT and Chairman of the Book-writing Group respectively; but there are several issues emerging out of these writings; the major issue is that of methodological concern in textbook preparation programme. In the Preface, the Chairman rightly confesses (Std.XI. p.vii), "Because of constraints of time, this edition has to be brought out in some haste. As a consequence, we are conscious that a number of errors have crept in"

But the puzzle is, "What made the NCERT and the Govt. of India to compell the authors or to put pressure on them to expedite?" Before NPE (1986), the educational system in the country had physics as well as other textbooks produced by NCERT; in a way it is good that by 1988 Std.XI physics textbooks were ready; but why did NCERT bypass the professionalism, by not taking a step of 'Experimental Try-out' of the textbooks in a limited representative sample of schools in the country? The Preface on p.(vii) labels these textbooks as 'experimental editions' and there was no experimental tryout. Where was the need to produce a huge number of copies and again to reprint and introduce the same throughout the Nation without 100% thorough review? If at all it was due to some pressure, the academicians should have ~~opposed~~ ^{type} ~~this~~ of rush at the cost of progress of Nation's younger generation as well its meagre resources; the Preface (p.vii) states that the first experimental editions of the books will undergo early revision, after the concerned members receive feedback from various sources. The investigator is of the opinion that the experimental edition textbooks should not have been implemented throughout the country because of the following two main reasons; first of all this whole-scale implementation has disturbed physics education programme of thousands of Snr. Sec. students throughout the country; secondly, when the authorities are ready with the revised editions, withdrawal of the experimental editions would be a big loss to the country and to the parents; and it is a problem for teachers as well as to CBSE. There are several noteworthy statements in Foreword as well as Preface and reference will be made as and when required during the course of discussion.

Among the pre-text pages, 'A Note for Students', ends with a greeting, "We wish you happy problem-solving in Physics"; though in a very broad sense this is somewhat meaningful, most

of the student-learners are likely to understand this as if physics consists of mainly problem-solving at Snr. Sec. level; the term, 'problem-solving' in physics normally may reflect on numerical problem solving as far as students are concerned. When we think of the nature and structure of physics it is definitely more than just numerical problem-solving it is a major step which is likely to appear at the end of the various steps involved in scientific method of acquiring and generating knowledge in physics.

'A Note for Teachers', given in pre-text pages, doesn't appear to contain all that the teachers need in using the textbooks; as such they need a separate 'Teachers' guide' to make use of the textbooks effectively; in advanced countries, a new curriculum is accompanied by not only textbooks, but also other important curricular/instructional materials such as Teacher's Guide, Films, Laboratory kits, Standardized Tests, etc. The consulted experts also, supported this view. In POA (1986), reference has been made to the term, 'instructional package'; (in p.146), the Time-Schedule Table clearly shows that instructional packages including textbooks should be developed and introduced; but as at present, based on the information obtained from responsible Snr. Physics teachers in the CBSE affiliated Snr. Sec. Schools around and from the local dealers of NCERT textbooks, the investigator understands that, among the instructional package materials only the two textbooks and two laboratory manuals are available from NCERT; but recently in an attempt to produce some standardized tests, NCERT has initiated some action by sending some cyclostyled test materials to some schools for try-out. In the pre-text pages, the content table could have been made more elaborate by giving the titles of all sections and their page numbers for quick and overall reference instead of dealing with only the titles of the chapters. List of Tables, Figures/Plates, Units,

Abbreviations used, Greek & Latin Symbols used, etc., could have become parts of pre-text pages in the textbooks; especially the Greek & Latin symbols and the way to read them in Roman Scripts are really missing in the textbooks, to cause reading problems to the students; this was reported by students too (p.377).

6.1.2: ISSUES BASED ON THE FINDINGS FROM THE TEXTUAL CONTENT PRODUCT ASPECTS AND PRESENTATION:

Now coming to the actual textual content, there is a need to look into content organisation; CBSE syllabus made use of the term 'Unit' to indicate the various content title whereas the textbook authors used the term 'Chapter' for the same; it seems both the Agencies have not bothered to differentiate between Unit and Chapter. Traditionally, in Snr. Sec. physics, the Units in the order of development are: Mechanics, Properties of Matter, Heat and Thermodynamics, Waves - Light & Sound, Electricity, Magnetism, Electromagnetism Atomic & Nuclear Physics, Solid State Physics & Electronics and Universe; e.g., in Std.XI, textbook, Ch.3-8 are under the Unit, 'Mechanics'; but the chapters are treated separately instead of relating them together under the umbrella of the Unit 'Mechanics'. 'Properties of Matter' which is ²Unit is treated as a long chapter with some 48 pages but with subdivisions of Solids, Fluids, Liquids and Gases; similarly there are some other textbook chapters, which look somewhat odd in their organization; Ch.14 in Std.XII is also not properly organised for the above reasons. It seems that the authors have not adopted an uniform policy regarding the splitting of chapters into sections/topics - some are too long and a few are too short; in some chapters, their introductions have been considered as their first sections; at times, these defective physical cum organisational aspects, might affect the academic organisational conceptualizations in the minds of learners; but the arrangements of paragraphs within the sections are by and large, suitable.

Std.XI textbook has taken care of the following Units: Mechanics, Properties of Matter, Heat & Thermodynamics and Waves-Sound; and Std.XII: Electricity, Magnetism, Electromagnetism, Waves - Light, Atomic & Nuclear Physics, Solid State Physics & Electronics and Universe; if one subscribes to the idea of 'Spiral Curriculum', it would have been better to deal with the simpler fundamentals about all the Units for both the classes in Std.XI itself and further develop the advanced ideas about each Unit in Std.XII. This type of content organisation has got a few advantages; the students will be in a position to get the simple but overall general picture of Snr. Sec. level physics at Std. XI and a better, advanced, concrete and complete picture using higher mathematics at Std.XII; in this way they will not be forgetting any Unit from Std.XI at Std.XII level. After all what is important is the terminal behavioural change in terms of overall picture of physics at the end of Std.XII from where students will be going to different careers, instead of allowing them to forget important Units such as Mechanics at the end of Std. XI. As discussed in Ch.III (pp.96,100), de Berg's (1989) study of gas laws in Australian Snr. Sec. physics and chemistry textbooks supports the textual presentation from simple to complex, qualitative to quantitative and verbal to algebraic, based on learning theories.

In Std.XI textbook, the first Chapter is titled as 'Introduction'; this, just a 3-page write-up may not be in a position to inspire the students fully to start learning physics seriously. In this chapter, there could have been a list of major concepts of physics studied in the previous classes, a short 'Entry behaviour test' and a list of major objectives of learning physics at Snr. Sec. level. Though it contains some useful information, it does not appear to be giving a proper introduction to nature and structure of science/physics, scientific method, scientific attitude, etc.; its 2nd

section, with the title, 'Scope and excitement', is too short to really excite the students fully; in this section, there could have been some interesting reference to scientists' biographies, popular quotations from well known physicists, short poems on physics topics, certain pictures/ coloured photographs, etc., to make the discussion lively, to create highly charged excitement, and to produce a strong desire to study and apply physics in different fields and in life; but this chapter mentions only Newton, that too briefly; there could have been some sketch diagrams to map the historical developments in physics which the students are going to study during Std.XI & XII and later on if they continue with the study of physics. Though interdisciplinary nature of scientific development is mentioned here, it is not fully discussed. The last section, titled 'Physics and Technology' could have been titled better as 'Science, Technology & Society (STS)', based on its content; the two paragraph write-up is not at all sufficient to discuss the well known STS issues which are multidisciplinary and global in nature. In this chapter, there could have been some efforts to introduce the concept of 'Medical Physics', because most of the biology students, who are to study physics, may have the wrong feeling that physics is more needed in engineering courses and may not be that much needed for them if they have to take up medical or related courses after Std.XII; because advanced medical science requires a lot of applications from physics too. Instead of giving 'A Note for Students' briefly along with the pre-text pages, it would have been better to give an elaborate write-up regarding the use of the textbooks, exercises, etc., in the Chapter on 'Introduction' itself. The end-of-chapter exercise for this first chapter, is interesting but highly advanced and does not seem to have much connection with or get help from, a 3-page write-up of this chapter; of course, these exercises are likely to help above-average physics students to get a better idea of nature and structure of physics.

Ch.2 in Std.XI is the actual beginning of physics content, which continues upto Ch.13 and again the continuation in Std.XII is through its 15 chapters. These Chapters do not start with listing down of pre-requisites/entry behaviour from the previous classes/chapters. None of the chapters starts with its statement of the major theme as well as its objectives, unlike in the case of NCERT's Snr. Sec. School (present) Chemistry textbooks in which these are clearly stated; earlier referred de Berg's (1989) study also supports stating of objectives before the beginning of the chapters in physics and chemistry textbooks. Most of the chapters in both the textbooks, contain by and large, suitable introductions which are more or less related to science/physics from previous classes or chapters within the textbook; however in some chapters there are too many repetitions from the lower classes instead of making statements just to enable the learners to recall from the previous classes or instead of listing them down in the beginning of the chapter as pre-requisites/entry behaviours; this has happened, for example, in Ch.2(Std.XI) and other chapters under Mechanics. This is where there is serious need for the textbook authors at higher level, before starting writing, to critically examine thoroughly the textbooks produced for the lower classes by NCERT; otherwise too many repetitions are boring to the students. There are quite a few chapters where the introductions are either totally missing or not very suitable. As far as introduction is concerned, Ch.4 in Std.XI textbook and Ch.12 in Std.XII, seem to be very good. The concept of an ideal introduction for a text chapter which is academic as well as pedagogic in nature, is not fully reflected in most of the chapters in the textbooks for both the classes; this first write-up in a chapter is expected to be a real motivator to the readers and it should carefully relate the already known information to what is unknown to the readers, so as to enable them to start reading further to know the

unknown with all the eagerness; it requires a brief reflection on the learning objectives of the whole chapter; in fact some modern textbooks even at higher level make an attempt to give the objectives, even in very specific behavioural terms in the form of introduction to a chapter. But this approach is difficult if the members of the writing team are only pure content specialists without the professional touch in the field of education or teaching-learning process. Moreover, introduction is the right place to give a few related popular quotations of scientists with their life background. In the case of a few chapters (about five) either the introduction looks too elementary or too short. In some cases actual introductions for Units such as 'Mechanics', 'Heat', 'Properties of Matter' have been merged with chapter introductions; in the physical set-up of the textbook there could have been separate mentioning of units with their introductions and the chapters following under them. Introduction to the Unit on Mechanics has not been properly treated, though this is the major foundation in the study of physics. As pointed out earlier, prerequisites/entry behaviours have not been listed down in the beginning of the chapters; but for the development of concepts in each chapter, the textbooks have rightly or otherwise assumed that the prerequisites are taken care of; in both the textbooks, if the development of the chapters one after other within the textbooks are considered, it appears that there are no problems for the learners, with respect to prerequisites from the learnings of previous chapters, while entering into the learning of subsequent chapters. But, there seems to be pathetic misconception in the whole treatment of the content in the textbooks in assuming that a few pages of brief write-up on calculus which looks like a typical lecture note of a traditional mathematics lecturer in a college, would be enough for the Std. XI students to digest everything in physics through its major language, i.e., mathematics

especially when the authorities are aware of the fact that calculus is taught not in Std.XI but in Std.XII mathematics course; even if a physics teacher tries his level best to teach needed mathematics in the beginning of the session, the investigator based on his experience in the field strongly feels that it would be definitely, altogether, insufficient training in this important aspect of the language of physics.

As far as the pre-requisite for the textbook is concerned, knowledge of calculus is definitely inadequate for the learners; moreover in this case of the position of physics students who are permitted to drop mathematics at Std.XI is vulnerable and pitiable; also the pre-requisite knowledge of mathematics needed for Std.XII textbook, is very much dependent on proper co-ordination of mathematics and physics courses, in that class. On the whole, there is a strong need either to persuade the Mathematics Department and hence its textbook writers to deal with calculus in the beginning of Std.XI (if possible with the introduction of fundamental^S in Std.X) or thorough treatment of calculus with sufficient number of solved and unsolved examples from physics is given in the beginning of Std.XI textbook supported by rigorous classroom teaching; this special treatment in mathematics is needed in the case of topics such as vector, complex number, Fourier theorem, etc.; of course, in the case of vectors, the treatment is, by and large satisfactory; and also, there is a need to revise and strengthen further these mathematical content in the beginning of Std.XII textbook too. The views on difficulties in calculus are supported by students' (pp.376-377) and teachers' (pp.395-397) opinions also. In general lack of co-ordination between physics and mathematics programmes is not only in India, but even in other countries. As discussed in Ch.II (p.41), Fuller (1972) remind us about the strong need for closest links between teaching of mathematics and that of physics at all levels, throughout the world.

Regarding the academic content section in each chapter, in both the textbooks, most of the sections, are well-written more or less and the details can be seen in Table No. 5.3 in Ch.V (pp.191-214); but chapterwise, it is very difficult to note even a single chapter in both the textbooks, which seems perfect in all respects. The contents⁷ present in both the textbooks are almost accurate and up-to-date; this is supported by experts' (p.401) as well as teachers' (p.387) opinions too; though these textbooks have been written in 1987, 'scanning tunnelling microscope' for which a Nobel prize was awarded in 1986 is mentioned in the Std.XI textbook; and in Std.XII textbook reference has been made to the recent extensive research work especially in the erstwhile Soviet Union, in the field of semi-conductors; some of the inaccuracies noticed may be considered apparently due to printing errors, for which, of course, there is no 'Errata' or 'Corrigendum' among the post-text pages; but the Preface (p.vii) mistakenly claims that such corrigendum has been attached to the textbooks. All the chapters in both the textbooks, contain references to physicists/scientists/a few other eminent personalities, with a maximum of 47 in chapter 12 of Std.XII and a minimum of 1 in Chapter 1^{of}/_{Std.XI}; but the details given about these scientists are not sufficient in most of the cases. Some students have expressed their desire to get more information about scientists. There could have been some more references especially to Indian Scientists and their works in relevant chapters, to strengthen the concepts such as national identity, national heritage, etc., which are reflected in our National goals of Education.

References to history and philosophy of science, especially during ancient Indian period, is one of the highly appreciable salient features of these physics textbooks; but there is a definite need to strengthen and increase these references. Though Std.XI textbook contains at least one

reference to the history of physics in all chapters, Std.XII. textbook contains, only in some six chapters; in Std.XII textbook, interesting and systematic historical presentations have been made in the development of history of physics and astronomy in Chapter 12 and 15, respectively.

From learners' point of view the investigator has come to the conclusion that Chapter 7,12 & 13 and Chapter 1,2,5 & 9 in Std.XI and XII textbooks respectively could be considered as difficult, dull and uninteresting in many respects and may not help much in the learning process; there is a need to look at these chapters and their sections thoroughly while revising the textbooks.

Though many of the starred sections in some chapters do play a special role in exciting above-average students, some of them might frustrate them because of the level at which they are written; because even some of the good student-readers may not have the background and training in digesting certain advanced concepts especially in mathematical physics which are dealt with actually at undergraduate level.

Though many of the solved/answered examples within the chapters are useful in overall understanding of the sections/chapters, as such, they have not been provided for every section; moreover the nature of the examples need to be more of mathematical nature rather than essay/short answer type.

The position of Integrated Science approach as discussed in Ch.II (pp.45-46) is somewhat disappointing in the content treatment of both the textbooks; however, one has to appreciate that there have been several references to astronomy as such. References to chemistry and biology should have been more in number; as physics is the major source of knowledge for application in engineering and technology, there could have been

many more references to this field in which most of the physics students will be interested in, after their Snr. Sec. course. There could have been references to biophysics and latest areas such as 'Medical Physics' to inspire students of physics even if their future plan is to become medical doctors; more than the integrated science approach nowadays emphasis is on interdisciplinary approach; (pp.46-48) areas such as Science-Tech-nology-Society (STS), economics, geography, etc., could have found more place in a physics textbook too. Compartmentalised physics programme is somewhat outdated. In addition to what has been stated in Ch.II (pp.45-48) these views get further support from Singhal's (1983)³ study (financed by NCERT) of physics education using non-formal methods. He concluded among other things, that, interdisciplinary talks were needed to be frequently arranged in each department at Higher Secondary and first year college stage to keep the students up-to-date with a variety of disciplines and to appreciate their relationship. So physics textbooks too may have to play a special role in coming out of the compartmentalisation.

Physics, being a branch of science, is expected to be highly systematized especially while being presented in a textbook; by and of large, this systematization is reflected in the chapters of ^{of} two physics textbooks under study; but the absence of major Units (as discussed earlier ^{Ch. I} p.414) in the organizational set-up might give the impression to the young learners that physics consists of too many major aspects as reflected in (13+15) chapters rather than representing the same through a few Units split further into chapters and sections; because, though physics is very broad, it is precise at the same time as it is nothing but simply the study of matter and energy, as its major components; no doubt the textbooks have dealt with these two components directly or indirectly, but there could have been special emphasis wherever and whenever possible to

make the young learners to fully appreciate this deep theme and to enable them to conceptualise physics in simple, familiar terms such as matter and energy.

6.1.3; ISSUES BASED ON THE FINDINGS FROM THE PROCESS ASPECTS:

In connection with the nature and structure of physics, product as well as process aspects for scientific inquiry are equally important for the development of physics especially if we want to get a few good physicists out of the youngsters at Snr. Sec. level later after completion of their doctoral study. As discussed earlier product aspects have been properly taken care of, except of course their pedagogical presentation; but the process aspects i.e., the dimensions of scientific attitude, scientific method and scientific process skills have been somewhat neglected in these textbooks, though in the Preface(Std.XI:.,para.1), the authors have stressed these; of course reference to history of physics and physicists help to some extent to develop process aspects too; but it is not enough. Developing interest by referring to the major applications and uses of principles of physics in daily life situations (which could have helped prospective engg/medical students) is seen only in very few cases; the other dimensions of scientific attitude, such as scientific temper, curiosity, open-mindedness, critical thinking, suspended judgement, etc., do not appear significantly in the textbooks, but the Government publishers and the authors claim everytime that the present textbooks have been written based on the NPE (1986) and POA (1986), in which the term 'scientific temper' is often very much stressed. The following Article in NPE (1986)⁴ emphasises very much on Environmental Education:

8.15. There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of society, beginning with

the child. Environmental consciousness should inform teaching in schools and colleges. This aspect will be integrated in the entire educational process.

Now it is very well accepted that Environmental Education is a multidisciplinary programme by its nature and it is for the whole nation as well as the globe, at all levels. Global understanding to save our dear planet Earth is not only emotional but also scientifically sound and it is within the broader perspective of scientific attitude; there was an opportunity for the textbook authors to bring in this topic more elaborately in Ch.9 (pp.231-232) in Std.XII textbook, where 'green house effect' is referred to; but unfortunately the topic is very briefly discussed; in fact, there could have been a separate chapter on this burning issue of Environmental Education to discuss thoroughly all the fundamental physics issues behind it; this addition could have made a big difference between the textbooks written before and after NPE (1986). Similarly, the topic on 'Nuclear holocaust' in Ch.13 (p.350, Std.XII), deserves a lot of multidisciplinary elaboration, with burning issues such as, The fusion confusion' (as one of the top physicists in India,

Iyengar⁵ wrote recently in 'Indian Express'), nuclear proliferation, India's nuclear club membership, the international politics in nuclear energy, Nuclear past and the future, Alternative sources of Energy, Solar energy, Energy Education, Global Peace Education, etc. The experts have also felt that the present physics textbooks would not help the students to get training in scientific method. The investigator has noted that though some 12 chapters of Std.XII reflect to some extent on scientific method, Std.XI textbook is inadequate in this respect. Though there are a few cases of direct or indirect support for the development of atleast a few process skills in the textbooks, they are not at all enough; perhaps the authors could not take care of the process aspects, as they decided to separate the Laboratory manuals from these textbooks; the number of activities

available in the manuals could have found their place in the textbooks to help the learners to understand the theory portion properly and to develop systematically the process aspects too. Separating theory from practice is against the spirit of scientific method. Romey (1968)⁶ states that the number of activities enables a text to become investigatory in approach; he adds that even a narrative text may be presented in such a way that it is investigatory in its approach. In this connection one should be aware that textbooks alone may not develop process aspects of physics; but they can always be narrated in such a way that ^{they} indirectly help the learners to develop process aspects along with the actual classroom teaching, and with activities at home/school laboratory. The importance of process skills cannot be ignored; Bhargava (1983)⁷ studied a few processes in science learning with reference to Hr. Sec. (now termed as Snr. Sec.) physics for his doctoral study, the processes identified were observing, measuring, drawing inferences, making predictions, hypothesis-making and hypothesis testing. Among his several findings it was noted that achievement in physics was moderately related to the three processes of science, viz., observing, measuring and drawing inferences and not so much related to other processes. In the study of physics, accurate measurements related to matter and energy are very important; observations using naked eye and with the help of advanced microscopes and telescopes, under normal conditions or controlled experimental conditions are equally important; the skill of measuring is emphasized mainly in Ch.1 & 2 in Std.XI textbook (Ch.2 being on 'Measurement' itself) and in Ch.3,11,12 & 15 in Std.XII textbook. The skill of observation is specially seen only in Ch.1,2 & 8 in Std.XI textbook and Ch.1 & 2 in Std.XII; however, the skills of experimenting, observation ^{and} inference which are likely to take place, are reflected in 12 Chapters (out of 15) in Std.XII, but not with much emphasis, whereas in Std.XI textbook, these are

very inadequate. Now to conclude about the importance of process skills another study is worth referring to: Ramesh (1984)⁸ in his comparative study of objective based science curriculum and conventional science curriculum at high school level, showed among other findings that the group taught through former curriculum was more effective with respect to acquisition of process skills than the latter; based on this study, one may think of suggesting that, the textbooks too - which are the mirrors for curriculum, should include objectives to enable the learners to help develop the process skills.

6.1.4 : ISSUES BASED ON THE FINDINGS FROM THE COMMUNICATION STRATEGIES :

Having discussed the product and process aspects, the next important question is whether textbooks are successful in establishing proper communication system between them and the users - learners; as discussed in Ch.I and II, textbooks are supposed to 'speak' to the learners, as these are the 'teachers in print', communication strategies have to be reflected in the presentation of the content and these are supposed to be based on mainly pedagogical considerations; questioning strategies, status of technical terms and illustrations and of course the language too, would make up the overall presentation of content in order to communicate suitably to the young learners, by keeping in mind the level of the learners. In the narration of content in textbooks, questioning is very important; Andre (1987)⁹ writes that there are more than 100 reviewed studies which establish the importance of adjunct questions and suggest that in science textbooks there should be questions throughout; several recent studies have provided textbook authors with valuable guidelines about adjunct question placement, taxonomic level, applicability, limitation and robustness. In the present textbooks, though most of the chapters have less than one

question per section (especially in Std.XII) rightly, about 80% of the questions are higher order questions; and students within the sample chosen, have liked (p.372) them; but to support the investigatory approach for physics, activity-oriented questions are too low in number and none in the case of several chapters.

Regarding the status of terms, in both the textbooks, it is encouraging to note that about 80% of the terms identified by the investigator are those whose definitions are given in the concerned chapters; this shows that the overall communication strategy with reference to the status of terms is fairly good; moreover about 95% of the terms identified appear to be understandable to the learners based on investigator's findings. Ch.1 in Std.XI seems to have poor communication with respect to status of terms; this should not have been the case as it is a chapter on 'Introduction'; Ch.9 in Std.XII also is not a good communicator based on the status of terms (p.221); incidently this chapter has to be considered as difficult one by the investigator (p.220) as well as by students (p.376) and teachers (p.396) sampled in this study. Of course there are some 7 terms in each of the textbooks, which are just appearing without being written something more about them or anywhere in later chapters or next class Std.XII book; based on investigator's observations those terms are : From Std.XI: Laser, optical interferometer, unit of resolution, mechanics, gravitational wave, isotropic liquid, logarithmic scale; from Std.XII: classical magnetism, positron, tolerance, relaxation time, thermoelectric coefficients, luminous intensity^{and} corpuscular theory. Incidently, except the term, luminous intensity all other terms in both the textbooks do not appear in the index even. Though these are only 14 terms out of (301+427) terms in both the textbooks, it is quite strange to notice particularly the two affected terms: mechanics and corpuscular theory.

textbook
 Std. XI/ contain^s 7 chapters on mechanics, but without being written that mechanics is the study of motion of bodies! Perhaps the authors might have assumed that there is no need to mention the meaning of such common terms; but the meanings of other related terms, viz., kinematics, dynamics, and statics have been somehow stated though not very systematically. It is strange that, 'corpuscular theory' also has not been given its exact meaning; because after all, it is this theory and the quantum theory, which are historically important in the development of modern physics from classical physics. There are certain terms in both the texts which are not very clear within the textual matters, but somehow, the authors have given some more explanation to them through end-of-chapter exercises; this is reasonable though not ideal; again there are certain technical terms introduced vaguely especially in the starred problems of end-of-chapter exercises, but ^{not} in the actual textual matter-and these terms are not included in the index; so, all these drawbacks are likely to affect the communication between the textbooks and the learner. There are several technical terms in physics which are originated from Greek, Latin and even Arabic languages; only in some cases, the textbooks have given the meanings of the terms by first giving the word meaning in the original language. Based on the psychological learning theories, it is highly recommendable to give a memory aid in the form of a complete list of such technical terms, their origins with the exact meaning and the present technical meaning, along with the glossary of terms among post-text pages as appendices; but even the ordinary glossary is missing in both the textbooks. In user-friendly textbooks glossary of important technical terms strengthens communication strategies very well.

Regarding the illustrations in the textbooks, figures/ diagrams/ tables and photographs play their own role in communicating to the learners; though most of the figures/diagrams and

tables are relevant in both the textbooks, only about 40% of the former and about 55% of the latter are quite adequate; others are defective due to one reason or the other (as shown in Table No.5.11-5.13 pp.295-331). There are very few photographs of physicists in the textbooks, but they contain somewhat interesting footnotes about them. Plates are not included in the textbooks. On the whole, almost all the illustrations are somewhat dull mainly due to the fact that colours have not been used even for a single illustration.

In connection with communication strategies, language also plays a special role; as such physics requires language of mathematics too and this has been discussed earlier, the other usual language as a medium, is English in this case. Specialists in 'English for Science & Technology' (popularly known as EST) are the right type of advisors for textbook writing in physics; nowhere in the pre-text pages it is mentioned that such experts were consulted before finalising the draft; it would have been better to include one such expert in the Book-writing Group or atleast in Advisory Committee and to invite some of the Snr. Sec. English language teachers along with the senior physics teachers, while reviewing the textbooks. As discussed earlier in Ch.II (p.71), based on Stevens' (1969) recommendations, a science-oriented English Language syllabus in which the choice of linguistic content could be determined by the requirements of the physics, chemistry, biology and mathematics syllabi is better for science students at Snr. Sec. level. Perhaps it would be better, if the textbook authors are supplied with a standard list of vocabularies, idioms, phrases, etc., the students are supposed to learn by the ^{end of} Std.X, XI & XII. There is a general notion that the students in arts stream are likely to have better knowledge of English language compared to science stream students; but a doctoral study by Bhat (1986)¹⁰ slightly disagrees with this view; he studied the reading ability of students of Std.XI & XII in English language in Gujarat. Some of

his findings showed that the readability of textbook for Std.XII was better than of Std.XI and science students were found to have better comprehension compared to other though the differences were not significant; as such, this study also implies, that the reading ability, the grade and the stream of the students should be taken into account in the preparation of textbooks. Another doctoral work by ~~Dev~~ Devi (1986)¹¹ to study the strategies for developing critical reading abilities among Snr. Sec. students in English language reported that some of the important critical reading skills such as identifying, organizing, relating, predicting, reasoning, judging, questioning and applying could be developed through probing questions by teachers; from this study one may notice the similarities in nature between the critical reading skills and science process skills and the need for teacher's help in the classroom by asking probing questions to enable the students to read their textbooks; but this may not be always very meaningful for all the topics in the case of physics textbooks; however, whether it is English language textbook or physics textbook in English, critical reading skills are necessary for a student to learn effectively and probing questions either within the textbooks or from the teachers might help the learner to read carefully and to digest the material systematically; all these are possible only if the textbooks are written with proper usage of English language and at the appropriate level. Language helps to frame proper questions in the textbooks; and especially to frame higher order questions the vocabularies are to be chosen very carefully; as discussed earlier, though questions are not enough in numbers in the textbooks, most of them are of the higher order type and the fact that the students (sampled in this study) liked them shows indirectly that the textbook language too is understandable; but a few students and teachers too, in general found the language used in the textbooks, difficult to understand. Ch.8 & 10 in Std.XI textbook and

Ch,12 in Std.XII textbook contain a few high sounding but interesting/exciting vocabularies such as contemplative mood, temporal behaviour of the universe, credence, perfect child of physics admirable decorum, privacy of the atom, well-behaved system, apology for perversity, fidelity, surrealist, etc.; as such these are not supposed to be difficult for Snr. Sec. students- even if they are, ^{they are} very few and always dictionaries and teachers in the school are available for consultation; by and large, the vocabularies used in the textbooks do not appear to be difficult at Snr. Sec. level; this does not mean that the learners may find everything easy to understand; though the vocabularies are simple, the way of presenting them to express concepts from physics matters, language-wise as well as psychologically. Though, most of the technical terms in the textbooks appear to be understandable, there are a few, which were found to be difficult; in this case, the language used might also be one of the reasons for difficulties. Some of the students sampled in this study have expressed difficulties of different types and felt that language is also responsible for their problems; teachers also have reported that they have found some cases of lack of clarity in an attempt to achieve brevity in the textbooks; but they did not specify such cases. If one wants brevity, at times one may lose control over the clarity of presentation, and it is very difficult to bring a compromise between these two, though in a subject like physics it is somewhat easy because of the availability of additional special language i.e., mathematics. At higher level in physics, mathematical language is dominant but at Snr. Sec. level it should be moderate, especially because of non-mathematics biology students who have to study physics too. In the present textbooks, the language used seems to be a little more mathematical and it would be better to make use of more of English language statements rather than mathematical (especially using calculus) statements in the interest of all.

Language specialities such as analogies, metaphors, idioms, phrases, exclamatory marks, etc., play a special role to some extent in understanding physics especially at micro and cosmo level. At times, higher physics may look a little bit abstract especially to youngsters because of its several theorisations, models, hypothesisations, etc., in such cases, where there are problems of observation and experimentation at micro level, explaining with the help of analogies or models is the only way; several scientists adopted this method of explanation; several misconceptions in some of the abstract topics in physics can be avoided with the help of analogies; but regarding the usefulness of these analogies, models, etc., opinion is divided; Konopak's (1985) study (which was referred to in Ch.III, p.105) of comparison between two sec. school physics textbooks showed on the basis of results of retention tests that, the 2nd text which had a formal prose style based on explicit definitional information was better for retention than the 1st which had an informal prose style that depended on analogies and models; whereas, recently, Brown (1992)¹² showed that when students hold a misconception in physics, presenting a principle with supporting examples to show the range of application of the principle may not be effective; but examples may become effective when they can help students to draw on and analogically extend existing valid physical intuitions in constructing new conceptual model of a target situation. Earlier studies such as by Minstrell (1982) and Clement (1987), etc., (discussed earlier in Ch.II p.73) also support the usefulness of analogies. In any case, only a few chapters in both the textbooks contain just one or two analogies (pp. 343-345) ^{Table 5.14} and very rarely idioms and phrases. The investigator has not come across any metaphor, humor, rhyme, haikus, poems, etc., in the textbooks; as discussed in Ch.II (p. 73) Franklin (1990) and Smith (1991) speak high about rhymes/haikus and poems, which are available in topics such as radioactivity, theory of relativity, spectroscopy, mechanics,

etc. These could have helped to make physics interesting and to develop aesthetic values. The usefulness of exclamatory marks is also debatable especially when there are too many of them; in the cultural context of a language, these exclamatory statements are supposed to make a serious reader, to become extra conscious of the extraordinary information given in the statement, pause a while, chew and enjoy the content, internalise it and think more about it. But in a subject like physics, at times too many exclamatory remarks might become a sort of distractor for the continuation of reading. The investigator feels that there is a need for research in this area to establish facts; however, it may be noted that most of the chapters in both the textbooks contain a few (ranging from 1-12) exclamatory statements; but in chapters, Ch.7 (in Std.XI) and Ch.2 (in Std.XII) the number is above 45 ! But the irony is that, incidentally these two chapters appear to be not very well presented based on investigator's findings as well as opinions of some among the sampled teachers and students ! As far as language errors are concerned they are very few (^{Table 5.15,} pp.346-347) and can even be ignored as they are not of very serious type; of course there are several other errors/omissions etc., but they are apparently due to printing problems or due to lack of proper proof-reading; these cannot be altogether ignored in a good textbook because at times they may lead to misconceptions among the learners.

6.1.5: ISSUES BASED ON THE FINDINGS FROM THE POST-TEXT PAGES:

Post-text pages in any textbook also play a prominent role like pre-text pages; because normally a causal observer, say a student, a teacher, a parent and even an expert in the field is likely to get the first impression (though definitely insufficient to judge) of the textbooks by briefly looking at the cover page, pre-text pages, a few pages in the actual textual matter (but may not be systematically randomized) and the post-

text pages; overall summary, glossary of terms, detailed answers to the end-of-chapter exercises and a series of comprehensive tests with answers, perhaps, would be very much liked by an examination-conscious student and his educated parents; because after all the student has to face the highly competitive world immediately after the Snr. Sec. level, especially if he wants to enter into good professional institutions. Whereas a student who is slightly better enlightened and a good teacher and an expert in the field may look for (in addition to the above examination aids), post-text pages containing a good epilogue, a number of useful appendices, a good bibliography, additional information such as, a list of industries, manufacturing products related to the content, a comprehensive list of Research Institutes in Physics in India & abroad and their contributions related to the topics in the textbooks, 'Who is who' in physics, etc., an up-to-date index (separately for names and technical terms) and a complete errata/correigendum. Epilogue given at the end of Std. XII textbook (Part II) has made an attempt to give exciting link to many of the major concepts in physics, but this is not altogether successful in relating in a much significant way to what has been presented in the pre-text pages as prologue through preface as well as Chapter 1 - Introduction in Std. XI textbook. Moreover the overall summary of all the major concepts referred to, in the two volumes of physics textbooks could have found some place among the post-text pages perhaps earlier to the Epilogue (though not within this), in Part II of Std. XII textbook; after these, there could have been a series of comprehensive test papers based on the pattern of CBSE/IIT/Medical entrance examinations, followed by their expected answers. In both the textbooks, in all the parts answers are provided for most of the end-of-chapter exercises of all the chapters except that of Ch. 1 in Std. XI; these answers contain useful steps/hints to tackle the problems in addition to the final numerical answer; but, some students have expressed

that the hints given are not easily understandable (p.380) for short/essay type questions also, answers have been provided briefly but containing very useful/latest (in some cases) information. Among the post-text pages, index for Std.XI textbook (combined for Part I & II) clearly appears to be incomplete. Part I of Std.XII textbook doesn't contain any index; and index for Part II of Std.XII also seems to be incomplete. Though it is very difficult to prepare an ideal index which includes each and every term used in the textbook, it should have been made possible to include atleast those terms which are very important or which are sometimes given in italics in the textual matter or which specifically shape the general outline of a chapter based on the content given in the syllabus; otherwise the learners are likely to get frustrated while referring again especially during examination time. Regarding bibliography, though a good number of very useful books have been included in it, they are all from foreign authors, as if to give the impression to the young readers that no Indian physicist has ever written any useful physics book; there is a need to give some understanding to them regarding the standard reading materials that are available in India (with all the details including the price if possible) so that, they don't have to depend upon academically inferior study guides which are flooded in the markets, throughout India. Moreover, instead of giving a general bibliography at the end of the textbooks, it would have been better to give specific reference for topics at the end of ^{each} chapter with specific details including, title, author, the page numbers, etc.; then only learners would have some patience to look at such references; and all such references should be made available, as part of the new curriculum package to the school library. In addition to standard books, perhaps it will be better to recommend a few popular national and international/UNESCO magazines/journals meant for Snr. Sec. level, with specific references to the articles related to the textbook topics; similarly back issues of related articles in

newspapers can also be recommended, provided, the school library maintains such newspaper cuttings. A list of documentary or other films and a list of science fictions/poems/haikus, etc., which are directly or indirectly related to the topics in the text, might speak high of the bibliography and the authors' broad vision. As stated earlier Corrigendum or Errata as such is missing among post-text pages in both the volumes of the textbooks, though the Prefaces refer to this; as such as stated earlier, mistakes are not so many and they are either simple/ignorable ones or mainly due to printing errors, etc.; but an ideal textbook should take care of even a single mistake, of whatsoever form; the investigator has made an attempt to prepare an Errata Table No.5.16 (pp.353-534) which is expected to include most of such ^{major} printing or other type of errors; it is hoped that this type of Errata would be useful at the time of revision of the textbooks.

THE

6.1.6: ISSUES BASED ON END-OF-CHAPTER EXERCISES:

As discussed in Ch.II, the conceptual framework of end-of-chapter exercises is that of a self-evaluation for a student-reader; when the textbook is considered as an 'assistant teacher in print', end-of-chapter exercises may be considered as an 'examiner in print'. Pedagogically, instructional objectives should be equivalent to evaluation objectives; assuming that the instructional objectives have been taken care of while producing a textbook which is one of the important major instructional packages, the end-of-chapter exercises should reflect on the taxonomy of educational objectives (based on Bloom et al -1956 which are discussed in Ch.II, pp.40-41), in addition to this major criteria, end-of-chapter exercises have been discussed in terms of some more important aspects related to their structure and nature, to suit the overall efficiency of learning of physics and self-evaluation. End-of-chapter exercises in both the textbooks (totally 858 ^{items} /with 587

numerical problems) are in general, more outstanding academically compared to the content in chapters - but whether this position is pedagogically sound or not is a different question. The investigator has found only very few discrepancies in the answers obtained ^{and} the answers given at the end of the textbooks by the authors - this is a credit for those authors who worked very hard to collect different types of numerical problems, solve them and find out their answers before printing; of course there are some discrepancies in the decimal places of the answers given, but they can be ignored.

The investigator is of the opinion that it would be better if the ratio between the weightages in end-of-chapter exercises for mathematical exercises, activity-oriented, essay type exercises and objective type exercises in physics is like 4:2:1:3 Table No.547(p. 360) shows the overall picture by considering all the chapters; if chapters are to be seen separately, the position is discouraging altogether; because there are 4 chapters in STD.XI textbook and 11 chapters in STD.XII textbook which do not contain any objective type exercises. Most of the chapters contain mainly a large number of numerical exercises and a few short answer essay type questions. As the textbooks were produced in a great ^{hurry} (as admitted by the authorities in the pre-text pages) perhaps there was no time to construct time consuming objective type multiple choice items specifically to measure the content in each chapter. In advanced countries normally every new curriculum is accompanied by sets of standardized tests, which could be used for feedback/self-evaluation as well as for continuous evaluation/certification; though this was not done at the time of publishing the textbooks (based on the information obtained from one of the CBSE affiliated Snr. Sec. Schools), now, NCERT has already started preparing certain, mainly objective type test materials for Snr. Sec. Sch. physics and this seems to be in the try-out stage in some schools, in the process of some sort of standardization.

When we look at the structure or format of the end-of-chapter exercises, it is quite obvious that the weightage given to objective type questions (only 8% and 4% in STD.XI & XII textbooks respectively) is too low; though numerical exercises (above 60% in both the textbooks) also reflect upon objective type questions, still there is a need to make use of atleast, mainly/^{multiple}choice type items, which are considered as the best types of objective questions as they can measure several delicate higher order learning. Of course in physics, numerical problems are very important; but there is a danger in giving too many of them because certain numerical problems can be mechanically done if the relevant formula and the data to substitute are known. Within multiple choice, numerical problems too can come in, provided they do not contain too lengthy computations; moreover major disadvantage of guessing factor in multiple choice testing does not come/^{into}picture in the case of self-evaluation exercises.

The overall weightage given to essay type questions is somewhat good (26% and 21% in STD.XI & XII textbooks, respectively); once again it is good that the emphasis has been on short answer type of essay questions; but the long essay type questions cannot altogether be ignored as they can also measure certain types of originality even in subjects like physics, whenever it has to deal with certain debatable/theoretical topics.

In the format for end-of-chapter exercises weightage given to activity-oriented exercises is too low ($< 2\%$ & $< 1\%$ in STD. XI & XII textbooks, respectively), because physics is basically an activity-oriented subject. Though end-of-chapter exercises are mainly for self-evaluation of what has already been learnt after going through the textual content in the chapters, if there are activity-oriented questions there can be further

/provided in all the major areas/themes of physics; but this idea of strengthening of learning in the process of self-evaluation. NCERT has published a separate Laboratory Manual for STD.XI and XII physics courses, in which number of activities have been/ separating theory content from practicals is questionable, as it goes against the very spirit of science.

Lower percentage for the aspects in Sr. No. 4-8 in Table No.5^{18 (p.361)} suggests at least five major inadequacies based on the nature of given end-of-chapter exercises in both the textbooks. Only about 27% and 7% of the exercises respectively in STD.XI & XII textbooks, seem interesting or challenging to the students, based on investigator's opinion; but in the case of starred exercises, the percentage is slightly higher (40%) for STD.XI textbook though this is very low (8% only) for STD.XII textbook. At least starred questions should have been quite challenging and interesting. Regarding the development of process aspects it is quite obvious that these have not been taken care of in the exercises in both the textbooks (only 12% and 6%). There are some 20% and 32% exercises (respectively in the ^{two} textbooks) which can be considered as beyond the level of students; even among starred items of exercises about 20% of the items seem to be difficult in both the textbooks; of course it is justified to say that all exercises should be altogether not difficult as there can be always individual variations. At the same time there are some items of exercises which seem to be too easy or below the level. Lastly, there seems to be some sort of lack of planning of exercises; as about 6% and 4% (respectively in STD.XI & XII textbooks) the exercises do not show much relation to their concerned chapters or even to their previous chapters, but related (in some cases) to some later chapters; sometimes these exercises can frustrate student-readers, as some of them can be solved only after going through other chapters in the same class or in STD.XII or sometimes even beyond that level (Of course the

authors have given a hint about this peculiarity of their textbooks, in the pre-text pages - but this situation may not always help the learner much).

If we look at the nature of the end-of-chapter exercises, the classification (Table No.5¹⁸ p.361) based on Bloom's taxonomy of educational objectives reveals that exercises related to application and other higher^{order} objectives are the highest (68% & 73% in STD.XI & XII textbooks respectively) followed^{by} the exercises on understanding objectives (31% and 26% respectively); but the exercises on knowledge objectives are too low (2% and 0.4% respectively). Perhaps it is better to have a ratio of 2:3:5 between the exercises on knowledge, understanding and application with other higher objectives especially in a subject like physics. Knowledge questions also cannot be totally neglected though these are automatically getting included in understanding and other higher^{order} objectives, as they are hierarchical in nature.

There are a few (of course very few and only in some chapters) exercises which are related to daily life situations, sports & games, military science, urban and rural life in India, engineering and technology, health and medical education, latest researches in the field of physics, archaeology, astronomy, etc.; but these type of exercises are needed more in number in a good physics textbook.

Another speciality of the end-of-chapter exercises are their starred exercises which are specially meant for above-average students; in STD.XI textbook some 47 (11%) are starred exercises and it is good that the number is more than double in STD.XII textbook (i.e., 106, i.e., 25%); in these exercises also most of them are numerical problems. Though starred problems may help the above-average students, there can be a

psychological problem of inferiority complex for average students whenever they go through such advanced problems; moreover some of the starred problems are simply taken from advanced physics for higher classes and these may frustrate even above-average students; because they are not very much relevant to the textual matters. The investigator is of the opinion that it is better to separate these starred problems into a separate handbook for advanced learners.

Lastly, it may be noted that the general structure and nature of exercises do not appear to be same in all the chapters; of course these can't be exactly the same in all as it depends on the particular structure and nature of the topics in the chapter; however, there could have been some sort of general framework for all the chapters in giving the exercises at the end. On the whole it is very difficult to say that these end-of-chapter exercises serve the purpose of effective self-evaluation altogether; moreover the structure and nature of summative evaluation system (as conducted by CBSE Examination Board) is not exactly relevant to what has been presented in the end-of-chapter exercises; this may discourage student-readers to depend on the textbook and may encourage ^{them to depend} more and more on cheap but popular study guides.

6.1.7: ISSUES BASED ON THE FINDINGS FROM THE PHYSICAL ASPECTS:

Now the last theme to be discussed is the physical aspects of the textbooks, though their importance can never be of least concern; a few points regarding the 'first impression' in terms of the cover pages have already been discussed in the beginning of this chapter. It may be recalled that the physical aspects of the textbooks have been judged with the help of an expert in the field, i.e., the Manager of the M.S. University Press at Baroda and all the technical details are given on pp.153-154. The size, print area, interline spacing, type size,

type face are all acceptable in all the textbooks; but in the case of printing of solved examples, starred portions, foot-notes and end-of-chapter exercises, though the smaller type size is in order, the printed matter is very tiresome to the eyes of (even adult) readers and hence irritating, due to poor reproduction and unsuitable type face; this is one of the major distractors for the young learners; in this case the technical recommendation by the expert is to use 'Halvitica' or Universe type face to get rid of the problem at the time of revision of these experimental editions of the textbooks. Emphasis on chapter numbers, chapter headings, section headings, sub-section headings, actual text, are all printed with standard type size. Regarding the margins, in the case of Std. XI, Part I & II, and Std. XII, Part I, the average top and bottom margins are below the standards whereas, gutter margins and fore-edge margins are below the standard in all the textbooks. Textbook design is one of the factors in its overall effectiveness. Hickey (1984)¹³ studied the relationship between textbook structure and students' achievement in seventh grade science and found that altering textbook designs suitably, resulted in better achievement; perhaps among higher grade students this finding may not be very significant but it still matters. As discussed in Ch. II (pp. 74-76) Hartley's (1990) elaborations on textbook design would rightly warn us that this issue cannot be pushed aside as if it is not much academic. A doctoral study at Stanford University, in the U.S.A., by Varghese (1991)¹⁴, investigated the influence of text design in the case of middle school pupils by monitoring expository text comprehension; in this study, she defined monitoring as a process in which good readers recognize and repair comprehension failure. She concluded that text design in exposition can be a resource for students to monitor their own comprehension.

In Ch.II (pp.79-80) based on Von Restorff's (1933) studies 'isolation effect' or 'Von Restorff effect' has already been referred to and Panda's (1990) study based on this effect, has also been discussed in connection with isolation effects on learning retention of science text material among elementary children in India; based on these researches, the textbooks could have kept in view the importance of certain isolations using coloured background, underlining, enclosure in a box, circle or a rectangle, etc., especially for formulae, new terms, laws, principles, etc.; these are meaningful not only at lower level but at all levels, because according to Marton & Salje (1934) and Entwistle & Waterson (1988) (as discussed in Ch.II, p.78) there are 'surface' readers those who skim the text, retain only isolated facts and do not bother about the overall structure or argument present in the text, whereas the 'deep' readers search for the underlying structure of the text, question it, relate ideas to their own entry behaviour and so on. After all in any group of students, all cannot be 'deep' readers or this process of 'deep' reading is likely to go well only with above-average students, for whom ideally, anything and every word given in textbook is important intellectually; 'surface' readers, especially at the time of examination are likely to get more benefits from isolations in a textbook. So intellectually it may look odd to underline, to put in a box or to colour a few information in a textbook but pedagogically it is sound. These isolations may help in improving 'first impression' too, for a text, which has been discussed earlier. Based on the information given in the 'Foreword' by the Director of NCERT an advisory committee was set up under the Chairmanship of an eminent scientist to develop instructional packages from upper primary to the Snr. Sec. stage; but it appears that this advisory committee, unfortunately did not insist on certain uniformities atleast in the case of physical aspects; because NCERT's present Snr. Sec. chemistry and biology

textbooks and even science textbooks of lower classes, did make use of the concept of 'isolation affect' atleast to some extent, by making use of colours, boxes, etc.; but unfortunately none in the case of the present Snr. Sec. physics textbooks, except of course the use of italics for a few new terms, but that too not in all chapters; incidently there are a few terms or group of terms which are isolated using italics without much need for the same, in their context !

If we look at the details about the Printers for the present physics textbooks, Std.XI, Part.I was printed by one New Delhi based company; Std.XI, Part.II and Std.XII, Part.I were by another New Delhi based company and Std.XII, Part.II by another company based at Madras and none of the books were by Govt. of India Textbook Printers ! Perhaps this is why the publisher lost control over the physical aspects of the textbooks. The papers used for the cover pages as well as for the actual text are not of good qualities and are easily given to tearing, even by careful users; the qualities of the former affect the durability of the books whereas of the latter affect the durability as well as disturb readers' concentration on content due to poor opaqueness of the textual page papers. Except in the case of Std.XII, Part.I, the colour of the paper used is not sufficiently white and doesn't seem to be pleasant to readers' eye. The quality of the ink used in printing is not good and the printing is not even uniform. The printing of photographs of scientists are not attractive due to the poor reproduction; the printing sizes and spacing of other diagrams and Tables too are not upto the mark. Throughout the pages of both the textbooks there is not even a single instance of using any colour except black and white ! And there is not even a single colour plate connected with wave optics, spectroscopy, etc., though Std.XII, Part.II, p.285 states that they are included in the book ! Technically, the style of binding

is not upto the standard and this has affected especially the Std.XII, Part.II textbook, as it is very bulky with some 372 pages. The non-uniformity in gutter margin and poor quality binding together have made it very difficult to read properly some of the pages in some copies of the textbooks. On the whole in the case of these physical aspects, the technically suitable standards based on the expert's opinions (as stated in detail in Ch.IV. pp. 153-154) do not fully meet NCERT's¹⁵ requirements as stated in their "General Guidelines for Textbook Production" for Std.IX to XI, in their very well documented resource book for Textbook Research titled, 'A study of the Evaluation of the Textbook'; incidently the expert's opinion at Baroda by and large agrees with the standards specified by NCERT; but the irony is that though the above resource book, which elaborates very systematically the developments of textbooks starting from ancient period to the modern period in India and gives the concept of a modern model textbook, NCERT is, apparently not fully successful in producing and publishing such model books for Snr. Sec. physics curriculum.

In the earlier referred NCERT's brochure, it is stated that the books published by NCERT's Publication Department have won several awards including National Awards for Excellence in Book Production and this department delegates their experts in production and publication of books to help many other National Agencies in the field. In this connection perhaps in good faith, it is safer to blame the concerned authorities' 'haste' (as reflected in the 'Preface', p.ix) in getting the textbooks out in the market and not fully controlling the private printers' somewhat below standard work.

/and International

6.1.8: ISSUES BASED ON THE FINDINGS FROM THE OVERALL EVALUATION:
(i.e., SYLLABUS, GOALS & OBJECTIVES, ETC.):

Based on the discussion of all the above important themes, perhaps the idea of a sort of overall view to be discussed, can be considered as meaningful; but as far as possible the repetitions will be avoided here. Whenever a textbook is written, perhaps the first question is, "Is it based on the prescribed Syllabus?". But the investigator has intentionally decided to discuss this issue at the end, because of the context in which the new textbooks were made to be written, to serve as a 'model' at the National level in the high spirit of NPE (1986), (as stated in Foreword, p.iii, Std. XI), and perhaps, not necessarily based on any existing syllabus. Incidentally in India at the National level, the School Examining Body (i.e., CBSE) is different from a Body fully in-charge of National Model Textbooks for the schools (i.e., NCERT); and the task of actual framing of the syllabus is with CBSE; though both the autonomous bodies are under Govt. of India (Ministry of HRD), as far as examinations and certifications are concerned, the responsibility is that of CBSE and it appears that NCERT's position is only that of an advisor; in this connection it is surprising to note the following statements given in earlier referred (p.434) brochure by NCERT:

While the Delhi Administration and the KVS prescribed the NCERT's textbooks for Classes I to VIII for its students, in the case of Classes IX to XII, the NCERT's textbooks are among the textbooks recommended by the CBSE.

In the same brochure, it is stated that the factors such as reasonable price, good standard in content as well as design,

.....have made the NCERT textbooks extremely popular and a large number of schools other than KVS have been prescribing these textbooks eventhough there is no compulsion to do so.

From the above statements by NCERT, and from the documents containing the prescribed CBSE syllabus for 1987 and the revised syllabi in 1991 & 1993 for Snr. Sec. physics (Appendices F, G & H respectively-last para) it is very clear that the present (as well as even the former) NCERT textbooks at Snr. Sec. level are only one set of the recommended textbooks and the set is not compulsory in other private Snr. Sec. Schools, which are affiliated to CBSE. The findings of the present study of the Snr. Sec. physics textbooks raise doubts, of course with purely research spirit and without any prejudice, regarding the claim made by NCERT's textbooks, that they are 'extremely popular'; of course this study will not be in a position to say positively about the extreme popularity of NCERT's textbooks other than the present experimental addition of Snr. Sec. Physics textbooks; based on the earlier discussed findings and the opinions of sampled teachers, students and experts, the investigator, cannot help in not fully agreeing with the NCERT's claim, but is very optimistic that revised additions of these textbooks would have a lot of scope to become popular and even compete with other CBSE - recommended books by private agencies provided the publishers and the authors who had requested for feedback from various sources in their Preface (p.ix), ^{of the textbooks} do implement the same in the new books; moreover, to achieve this the Printers should be given enough time and the publisher should fully guard their interest and protect the image of NCERT textbooks. The present experimental editions of physics textbooks are by and large good, as far as content is concerned, but there are many more things to be done to improve the pedagogical as well as physical image of the textbooks.

Now coming to the syllabus again, CBSE has included the present physics textbooks as only one of the recommended sets of books for their examinations; as discussed at the end of Ch.V for the last objective of this study, NCERT's experimental edition textbooks for Std.XI and XII in physics written and published in 1988 and 1989 respectively, do not reflect much on CBSE - 1987 syllabus; but it appears that in a reverse way, the revised CBSE syllabus of 1991, reflects on the content of these textbooks, and this is more so in the case^{of} another revised CBSE syllabus in 1993. With these findings, perhaps one might guess the problem faced by the teachers and basically examination-oriented students during the earlier years, especially in Snr. Sec. Schools, owned by Govt. of India, (like KVS, Delhi Administration, etc.) where they are obliged to use NCERT textbooks. From the above findings, it also appears that the CBSE is perhaps trying to accept the 'model' textbooks prepared by its sister-concern NCERT in its advisory capacity, keeping in line with the recommendation of NPE (1986) and POA (1986); and at last now by and large, the topics shown in the syllabus are in the textbooks too; but it is difficult to know the exact^{expected} depth of these topics from the syllabus and in that case only the textbooks are helpful; but the examination-oriented students will still have problems, because the questioning pattern of CBSE examinations, apparently have not influenced the authors much to frame their end-of-chapter exercises. Here is a pedagogical paradox to an educationist: Instructional objectives are supposed to be the same as the evaluation objectives in any teaching-learning process; as the textbooks are one of the major curricular/instructional materials, they are supposed to be highly reflecting the instructional objectives and, hence, indirectly the evaluation objectives, based on which the summative evaluation, certification and further placement are supposed to take place. The paradox is that though the NCERT textbooks are by and large good in content which are within

the syllabus, the investigator, some of the experts and some of the students and teachers in the samples chosen in this study strongly feel that the present NCERT textbooks are not very useful for students to get good marks in CBSE as well as other competitive entrance examinations at the end of Std. XII.

The present physics textbooks have gone into much details about most of the chapters and still more details through starred sections; in fact there are a few more starred topics over and above the ones indicated in the CBSE 1993 syllabus; but the investigator is of the opinion that there is one important topic which has not been treated with sufficient details in Std. XII; i.e., X-Rays; this topic is mentioned in 1993 CBSE syllabus under Unit. 7, on 'Electromagnetic Waves' (Qualitative Treatment) and the textbook has covered it just by showing X-Rays as one of the components of electromagnetic spectrum (p. 230-231) and by briefly discussing its medical applications. When so many advanced topics have found place in the syllabus as well as in the textbooks even at Snr. Sec. level, a detailed treatment of a topic such as, 'Nature, production and properties of X-Rays' is not at all too much; in the historical development of modern physics about which the Std. XII textbook spoke so much in Ch. 12, did not elaborate much on production of X-Rays, which is the inverse process to the photoelectric effect; moreover, the detailed applications of X-Rays in the study of crystalline structures, in industries and in medical fields would have enlightened more, the prospective young physicists, engineers & technologists and medical practitioners, respectively. As discussed earlier in this chapter (p. 450), another important unit that could have been added in the syllabus and hence in the textbooks is on 'Environmental Education & World Peace Education' to really reflect the high spirit of NPE (1986), with the fundamental physics behind this, through a real multidisciplinary approach. And,

there could have been another Unit/chapter on 'Fundamentals of Solar Energy', with special emphasis on topics such as, solar village, rural development, etc.

As discussed earlier in this chapter (pp.449-452), an overall impression of the physics textbooks in terms of nature and structure of science in general and physics in particular is found to be somewhat disappointing especially because of the inadequate help available in the texts for the development of process aspects of scientific inquiry; this may be rectified by integrating the activities/ experiments given separately in NCERT's Laboratory Manuals into these theory textbooks; this inadequacy has indirectly affected the fulfillment of National goals and broad objectives of Education/Science Education in general; because after all 'scientific temper' is the key term in most of the earlier National Education Commission Reports; and the present NPE (1986) also did stress a lot on this term; mere high level content alone, without the strong pedagogical considerations may not help to develop or cultivate scientific temper. Finally, we conclude here by briefly referring to the fulfillment of the 5 broad Objectives of the Snr. Sec. physics curriculum (as mentioned in CBSE - 1991 & 1993 syllabi) the details of which have been elaborated in the previous Ch.V (pp.428-432). The 1st Objective (of CBSE physics curriculum) refers to the development of competence to pursue professional courses like engineering, medicine, etc.; in this case, the investigator is of the opinion that the textbooks contain more than enough basic physics for the professional courses; in fact the prospective medical students may not require so much details in a few chapters; but the drawback is that the textbooks have not provided a good number of exercises, references, illustrations, etc. to provoke positively the deep interest in advanced physics as directly applied in modern engineering/technical and medical fields; though the 1st Objective refers to 'competence', as discussed earlier, it is not sure, whether the students those

who depend on these textbooks will be in a position to compete well in entrance tests to these professional courses.

The 2nd Objective (of CBSE curriculum) is to get knowledge, understanding and application abilities about different aspects of physics; by and large the depth of content knowledge including the latest details with starred sections present in the textbooks is unquestionable; but, several loopholes in pedagogical presentations hinder the development of understanding and application abilities; non-integration of theory into practice is another reason for the above hindrance. Lack of sufficient knowledge of mathematics at the appropriate time especially for non-mathematics biology students, who have to study physics is another serious hindrance; as such, for such biology students these textbooks may not serve the purpose at all. The 3rd Objective (of CBSE curriculum) is to strengthen foundations for further study in physics; this Objective appears to be somewhat over-emphasized in the textbooks; if mathematics courses are properly co-ordinated with physics courses, though the textbooks have a few pedagogical and physical limitations, above-average students are likely to get a lot of benefits especially from starred sections and starred exercises, if they wish to pursue a career in physics; in this connection, it is expected that the NCERT would make sure that their National Talent Examination would be based on the content presented in their own textbooks (unlike in the case of CBSE and other competitive examinations).

The 4th Objective (of CBSE curriculum) is to develop interest in the study of physics; development of interest in physics is one of the important dimensions of development of scientific attitude; as discussed earlier, the textbooks look too much theoretical because of the separation of activities/experiments into another book, i.e., Laboratory Manual; reading and accomodating theory and practice separately looks artificial in science and develops a wider gap between the two, which

in turn delays or hinders the development of real interest; this dichotomy is against the spirit of scientific method; it may be recalled that the experts too have supported this view in addition to some of the students and teachers within the sampled groups. In these textbooks, very few references are available (Ch.V, p.240) to the major applications and uses of principles of physics in daily life situations, to develop interest in physics; mere reference to examples in advanced physics/technology alone may not develop much interest especially among average students. CBSE's last Objective in physics curriculum is to enable the learner to acquire necessary manipulative and experimental skills; as this Objective is under psychomotor domain, the present physics textbooks under study may not be expected to directly help the learners to achieve the same and discussion on this Objective is beyond the scope of the present study.

6.2. : DISCUSSIONS ARISING OUT OF IMPORTANT ISSUES NOTED AMONG THE OPINIONS OF STUDENTS, TEACHERS & EXPERTS:

As discussed in the previous section 6.1, there are several findings of the study which get support from the students', teachers' and experts' opinions; instead of repeating the same, in this section, only a few salient features of the opinions especially wherever they are somewhat different from that of the investigator, will be highlighted with an intention of giving a further, better picture of overall evaluation of the physics textbooks under study.

In this study it is very strange to note that the sampled students as well as teachers, who responded to the separate questionnaires (with the response pattern being, YES, NO, UNDECIDED - Y,N,U ended with several cases of average rating scores between - 0.49 to + 0.49 reflecting 'U-UNDECIDED' or uncertain (as shown in Table No.5-2015-21 in pp.369-371 & pp.388-39)).

This shows that both students and teachers as groups are not very clear about number of aspects connected with in-depth as well as overall suitability of the present textbooks. This indecision in the case of students is understandable to some extent but not in the case of teachers; even among students, it may be recalled that the sample was chosen in such a way that there were atleast one above-average student and one average student from each concerned class. When above-average students also show indecision, indirectly it may mean that, they too, might not have ^{been} using these textbooks so seriously. In the case of sampled teachers' group, it is a sorry state of affairs; it is likely that they too have not been using these textbooks so seriously; this may be due to ^{the} fact that they might not have been oriented by the concerned authorities regarding their use. The efforts in writing of new textbooks will be of no use, unless being followed by intensive in-service programme with suitable orientation for teachers regarding how to make use of them. In this connection, it is worth noting the experiences of the Philippines reported in a paper by Guzman II (1989)¹⁶ in the World Bank's EDI Seminar Series under the title, "Textbooks in the Developing World": Immediately after writing textbooks, the concerned authorities proposed two in-service teacher training programmes; one for orienting teachers on the use of textbooks and the 2nd for studying the learning effects of the new books on students; according to the report, the teachers were specifically trained to :

- Apply their skills in curriculum analyses to the use of textbooks in the classroom.
- Identify and demonstrate teaching strategies appropriate to specific lessons.
- Manage instructional resources so as to create effective teaching and learning situations and increase the useful life of educational materials.
- Integrate curricular areas for the development of specific skills.

There was some resistance to this in-service training concept in the beginning, because some of the bureaucrats in the Ministry of Education in Manila thought that there was no need for such expensive programme, as their teaching force with high level of qualifications, was traditionally familiar with textbooks. However, the progressive educationists in-charge of the World Bank assisted Textbook Project, could convince them regarding the usefulness of the training and conducted the same for some 5-10 days throughout the country. Though this programme was of somewhat shorter duration, it must have helped all the teachers in the country at least to some extent. India needs to learn from the experiences of the Philippines in this regard; then only the spirit behind the NPE (1986) and POA (1986) could truly get reflected in the classroom based on the use of the textbooks; there is a need to strengthen seriously the in-service programme for teachers in connection with new textbooks.

Though as groups, the students and teachers were indecisive, as individuals they have given several interesting additional responses as presented in Ch.V (pp.375-386 & pp.394-400 respectively). And in the case of experts, though they have kept the textbooks and their opinionnaire for about 6 months before responding to the same, some of their opinions are not very specific and elaborate; however, more elaboration on the items in the opinionnaire as well as on many other related issues were possible during a few interviews with them to come out with several very useful information.

6.2.1: REGARDING OPINIONS OF STUDENTS :

Many students have indicated several difficult topics, which by and large agree with the findings by the investigator. Some of them have expressed their serious problems related to mathematics and some other, even that of language; but in the case of language, the investigator may not agree fully with

those students; the language used in the textbooks, in general, is not that difficult; perhaps, due to the way in which the mathematical physics concepts and the technical details are presented and developed, (without bothering much about the pedagogical aspects) might have confused the students to blame the language aspects of the textbooks.

Some students requested for additional details about scientists in the revised edition of the textbooks; a few liked the way in which some questions are explained diagrammatically; some of them found very interesting short questions on giving scientific reasons at the end-of-chapter exercises; non-starred end-of-chapter exercises are very interesting and challenging, but the starred questions are extremely difficult; NCERT physics textbooks are quite helpful for knowledge but not for getting high scores in competitive examinations; the textbooks are good, but only for bright ones; it is good to raise standard- but the physics textbooks have gone beyond limit. Among individual additional responses by students, inadequacies pointed out are more than the positive aspects; in this connection, the following two detailed and very frank statements made by two students are ^{note} worthy to understand the depth of their grievances (most of the additional responses by others too, by and large, reflect the same feelings; and here it may be noted that the statements are quoted as they were made by the students without correcting the grammatical or other errors to maintain the originality) :

The physics book is very difficult to understand. The authors have not taken much pain to make it. Everything is given in such a way that the student have to spent very much time to understand it. It is written just to cover entire topic in a very comprehensive manner and for this reason students have to spent their valuable money on expensive reference books. The authors of reference books

are much less qualified than the authors of NCERT Book. Then what is the reason for such a poor explanation of topics. The matter of the book should be very clear and elaborate. The authors have not taken in mind those points. On the whole the textbook is unsuitable for Class XII and to score good marks.

Second one :

I would rather say that NCERT textbooks do not give us the basics. In an attempt to give us good knowledge, perhaps they have overlooked the basics. Why afterall a single author like N.K. Bajaj satisfies the students more inspite of the fact that NCERT has a host of brilliant professors ? The volume of textbooks like say N.K. Bajaj is almost the same as the two volumes of Class XII put together. I would suggest that more stress should be given in NCERT books on basics and the author should think himself to be a student while writing. Perhaps the NCERT professors would agree with me that "It is very easy to write a difficult book but very difficult to write an easy book". Thanks.

No doubt there are language problems for the above students; in fact many students who gave additional responses for the items in their questionnaire, could not write correctly; but they all have rich and frank ideas. English language is still a problem in India and this may be affecting science education programme too; this is how some of the students have felt that the language used in the textbooks is very difficult to understand - but as discussed earlier, the investigator's findings do not support students' views as far as language is concerned. Now coming to the actual stuff in the above statements, if we have to content analyse them systematically, the findings and their extrapolations would be quite interesting and very useful in the teaching-learning process. Afterall writing textbooks inside the ivory towers by intellectual giants may not solve Nation's educational problems at school level; we have to understand the grievances of the younger generation, by living with them; perhaps the student is right in saying that the author

should think himself as a student while writing; this is possible for highly experienced teachers (of course with good qualifications), at the level at which the textbooks are to be written; top level scientists or professors are definitely helpful but mainly as advisers. Most of the students have indicated that they have been depending on some well-known private authors' textbooks or refresher courses (as shown in Ch.V on pp.382-383): and this is an open challenge to NCERT as well as Government's policy on Nationalisation of textbooks ! Very rarely students have indicated the foreign books given in bibliography at the end of NCERT physics textbooks, as their dependable or helpful books; there are more than two dozen physics textbooks/refresher courses by Indian authors which have become very popular among the sampled students and a few of them have indicated that they do not even touch NCERT textbooks ! Based on his own findings, the investigator disagrees with some of the students who think that NCERT textbooks are that much disappointing. There are so many good things in the NCERT textbooks though there are too many loopholes; and first of all, teachers have to be properly oriented to guide the students to make use of the textbooks effectively.

6.2.2: REGARDING OPINIONS OF TEACHERS:

Several additional responses were provided for some of the items in the teachers' questionnaire, but mainly by experienced teachers with additional higher qualifications such as M.Ed., M.Phil. and Ph.D. in physics/education; so these responses are likely to possess higher weightage. Though students pointed out atleast a few positive aspects among their additional responses, their teachers stressed on mainly the inadequacies. The list of difficult topics for the majority of their students, by and large agrees with the findings of the study by the investigator; their list includes many mathematical topics too; they have complaints regarding the status of certain terms, size

of certain diagrams, physical aspects, end-of-chapter exercises, language used, etc.; some of them even felt that Std.XI, Part.I textbook should be rewritten in more clear and simple English; as discussed earlier, here also the investigator would like to partly disagree with the teachers; as discussed in 6.2.1, it is the mathematical language that is used in the textbooks which is likely to worry the learners and not the English language; moreover in Std.XI textbooks language aspects are somewhat simpler compared to Std.XII textbooks. Though there are a few grammar/language ^{in Table 5.15} errors as shown earlier (pp.346-349) in the textbooks, some teachers wrote 'NIL', while giving additional responses for the concerned items in their questionnaire. Neither the investigator nor the teachers have come across any spelling mistake in the textbooks though the investigator has found some printing ^{editorial} errors, as reported earlier ^{in Table 5.16} (pp.353-358).

Some teachers have frankly accepted the fact that the present educational system is examination-oriented and their students as well as themselves use other private authors' books for their major purpose. On the whole some of them ^{strongly} feel that the present experimental editions of the physics textbooks require a complete revision by giving much importance to the students' opinions as the textbooks are meant for them; but the investigator is of the opinion that the present textbooks may not require complete revision in the strict sense of the word 'complete', but there are many major and minor aspects to improve upon seriously; moreover, only students' opinions are not sufficient while revising, because after all a particular set of students come and go in the system; but the teachers do remain till they retire. Just 5-7 days of Review Workshop where teachers from a few important cities get invited, looks like partly academic, but mainly social picnic or gathering, to review some 700 pages of the textual matter, that too in a discipline like physics ! The investigator is of the opinion that 'Textbook Research & Development' should be a full-time

job just like R & D Department in well-established industries; but here the Researchers cum Developers should be from a group of well qualified but experienced teachers representing the whole Nation and who have been teaching for several years at the particular level for which the textbooks are to be written and they have to be deputed atleast for some 6/10 months; the venue may be ideally the NCERT campus itself where very good library facilities as well as experts' help are available; the authors should have an access to a good school where they ^{can} teach every week, whatever they have written to get the first-hand feedback from the students. One or two top level specialists in the discipline in Universities/Research Institutes, one or two educationists with strong background in the concerned content as well as pedagogy and one EST language specialist may be included in the Textbook Writing Team, along with the teachers; but a good representative sample of specialists, educationists, and academically and professionally strong representatives of the teachers' professional associations may be appointed as members of the Advisory Committee; in the review workshops' even a group of students may be invited to help revise the textbooks.

6.2.3: REGARDING OPINIONS OF EXPERTS:

There are many aspects from the five experts' opinions, which agree with that of the teachers' as well as students' and the investigators' findings from the major content analyses; three of them specifically agreed that the concepts and facts given in the textbooks are accurate and up-to-date; but four of them opined that their presentation and understanding of the same by students are doubtful in some cases. All the experts felt that the number of illustrations/diagrams/pictures, etc., are adequate in the textbooks; but all of them opined that the textbooks would not help the students to get training in the

scientific method and they are totally dissatisfied with the overall get-up and the print of the textbooks. For some of the questions in their opinionnaire, their opinions were somewhat divided - on issues such as clarity of language communication, overall reflection of the nature and structure of science/physics, overall usefulness for the actual classroom teaching, etc.

Among the additional responses given by the experts, many of them are quite useful. Some of them appreciated that the Std.XI textbook started with introduction for observation and measurement in physics but they didn't bother to comment regarding the inadequacy of the chapter on 'Introduction'. They also appreciated the aspects such as discussion on historical developments, latest/future applications, availability of ample quantitative dataⁱⁿ/material science, graphical illustrations, etc. One of them specifically appreciated the treatment of the concept of 'Magnetism' in Std.XII textbook, in which magnetic field produced by electric current has been introduced first before introducing the field produced by a bar magnet on earth, as the former is the basic; nowadays, though most of the modern textbooks in physics subscribe to the above idea, this is somewhat debatable issue; historically as well as pedagogically, it may be more meaningful to introduce the latter concept first. Another expert appreciated the concept of 'Spiral Curriculum' during the time of interview; but she felt that it is very difficult to practise it of course without elaborating the reasons for the same. As discussed earlier (p.441) the investigator is of the opinion that there is strong need to try and experiment this issue, because after all it is not that difficult and it is not against the nature and structure of science/physics nor to the pedagogical principles; as this is a new idea, perhaps it will take time to accomodate. One expert is against too many historical discussions in Ch.12 of Std.XII by argueing that too much dwelling on non-technical details may lead to

strange and non-professional approach; once again, this issue too, is debatable; the investigator would like to mention that this Ch.12, is one of the best chapters in the textbook, because of the factors such as presence of detailed historical developments, opportunities for knowing more about scientists, excerpts from Nobel Prize lecture, language specialities, an element of multi-disciplinarity, etc., wherever historical incidences are available why not allow our younger generation physicists to know about them? There are many things to learn from the history of physics too. Unfortunately, history of physics is being neglected by many teachers, several textbooks and Examining Bodies; hence students too have been ignoring them, without tasting the scientific spirit behind history of physics; knowledge of history in any discipline leads to its further systematic and error-free development, with a lot of applications for the future. If physics becomes purely or mainly technical, our youngsters are likely to get frustrated, as it happened in the case of some topics in the textbooks, and they specified them (pp.375-376).

The experts too, have bitterly complained against the lack of co^ordination of physics with mathematics and too much of calculus as reflected in most of the chapters especially in the starred sections and end-of-chapter starred exercises; as they felt that most of the starred portions are too difficult for even good students because of mathematics, they suggested to introduce more and more non-mathematical starred sections. Some of the experts have accepted the bitter reality of the existence of examination-conscious students and stressed that the end-of-chapter exercises should help the students to score good marks in CBSE and other competitive examinations. Should the students be examination-conscious or not? This is another debatable question; even if we think of one more NPE after a few years there is no solution for this problem, because the social norms and respect are based on paper qualifications ^{and} percentage

of marks/grades and admissions (to professional programmes in Higher Education Institutions). Experts, teachers and students are all of the same opinions that the present physics textbooks are not useful to get high marks; in this connection, there is a real need for a serious investigation into the objectives, nature and structure, etc., of CBSE as well as other competitive examinations. As discussed earlier, if the instructional objectives (based on International, National, Institutional and of the discipline) are different from evaluation objectives, there is a pedagogical paradox; prescribed textbooks are supposed to be based on instructional objectives, but in the case of present textbooks this is not fully satisfied (as discussed in Ch.V, pp.428-432). After a thorough investigation if it is found that CBSE and other Agencies conducting competitive examinations are right, there is a serious need for the textbook agencies to revise accordingly; the investigator is of the opinion that the textbooks should be revised only after the above investigation. If we are willing to accept the reality, there is a need for more investigations in the line of comparative studies of the present National physics textbooks with some of the popular/private physics textbooks, before the final review; in fact some of the students under this study have given this bright idea !

6.3.: REGARDING ISSUES ARISING OUT OF THE METHODOLOGY USED IN THIS STUDY :

As discussed earlier in Ch.IV on 'Methodology' (pp.131-137), 'Content analysis' has been used as the major technique for collecting data in the case of objectives from No.1-6 and 8; for Objective No.7, questionnaires, opinionnaire and interview have been used.

6.3.1:ISSUES BASED ON CONTENT ANALYSIS AS A RESEARCH TECHNIQUE:

Content analysis is a scientific method to describe various aspects of communication content in a summary fashion; as discussed in Ch.IV (pp.131-135) it is a procedure for the categorisation of verbal or behavioural data for the purpose of classification, summarization and tabulation (Fox - 1969); and the content analyses of the physics textbooks have been carried out at manifest as well as at latent level; at manifest level the analysis is strictly bound by what the textbooks contain without assuming anything more about it, whereas in the latter the investigator had to go beyond transcription of what was said directly and sought to infer what was implied or meant. Based on the nature and structure of physics, content analysis at manifest level was found to be suitable especially for objectives connected with content, communication strategies, physical aspects and end-of-chapter exercises whereas for the process aspects as well as overall evaluation based on certain documents, needed content analyses were carried out mainly at latent level where the feeling tone leading to value judgements crept in; as such, for all the concerned objectives of the study, it was unavoidable to carry out content analyses at both the levels and sometimes simultaneously to come out with meaningful inferences. Fox (1969)¹⁷ is of the opinion that the content analysis at the manifest level can be accomplished reliably and and validly but not at the latent level; Kirppendorff (1980)¹⁸ defines content analysis as a research technique for making replicable and valid inferences from data to their context;

the fixed criteria for evaluation (pp.138-167) suits well to the manifest level, but at times somewhat vaguely to the latent level; however, the researcher would like to mention that in carrying out content analyses at latent level too, he drew on his several years of experience in teaching physics as well as education courses at various levels including that of at Snr. Sec. level, whereby he has had the opportunity of making use

of several good as well as below standard, national as well as international textbooks in physics. Moreover, the corroborative evidences obtained through Objective No.7, from students' teachers' and experts' opinions, do support the findings of content analyses carried out even at latent level by the investigator. But Krippendorff's demand for replicability as in the case of natural sciences, may not always be fulfilled to the full extent, in a mainly qualitative study such as physics textbook evaluation, where, content analysis at latent level is unavoidable, to reach a satisfactory stage of overall evaluation; though physics is one of the natural sciences, areas such as physics education and physics textbook research come under social sciences, where replicability is not always possible. It is likely that if the same textbooks are evaluated by some other investigators with different background and experience, and by making use of different methodology within the content analyses technique the findings of such studies are likely to be different at latent level; however at the manifest level, the two sets of findings are expected to have high correlation; but in general, there can be variations, because after all even Fox (1969)¹⁹ writes, "In a sense, content analysis is a personal statement by the researcher of his perception of the data". Perhaps these preceptions would vary based on researcher's background and experience.

Here the investigator would like to share his experiences with his professional colleagues in this very tedious process of evaluation of textbooks; perhaps it is easy to write textbooks compared to the job of evaluating them; as suggested earlier, textbook writing should be a full-time job and so is the case of evaluation of textbooks; perhaps the Textbook Boards in the country have to realise this. This thorough analyses of some 700 pages of the Snr. Sec. physics textbooks contain Tables in Ch.V, on 'Analysis & Interpretation' with ^{some 145} pages in

this report. The investigator had to go through the textbooks again and again to come out with meaningful findings especially at latent level; and everytime he went through the pages, innumerable new data and their interpretations were coming up. The technique of content analysis depends on systematic and comprehensive, classification of data obtained; but tools such as 'information sheets' in the content analyses even with several tabular columns and rows, however elaborately designed, may not be in a position to accomodate all the innumerable data available to an investigator. Tabular columns and rows have the mechanical limitation of two to three words or short sentences. In spite of having so many short and long Tables, if all the data to be presented cannot fit into rows and columns, then the only alternative is to present them in the ordinary but difficult or inconvenient ways of long statements; and this is how it is done in this investigation. On the whole, the investigator strongly feels that there is a serious need for computerisation of textbook evaluation to make the whole process more systematic, more comprehensive and faster. This investigation is basically qualitative in nature; Berelson (1954)²⁰ opines that content analysis must be quantitative but he doesn't mean that there should be always assignment of numerical values to the analytic categories; sometimes it can take the form of quantitative terms such as more, always, often, sometimes, increase, decrease, somewhat, etc.; he states that these terms are just as 'quantitative' as the terms like 'percentage'; if we accept the views of Berelson, then this investigation can also be considered as partly quantitative. The methodology used by Fox (1969)²¹ in the process of semantic content analysis seems to be highly quantitative with the coding system of using three digits and their weightages; the investigator is of the opinion that the semantic content analysis, which involves the development of a set of categories intended to represent the dimensions and specifics of the actual content along with their weightings, is suitable only for

small documents and not for textbooks with hundreds of pages, especially if computer assistance is not available. If we look at the history of content analysis as a research technique, in its developmental process, it has been mainly using steps such as certain intensity measures, certain categorisations/classifications, tabulations, counting of frequencies, computation of percentage frequencies, etc.—most of the textbook analyses studies in India as well as abroad following this simple but detailed content analyses with the above major steps, could come out with very useful findings for the revision of textbooks.

The investigator is yet to come across any study in textbook research, using computers seriously. But Kerlinger (1964)²² reports that in the USA, computerised content analysis started sometimes in 1960s; in India, it seems this is yet to become popular. A computer programme known as 'The General Enquirer' was the first one in this field; it is a set of computer programmes geared to the content analysis of verbal materials; this set is generalised so that it can be used for a variety of research problems. Singh (1991)²³ informs about the a few computer programmes that are available for content analysis ; but it appears that these are yet to become popular in India. Both for detailed qualitative as well as quantitative textbook research computers would be very useful, especially if revision of textbook has to be done earlier in the interest of the students; but computers may analyse the textbooks mainly at manifest level; at latent level, analyses may have to be done manually by an experienced investigator.

Traditionally content analyses and hence textbook researches are mainly conceptualized as qualitative studies, but, in the last decade, a few quantitative studies have also been carried out; Clifford (1979)²⁴ at the University of Birmingham used

quantitative techniques to compare physics textbooks in terms of the differences in sequential organisations. Krippendorff's (1980) book on 'content analysis' discusses issues with the quantitative orientation; Sanchez (1988)²⁵ made a comprehensive and comparative analyses of Chilean biology textbooks using quantitative techniques. Anderson and Botticelli (1990)²⁶ from Columbia University Teachers' College employed a quantitative technique to assess thematics and sequential organisations of textual material of some of the biology textbooks used in secondary and college instructions. In this study a comparison was made between the quantitative data obtained and the subjective judgements made by external reviewers who analyzed the textbooks based on the perspective of science education. They made use of quantitative variables such as progression density coefficient and a graphical analysis known as 'Kinetogram'. The explicit analysis for progression density clearly showed increasing values across the four textbooks under study corresponding to increasing difficulties of the textbooks as stated by general reviewers of science books and films. The kinetogram produced a fairly consistent pattern of sequential organization within each text sample. As stated earlier, at the time of conceptualization of the present investigation for the evaluation of the physics textbooks, the investigator was mainly guided by qualitative studies in India and abroad; but after reading some reports about quantitative studies outside India, one would be tempted to embark upon similar studies in India too. Qualitative studies in textbook research, depending on the context, have their own merits; however, if the quantitative approach can supplement information in the field, it is worth considering.

6.3.2: ISSUES CONNECTED WITH QUESTIONNAIRES, OPINIONNAIRE AND INTERVIEW :

Now coming to the issues related to the methodology used in Objective No.7, i.e., opinions of students, teachers and experts, the investigator found their responses inconclusive. There is no doubt about the usefulness of the opinions of the users, in this type of investigation, provided they are willing to co-operate fully with the investigator and indirectly help themselves/ the prospective users; but, because of the technical and practical problems associated with questionnaire as a research tool, it was a challenging task to collect, analyse and interpret such data. In developing Nations the academic circles are yet to fully develop and appreciate the 'research and development' spirit; out of 108 schools in the western region of India to whom the questionnaires were sent with a humble request, only 60 schools responded and that too after reminders, personal visits/telephone calls, etc., in a few cases. One of the reasons why there is normally poor response for the questionnaires is that the investigators expect too much from the respondents by including too many items; after all they are not obliged to respond by spending several hours as their academic co-operation is purely voluntary; in the present study, there were only 2 and 4 full-size pages in the questionnaires for students and teachers respectively, but still the returned responses were not that encouraging (p.367). No doubt in a textbook research, detailed opinions from students, teachers and experts are very useful; Hansa (1990)²⁷ embarked on a very ambitious doctoral research work at the University of Bombay by posting to the experts and others in the field, a printed questionnaire containing 41 (quarto size) pages with over 250 items. Her booklet contained a brief write-up and a model for each of the 40 techniques she thought of for writing a textbook of mathematics and she sought the opinions for each through 5 ratings; in addition, she expected reactions for each from the experts for which she

provided some space on each page. No doubt her sincere hard-work has to be appreciated; but the question is how many people would respond and even if they do so, would it be with serious thinking ? Because, just to go through her booklet itself, it took some three hours to the investigator ! Responding to such long questionnaires is almost like a consultancy work, which attracts normally some sort of honorarium; but if it is voluntary, either there will be poor response or the responses will be without much reliability and validity; because after all, completing the questionnaire for the sake of completing or leaving some items without responding or showing uncertainty to many items - are all symptoms of lack of co-operation and interest in 'research and development' activities. In this connection, researchers in Education as well as in other social sciences may have to give a serious thought to an observation made by, Buch and Govinda (1988)²⁸: "A major weakness of educational research in India is its over-dependence on the use of questionnaires and.....". Of course the position may not be better altogether in other countries too. Research and development in natural sciences need not always depend on opinions, but social sciences, because of their very nature and structure, often require opinions too; having fully convinced about Buch and Govinda's important view in this regard, the present investigation, did not depend too much on questionnaires, and depended more on in-depth content^{analysis} by the investigator himself; the responses from the short questionnaires were used in this investigation through one of its objectives, as corroborative evidences to the results of content analyses, for the other 7 objectives, in an attempt to establish some sort of external validity, for the whole study. In an ideal situation, opinions of actual users of a product to be evaluated are very important, in any evaluative study; because, after all it is the students and the teachers who are the real

clientele in the use of these textbooks as one of the major tools in teaching-learning process.

Collection of opinions from experts was also found to be not a very easy task; because they are all very busy people in their own field; however, it was possible to establish some sort of professional rapport with them to get their purely voluntary but academically and professionally supportive help; hence the investigator could somehow collect a lot of information in the form of opinions from them based on their responses for an opinionnaire followed by a few semi-structured interviews with them. Though this process took quite a few months, methodologically, it was found to be worth doing in an investigation of evaluation of the textbooks at Snr. Sec. level; but one cannot think of over-dependence on them, too. As discussed earlier in this chapter (pp.485-488) though many of their views were, by and large, in agreement with the results of other parts of the study, i.e., the opinions of students, teachers and the finding by the investigator in connection with other Objectives, there were some issues raised or elaborated upon by them, which sounded somewhat different.

It is hoped that the various issues raised and discussed in this chapter and all the findings of this investigation^{as} shown in Ch.V would give a detailed picture of an evaluation of the present physics textbooks for Snr. Sec. schools; and it is also humbly hoped that the content of these two chapters in this report would be useful in the process of revision of the textbooks. The next chapter, will contain summary, findings and conclusions, possibly with certain suggestions in connection with the scope for further study in the field.

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