AN INVESTIGATION OF THE CONTENT OF SOME OF THE PHYSICS TEXTBOOKS USED IN THE SECONDARY SCHOOL

中等學校物理教科書內容之研究

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Introduction

Science was introduced to the school curriculum at the start of the academy in 1751, in the United States; even in China which is late for science development, there is a record of more than 80 years of teaching science in schools. In the late years, the rapid growth of science has emphasized science education in schools, especially in the field of physics. Does the science education develop to some extent which meets contemporary demands? The question has been posed by every one who is it charge of science education, and many of them thought that there have been few changes within the science program, in recent years, unlike most of the other subjects of the high school course of study. From the viewpoint of textbook writing, the foregoing is probably true, as for many decades, science educators have been much aware of the error of the classic arrangement of physics in textbook, but they have done little in rewriting a textbook on the modern physics basis. Up to the last year, a newly arranged textbook was written but has not been widely utilized in secondary schools yet.

The textbook is one of the most important agents in our educational system, the frustration of the rapid development of science might exist for this reason. Maybe, an insight that the teacher can have an influence which extends far beyond the printed pages; however, in all too many cases today, we find science being taught by those who are not properly trained and who may be so overloaded with teaching duties that it is not possible for them to give the personal attention necessary to bring out latent interests in the students. Such situation places a great burden of responsibility upon the textbook. Especially, in that many science educators have pointed out that lab-experiment method of teaching science is a luxury in both time and money: although it does not cause a trend to alleviate the activities of laboratory work, the scientific conception is secure to be built by communication of teaching with textbooks.

In the long run, there are so many reasons which cause the importance of textbooks that it is impossible to list all of them, one by one. But the effectiveness of texts are confined themselves by other factors, for instance, many textbooks tend to include too many instructional subjects, many use too many illustrations, and some are lack of recommendation of modern physics concepts, and which ones are adequate, the investigation of this paper is dedicated to give some information.

Because of the inclusion of two different languages in the selected textbooks one of the most important analyse, the computing of the reading difficulty, is omitted. The invertigation is to compare the texts on the basis of the number of applications of 29 theorems, and to count the number of different laws and theorems, in the field of modern physics, the number of problems and the illustrations.

Review of Related Research

One of the barriers to rapid development of science education was the textbooks. Most educators recognized the seriousness of this problem, but did not attempt to solve the problems. The lack of proper textbook added an increased responsibility on the teacher. References showed that this responsibility was beyond the capacities of many science teachers.

In 1959, David S. Sarner and Jack R. Frymier (11) concluded that there seemed to be a definite need for some sort of uniform minimal code of requirements for certification of science teachers throughout the United States. There was a trend to remedy the inadequacies which existed in various state certification laws for teachers of courses related to science. Furthermore, they concluded, the improvement could be carried out by teacher education institutions, and they expected the various colleges and universities to insist upon higher than the minimal requirements in academic preparation. Drawing inference from this statement, the problems caused by textbook could be solved only after the improvement of teacher's education which, under the trend of universal progress, could never be satisfactory. The evidence was that many kinds of experiments were undertaken on higher education level to try to get a more perfect education in the future.

Edward Victor (13) said that both groups of teacher, those converted or drafted as science teacher, indicated that much help would be needed. In his paper, he designated that the necessary help was related to the provision of teaching experiences and sources units.

After consulting an investigation which was made by Milton O. Pella (10), the reason was apparent because the average high school science teacher of physics had a background of 13.5 semester credits in physics. Could they be competent in their teaching job? Did they need to resort to teaching materials like textbooks? Because of the background of the teachers, the teaching of high school physics was, for the most part, confined to the textbook, and the textbook organization.

Scope and sequence of the subject matter has been the problem of every science textbook writer. Perfection has not been attained for many reasons, especially the individual differences of students, and the continual curriculum reorganization in schools. Richard F. Bruns, and Alexander Frazier (3) stated that there appeared to be no well defined pattern of scope and sequence for science topics that could be identified as basic to the elementary curriculum of any significant number of the school systems included in their survey. In short, there was no typical clear-cut pattern.

Laterly, in September 1960, Charles H. Heimler (5) made a survey of science teaching in small central schools which showed that there were considerable difference among schools on regard to the quality of the science programs.

Besides the problems pointed out in the lower school, it was also true on the higher level of education as Paul Westmeyer's investigation (14) claimed. The re-examination of methods and contents which was admittedly necessary at the secondary school level was not inappropriate at the college level. Hence the elementary school and the college both felt no confidence in scope and sequence arrangement of the secondary school curriculum.

The same conclusions were derived concerning the pupils' individual background. Doris Young (16) in her survey about atomic energy concepts of children, indicated that at least one-fourth of the eight and nine year olds surveyed were ready to pursue further study, but at the same time, many misconceptions existed among both age groups. The great diversity of individual difference among them was obvious. The author avoided reporting on the three-fourths who were not ready to pursue further study.

Owing to the fact that class grouping might ignore pupils' background and the inadequate scope and sequence of the science courses, the textbooks could rarely meet the needs necessary to develop science education.

All that was stated in the foregoing paragraphs, no evidence was to delete the validity of textbook. On the contrary, because of their necessity, people have paid attention to them by making a series of survey.

As early as in 1957, two groups of investigators were engaged in solving the reading problem of textbooks for science. The first group was combined of Kenneth B. Crooks, and Charles H. Smith (4), and the other, George Greisen Mallinson, Harold E. Sturm, and Lois M. Mallinson (9). They all were aware of the difficulty in reading by learners and claimed authors of science texebooks should not become so engrossed with the presentation of subject matter that they forget the learners who were to read their books. Their investigations might promote the quality of recent textbooks to a certain extent.

The question "Are heavy textbooks necessary?" posed by Francis St. Laurence (7) has become an alarm to authors and forced them to make efforts to eliminate the confused, and exceeded verbal symbols. Meanwhile, in part of the teacher, he was suggested by Roma Lenore Herrington, and George Greisen Mallinson (6) to use the evaluation determined by a read-ability formula in combination with his own judgement as to content, organization and interest level in the selection of reading materials for classroom use.

The efforts offered by these outstanding authors were evidently not useless and what happened to us, was a wide series of innovation in textbook writing.

The foregone selection of reading materials for classroom use should be a teacher's intelligence. The wise selection could develop the usefulness of science textbooks. As stated by Billy G. Aldridge, and Kenneth D. Anderson (1) that word usage and social studies reading were high contributors to natural sciences reading ability, teachers had better correlate themselves in the selection of textbooks to help learners read.

Furthermore, the mathematical processes needed in learing high-school physics was not advanced, and then the misunderstanding of the level of mathematics in physics textbooks by pupils could be overcome. The conclusion of Bryce J. Lockwood (8) stated that an extensive use of addition, substraction, multiplication, division, ratio, exponential notation, trigonometric functions, algebra, graphical vectors, chemical equations, table reading and logarithms was made in textbooks and students successfully completing the the first cource in algebra had no valid reason for avoiding physics because of the level of difficulty of mathematics content of this course, since the processes considered to be advanced mathematical processes at the high-school level were not found in the textbooks surveyed.

On the long run, the barriers to science development caused by textbooks were investigated by concerned educators. It might be permissible to say that some of them were hard to remove, but some of them have being controled and improved toward better conditions.

If teachers' selection of the textbooks would best be undertaken and carried out by first operationally defining what student behaviors were desired as a result of this type of a general education course, as Robert T. Blackburn (2) pointed out, the state that the majority of high school pupils avoided in taking physics courses (12) as their elective might be changed and the future scene in cultivating physics experts would be bright.

The textbooks with excellent, significant and clever illustrations would supply a wealth of facts, ideas and attitudes, but good textbooks should contain only appropriate illustrations and teaching aids. In this report, the investigator, consulting Harold E. Wise's comparison method (15), has proposed to compare some of the textbooks currently used in order to offer teachers a reference in selecting useful textbooks.

Research Methods

The investigation was dedicated to compare five secondary high school textbooks in physics, two in Chinese and three in English. The comparison pretained to the depth of explanation, the number of illustrations, and that of problems in every textbook. To facilitate the discrimination, these textbooks were listed from A to B.

In comparing the depth of explanation, every textbook was divided into two parts in terms of its content. The first part was classic physics and the second part, modern physics. In part of classic physics, 29 theorems covered the majority of the body of textbook were selected. They were eight in mechanics, five in heat, six in optics and ten in electricity and magnetism. The interpretation of each theorem in every textbook was carefully analysed, and its key idea and its diverse ways of application were listed in a work table to count their frequencies of appearance. Dealing with the modern physics part, because of its relatively small number of items appeared in the textbooks, instead of selecting some representative theorems to treat with, all of the theorems and laws in modern physics were listed and counted by use of another work table. Both the frequencies in classic part and that of the items in modern part were summed up, at last, and their total sum in every textbook were considered as the frequencies of an index of the usefulness of these textbooks.

Because of the explanatory functions of the illustrations and the problems, an important role was played by the illustrations and the problems in the textbooks. Therefore, their numbers should be compared, and they were reported in the third work table where the sum was calculated.

To assure that no application or illustration was dropped in listing them on the work tables, the tables were checked item by item, by use of the index and guide to terms of every textbook. And also, the possibility of the overlapping, as to count the ways of applications of every theorem, was minimized by consulting the teachers' hard book of textbooks.

These foregoing work tables were treated as row data which were arranged, computed, and tabulated in two tables, and one graph.

Results

In general, both the classic and modern physics were explained by every physics textbook, however, a great difference in the depth of the content appeared among these five texts. The significance of the difference, expressed by the number of applications of the theorems, and the number of items, was illustrated by Table 1 which showed the sum of the applications and items in five sections, mechanics, heat, optics, electricity, and modern physics, and facilitated to realize the depth of the scope adapted by diverse texts.

Every textbook has had a great number of problems, and illustrations, and their numbers had available differences. Table 2, put the number of illustrations and problems in contrast to the number of applications and items, illustrated both the subsum and sum of each item.

Table 1. The Number of Applications and Items for the Explanation of Every Textbook

Number of applications items	Text A	Text B	Text C	Text D	Text E
Mechanics (8 theorems)	19	14	15	15	24
Heat (5 theorems)	12	4	13	17	9
Optics (6 theorems)	26	11	18	22	34
Electricity (10 theorems)	18	14	11	11	19
Modern physics	9	4	23	18	39
Total	84	47	80	83	125

Remarks:

A—Shen, Yu-kuan, and Chang, Nee-yuon, ***High School Physics***, Fifth Edition, Fu Shan Book Company, Taipei Taiwan, 1959.

B—Tzu, Sze-hen, ***The Essential Physics***, Shan Ven Tsei Book Company, Tainan Taiwan, 1958.

C—Blackwood, Oswald H. Herron, William B., and Kelly, William C., ***High School Physics***, Ginn and Company, Boston, 1958.

D—Dull, Charles E., Metcalfe, H. Clark, and Brooks, William O., ***Modern Physics***, Henry Holt and Company, N. Y., 1958.

E—Physical Science Study Committee, ***Physics***, Recording and Statistical Corp., 1958.

Table 2. The Sum of the Applications and Items with the Sum of the Illustrations and Problems

Text-books	Number of applications in classic part	Number of items in modern physics	Total	Number of illustrations	Number of problems	Total
A	75	9	84	615	672	1287
B	43	4	47	64	320	384
C	57	23	80	696	579	1275
D	65	18	83	849	577	1423
E	85	39	125	613	708	1321

Obviously, there was some relationship between these two foregoing kinds of data, Figure I was plotted to show it. By use of Sepearman rank order formula, the coefficient of correlation was computed as 0.7 which proved the figure deemed appropriate.

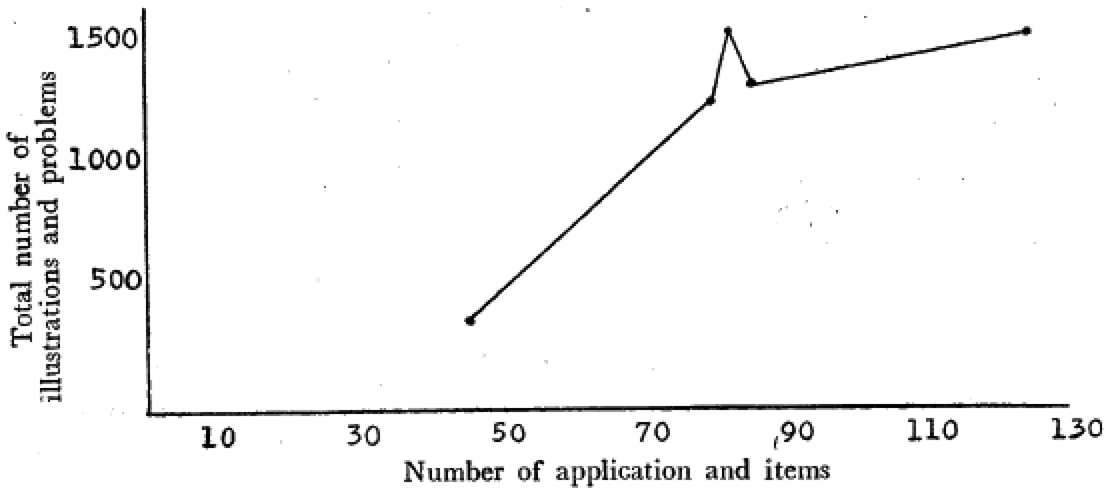

Figure 1. The Relationship Between the Explanation and the Figures Shown in the Five Textbooks

Conclusions

The results of this investigation showed the following conclusions:

1. The textbook E has taken two semester years to complete the study in high school, and then, from the Table 1, it had a number of applications and items 29% more than the mean of the other textbooks. This increase was not proportional to the extention of the time; since the same Table showed that all the frequencies of the textbook E, especially in the row of modern physics, increased greatly except for heat which is not closely related to modern physics showed a decrease in the number, therefore, the conclusion that the textbook E was written under the emphasis of explaining modern physics could be ascertained.

2. There seemed to be a trend to decrease the number of problems in the textbook E, as the Table 2 showed that it increased a great deal in the depth of the content, and the numbres of problem remained to a slight augmentation.

3. From Table 2, the textbook B had the least content compared to other textbooks; it could not meet the level at which a high school student should attain.

4. By the examination of the Table 2, the two Chinese textbooks had an average percentage of 9.5 of modern physics items in the content, and the three American textbooks had an average percentage of 27.3. The American textbooks have been made much more efforts to correct the error of the classic arrangement.

5. In contrast to the conclusion expressed in the last paragraph, the Chinese textbooks have kept the classic arrangement in writing.

6. There seemed to be a trend that every textbook had a number of illustrations and problems proportional to the depth of explanation, as showed the Figure 1, although the exception existed in the textbook D. By use of the Spearman's ranking order coefficient of correlation between these two data, it was computed as 0.7. The conclusion of the relationship could be generalized, if the sample of the population grew up to a cortain extent.

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