A COMPARATIVE STUDY OF SCIENCE TEACHING AT THE HIGH SCHOOL LEVEL, INCLUDING SOME POSSIBLE WAYS AND REASONS FOR IMPROVING IT

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This paper is dedicated to those parents, students, and teachers, the true friends of our public schools, whose interest, devotion, and effort, have created the greatest system of free education in the world. Gratefully acknowledging the patient counseling of Drs. James H. Zant and Imy V. Holt.

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CHAPTER I

INTRODUCTION

There is nothing more important about education than its future. Parents, school boards, teachers, and society are becoming more and more concerned about the future of education. They realize the school has an ever increasing duty to perform, and that our nation is threatened with disaster if the school should fail to do its job well. Many vital needs of man cannot be realized except through the extensive and rigorous application of good teaching. No agency but the schools can provide the systematic discipline and intellectual training required to be successful in our competitive modern society. It is the schools responsibility to provide equal opportunities for all youth, regardless of intelligence level, socioeconomic status, race, nationality, or creed; to meet their needs, solve their problems, and extend their interests in such a way as to promote their fullest personal development as respectable citizens.

The science that has been taught in the past will not suffice for the modern schools of today or for tomorrow. Many people have shown an unyielding interest in keeping up with science, and they demand that their children be prepared for understanding a scientific world. It is interesting to note, that, educationally speaking, people are lethargic in accepting improvements, or changes in the ways of doing things. Progress is painful, generally. However, this is not true with the recent interest in science. It would be more accurate to say that people are adamant in demanding an awareness of what is going on in the teaching of science, and particularly at the high school level.

"There is much reason to believe that a carefully planned arrangement comprising the best elements of a functional approach will make science one of the most useful segments in providing the tools and equipment for life adjustment."[1] Therefore, the teaching of science in today's schools must take on a new perspective of providing adequately for the knowledge, skills, and attitudes which should be incorporated in the basic fundamentals considered as essential to all youth, including possible reorganization of the traditional science courses which are so well known and defended.

This investigation is concerned with discovering whether students who had taken courses in biology, chemistry, and physics at the high school level were more or less successful as judged by grades attained during the first semester of similar courses in college than students who had not taken these courses. The merits of high school biology were analyzed at Phillips University, Enid, Oklahoma; while similar studies of chemistry and physics were made at Fordham University, New York City, New York.

The objective of this report is to make an analysis of the teaching of scientific subjects at secondary level, including some possible ways and reasons for improvement.

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[1] Douglass, R. J. Teaching Science for Life Adjustment (New York, 1950), p. 135.

CHAPTER II

FACTORS INDICATING THE NEED OF ANALYZING CERTAIN SCIENTIFIC SUBJECTS IN HIGH SCHOOLS

Many teachers in various fields tend to omit a very important aspect of their experiences. This is the consideration of the symptoms of their problem. How do they come to the realization that a real problem exists? It is too easy to assume that "everybody knows we should have an analysis of our educational system", or "if they did not know they had a problem they would not be reading or asking advice on how to solve their problems". The discovery of an illness in time for treatment is made by observing characteristic symptoms. A medical doctor, upon learning of a superficial complaint of a patient, will take certain steps to find out the condition of the vital organs and processes. Then, he will relate the results of this investigation to his knowledge of diseases and their symptoms. This information and procedure will lead him to a diagnosis and treatment. The results may be good or bad. The functioning of our educational system must be observed in the same manner. Its operation must be observed, the complaints of the people involved must be heard, and many questions should be asked. Then, with these symptoms in mind, diagnosis can be made and treatment can be prescribed.

There are certain indications that our educational system is sick, that a diagnosis of its basic weaknesses should be made and the necessary treatment prescribed.

The idea has been suggested that students who have had high school biology, chemistry, and physics make no better grades in college than those who have not had previous instruction in these subjects.[1] If this is true, our high school science departments are wasting a great amount of time.

Some of the reasons given for this supposed fact are: Pupils having had high school biology take it in college for a "snap" course. They have the idea that college biology will be a repetition of their high school work, and thus will require little effort or time on their part. These students will become more or less bored with the similarity of the two courses. It has been implied that the high school teaching may not be on as high a level as it should be. It has further been stated that it is not the purpose of high school biology to prepare pupils for college biology. Some interesting studies have been made on the relationship between high school and college science. A few of these will be discussed before going into the findings of this study.

Professor George E. Nichols[2] at Yale University makes the following statement:

> For students who plan to take further work in either botany or zoology, an introductory course in general biology is especially disadvantageous. It is primarily essential that such students, at the outset, should lay a firm foundation of fact upon which to base subsequent studies. It is disadvantageous that the introductory course should encroach upon the work of more advanced courses for when the student begins these more advanced courses he loses the advantage of entering entirely novel fields.

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[1] H. H. VanCleave, "The Influence of High School Science Courses Upon Grades of University Freshman in Zoology", School Science and Mathematics 18:483-491, (1918).

[2] George E. Nichols, "The General Biology Course and the Teaching of Elementary Botany and Zoology in American Colleges and Universities," Science, 50:509-517 (1919).

These statements show the attitude of some college professors concerning the value of a high school course in general biology.

Ralph E. Horton[3] of the Steward Park High School, New York City, states:

> High school sciences are not set up so as to form a sequence with college courses, and at the present time this leads to dissatisfaction among college teachers with their students preparation and the lack of definite aim on the part of the high school teacher. If high school science courses are to be preparatory and a prerequisite to college courses this aim will make a very great difference with both content and method. The fact now is that science subjects given in high school and offered for college entrance are not satisfactorily related to the first college courses.

Mr. Horton quotes L. W. Koos[4] as follows:

> Although there are some differences between high school and first college courses in Chemistry, they are remarkably alike. If a student takes a course in general inorganic chemistry in college after having a high school course he is repeating almost all of it.

Archer W. Hurd[5] made a study of physics and reports as follows:

> While high school and college physics bear upon the same general field, the treatment is so different that what is gained from a study of one does not help greatly in a study of the other.

H. J. Van Cleave[6] made a valuable study of the influence of high school biology courses upon the grades of university freshmen in zoology. Van Cleave did not consider the ability of his subjects but made a comparison of the grades made in college zoology by each of the two groups; those having had high school biology and those not having had high school biology. In this comparison very little difference was observed in the final grades of freshmen in zoology who had previous training in biology and those who had not had biology. Taken alone this

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[3]Ralph E. Horton, "High School Science, A Foundation for Science Courses in College", Science Education 19:163-169 (1935).

[4]L. W. Koos, The Junior College (Minneapolis, Minnesota, 1924).

[5]Archer W. Hurd, "High School Physics Makes Small Contribution to College Physics" School Science and Mathematics 31:468-470.

[6]H.J. VanCleave, "The Influence of High School Biological Courses Upon Grades of University Freshmen in Zoology", School Science and Mathematics 18:483-491, (1918).

seems to substantiate the opinion frequently expressed by college and university professors, namely, that the study of or the omission of biology in high school has little or no influence upon the kind of work done by students in the same subject in college or university classes.

While the research material in this field is rather limited these comparisons should give a general idea regarding the consensus of opinion of educators in this field. The statements of these men indicate the general trend of criticism as it is related to the teaching of high school science. Furthermore, these opinions may easily be the symptoms preceeding important decisions regarding the future of our high school scientific curriculum.

CHAPTER III

A STUDY OF THE BENEFITS DERIVED FROM A HIGH SCHOOL BIOLOGY COURSE

The purpose of this study is to show the relationship of the grades made in the first course of college biology, between those students who have had high school biology and those who have not had high school biology.

The subjects for this study were the freshmen of Phillips University, Enid, Oklahoma, who took biology during the years of 1934, 1935, and 1936.

This study will attempt to solve the problem by comparing the average grade in college biology of the two groups mentioned previously, with the average psychological scores of the groups.

The psychological scores of the individuals used to make this study were scores which were made in the Psychological Examination for High School Seniors and College Freshmen by L. L. Thurstone and Thelma Gwinn Thurston[1] which all freshmen who enter Phillips University are required to take. This test was given to all three classes.

The participants in this analysis were divided into two groups; those having had high school biology, and those who had not had the course. The members were also divided into groups according to sex.

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[1] L. L. Thurstone, Psychological Examination for High School Graduates and College Freshmen. American Council Education 1933.

These groups were then matched by their psychological scores; their variations not being greater than five points. The group having had biology was composed of fifty one students, twenty men and thirty-one women. The group not having had high school biology was composed of fifty-five students, twenty-seven men and twenty-eight women.

By statistical methods the average, median, sigma quartile, sigma average, and sigma differences of these groups were compiled, including their grades and psychological scores.

When the results were summarized and the analysis completed it was found that over a period of three years the students having had high school biology received slightly higher marks than the students who had not taken biology. It was interesting to note that the difference in the women's average grade was 3.16 and in the median grade was 3.55. Both differences were in favor of those having had high school biology. The difference in the average psychological scores of the two groups was 2.92 in favor of those having had high school biology.

The conclusions which might be drawn from the facts brought out in this study indicated that the average final grades of freshmen in college biology are favorably affected by experiencing previous training in high school biology. According to these facts there are fifty-seven chances out of one hundred that men, having had high school biology, will make better grades in college biology; while women have nearly ninety-two chances out of one hundred. However, the men having had high school biology were far below in the psychological median. This shows further advantages for the group having had high school biology.

It was found that students with relatively high psychological scores could make high marks regardless of their previous training.

The results indicate that the lack of greater influence upon students who had previous training in biology was due to the lack of correlation between the standards of high school and college courses in biology.

Table I

Frequency Distribution for Psychological Scores

Psychological Score	Distribution of Psy. Scores made by students who had no biology	Distribution of Psy. Scores who had biology
30-39	1	
40-49	1	
50-59	0	
60-69	0	
70-79	2	3
80 89	2	
90-99	1	3
100-109	1	1
110 119	3	6
120-129	4	5
130-139	5	2
140-149	1	7
150-159	7	3
160-169	4	5
170-179	4	3
180-189	6	4
190-199	3	2
200-209	2	1
210-219	3	2
220-229	2	1
230-239	2	
240-249	1	
250-259	0	
260-269	0	2
270-279	0	
280-289	0	
290-299	0	1
	55	51

CHAPTER IV

A STUDY OF THE BENEFITS DERIVED FROM A HIGH SCHOOL CHEMISTRY COURSE

This investigation was concerned with discovering whether students who had taken courses in chemistry and physics at the high school level were more or less successful as judged by grades attained in the first semester of the college chemistry course than students who had not taken these courses. The subjects participating in this study were eight hundred students enrolled in the first course in chemistry in two colleges and three universities located within the metropolitan area of New York. Group I was composed of four hundred students who had a course in chemistry at the high school level, while group II consisted of four hundred students who had not had such a course.[1] The students in these groups were equated on the basis of the raw "Q" and "T" scores attained on the American Council on Education Psychological Examination. In addition, the subjects were matched on the basis of sex and the college or university attended. The two, one hundred twenty-six member subgroups (III and IV) were chosen from the members of group I on the basis of their having had or not having had a course in high school physics. In a similar manner, two, ninety-eight member subgroups (V and VI) were chosen from among those in group II. The members of these

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[1]John J. Carlin, "Do Courses in Chemistry and Physics at the High School Level Contribute to Success in Beginning College Chemistry?" <u>Journal of Chemical Education</u> 34:25-26 (January, 1957).

subgroups were matched on the basis of the "Q" test scores and also on the basis of sex and the college or university attended. Table 1 shows the relationship between the various groupings.

TABLE 1[2]

Group I (400) (No high school chemistry)		Group II (400) (High school chemistry)	
Group III (126) (No high school chemistry or physics)	Group IV (126) (No high school chemistry but high school physics)	Group V (98) (High school chemistry but no high school physics)	Group VI (98) (High school chemistry and high school physics)

The grades attained by the participating subjects were converted to quality points. This step was employed to obtain uniformity among the grades recorded from the college permanent records.

The statistical measures employed to determine the results of this investigation were the following: the mean score; the standard deviation of the mean; the standard error of the mean; the standard error of the difference between two uncorrelated means; the difference between the means; and the critical ratio. The five and the one per cent levels of significance were chosen as criteria.

The critical ratio is a statistical measure used to determine whether a real difference exists between two comparable groups. It is obtained by giving the difference between the means of the groups by the standard error of the difference between the means. The standard error of the difference between two means is obtained by extracting the square root of the sum of the squares of the standard errors of the

[2]John J. Carlin, "Do Courses in Chemistry and Physics at High School Level Contribute to Success in Beginning College Chemistry?" Journal of Chemical Education 34:25-26, (January, 1957)

means. The standard error of the mean is obtained by dividing the standard deviation from the mean by the square root of the number of subjects.

A critical ratio of 2.58 would indicate that the probability is ninety-nine to one that no real difference exists between the two groups. A critical ratio of 1.96 would indicate that the probability is ninety-five to five that no real difference exists. Critical ratios higher than 2.58 and 1.96 indicate significant differences at the one and five per cent levels, respectively. As the critical ratio increases, the difference becomes more significant. The critical ratios obtained by comparing the achievements in college chemistry between matched groups in this study are arranged in Table 2.

The critical ratio between group I and group II was 7.84. This critical ratio was very significant with the difference in favor of group II. The high significant difference between the two groups was an indication that high school chemistry was a contributing factor to success in the first semester of the first course in college chemistry.

The grades of the members of group III were then compared with the grades of the members of group IV, and the critical ratio was 1.62 in favor of group IV. Although group IV exceeded group III, the difference was not considered significant at either the one or the five per cent levels. This signified that a course in chemistry may not be a contributing factor to success in the first semester of college chemistry.

The grades of the members of group V were then compared with the grades attained by the members of group VI, and the critical ratio between the two groups was 2.55, which was significant in favor of group VI. This revealed that students who had high school chemistry

TABLE 2[3]

Critical Ratios of Grade Performance in College Chemistry by Groups of Varying High School Preparation

	Mean	Standard error of difference	Critical ratio
Group II	2.22	0.074	$\frac{0.58}{0.074} = 7.84$
Group I	1.64		
Differential	0.58		
Group IV	1.79	0.135	$\frac{0.22}{0.135} = 1.62$
Group III	1.57		
Differential	0.22		
Group VI	2.38	0.141	$\frac{0.36}{0.141} = 2.55$
Group V	2.02		
Differential	0.36		
Group VI	2.38	0.132	$\frac{0.81}{0.132} = 6.136$
Group III	1.57		
Differential	0.81		
Group VI	2.38	0.143	$\frac{0.59}{0.143} = 4.126$
Group IV	1.79		
Differential	0.59		
Group V	2.02	0.136	$\frac{0.45}{0.136} = 3.309$
Group III	1.57		
Differential	0.45		
Group V	2.02	0.143	$\frac{0.23}{0.143} = 1.608$
Group IV	1.79		
Differential	0.23		

[3] John J. Carlin, "Do Courses in Chemistry and Physics at High School Level Contribute to Success in Beginning College Chemistry?" *Journal of Chemical Education* 34:25-26 (January, 1957).

and high school physics attained slightly higher grades in the first semester of the first course in college chemistry than students who had a course in high school chemistry but not in high school physics.

Group III was then compared with group VI with respect to grades attained, and the critical ratio was found to be 6.136, which was very significant in favor of group VI. The attainment of group IV was then compared with the attainment of group VI and the critical ratio was 4.126, which was significant in favor of group VI. The difference between group VI and group IV was not as significant, however, as the difference between group VI and group III, which offered evidence that high school physics is a contributing factor to high grades in college chemistry.

A comparison was also made of the attainment of group III with the attainment of group V, and the critical ratio was 3.309, which was significant in favor of group V.

The critical ratio between group III and group VI was 6.136, which was 85.43 per cent higher than the critical ratio of 3.309 between group III and group V. The subjects of group VI had a course in physics at the high school level; the subjects of group V did not. This, again, indicated that a course in physics at the high school level contributes to success in college chemistry.

Finally a comparison of attainments of group IV and group V was made, and the critical ratio was 1.608, which was not significant. This gave evidence that there was no real difference between group IV and group V with respect to grades attained in the first semester of college chemistry, and furnished additional evidence that a course in high school physics in a contributing factor to success in college chemistry.

The results of this investigation justify the following conclusions:

(1) A course in chemistry at the high school level is an asset to high school students who intend to continue the study of chemistry in college.

(2) A course in high school physics without any high school chemistry contributes little to success in college chemistry.

(3) A course in physics and a course in chemistry at the high school level contribute more to success in the first semester of college chemistry than a course in chemistry alone.

(4) Both high school chemistry and high school physics contribute more to success in the college chemistry course than a course in either of these high school subjects alone.

CHAPTER V

SOME OF THE WEAKNESSES OF OUR PRESENT EDUCATIONAL SYSTEM

In considering ways to improve our schools, we must recognize the fact that no institution is so hallowed by age or tradition that it should be exempt from periodic examination, and appraisal, in terms of whether it accomplishes the goals for which it was established, and whether it is adjusting itself to the realities of a rapidly changing world.

One weakness may easily be the lack of special attention for students of superior mentality. The time has come for higher standards in our schools. A comparison of our schools with those of England, Germany, and Russia might reveal some startling weaknesses. We need not indiscriminantly copy schools of other countries; neither should we succumb to the happiness of ignorance. In studying their ways of educating the young we may find valuable ideas. To these ideas we could add the experience of the few American secondary schools that have already established accelerated courses for talented students. Thus, classes could be arranged, open to all students on the basis of entrance examinations, and proceed alongside our present high school courses. This program would demonstrate what could be accomplished by competent teachers, a proper curriculum, an adequate school year, with interested as well as talented youth for students. They would set goals and living examples of what could be done for education in it's time of need.

This reasoning may not be sound in light of the fact that out of one hundred pupils entering the first grade, only thirteen graduate from college. Furthermore, one-half of the capable students are lost in this manner and one-third of this group is highly talented.[1]

Dr. Robert MacVicar made the following statement to a group of teachers, "Textbooks are behind the times, because of the rapidity of new discoveries in scientific fields. We have a horse and buggy curriculum in a jet propelled age".[2]

Due to their crucial importance to the school program, and because they give tangible evidence of what is taking place in our classrooms, instructional materials have always attracted the attention of citizens interested in education. Rare, is the parent, for instance, who has not at some time looked at a childs textbooks. Many other citizens, not parents, are deeply concerned with the classroom tools being used to instruct tomorrows citizens. It is natural, since this is so, that a major share of the criticism directed against the school should focus upon instructional materials.

To ignore, or try to avoid criticism would be as unwise as it would be impossible. The critical interest of American citizens in their democratic institutions is the best insurance ever devised for the survival of these institutions. The need is for wider knowledge and understanding of the schools, and their problems so that criticism will be informed as well as constructive.

Mistakenly, the public believes the war produced many scientific advances. Actually, there was no time for research. Teams of the best

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[1] J.S. Hume, "The Challenge of Educational Change", Oklahoma Times, Oklahoma City, Oklahoma, February 8, 1957.

[2] Robert MacVicar, "Education and the Future", Oklahoma City Times, Oklahoma City, Oklahoma, February 8, 1957.

scientific minds attacked only the most pressing problems, and these dealt solely with warfare. To do this they drew upon the fund of existing knowledge. Very little, if anything, was contributed to basic science. The atom bomb, radar, the proximity fuse, and all the rest were mere applications of laws and principles known before the war. What is the 1957 situation? At precisely the time when we need scientifically trained men and women most, the supply is woefully small. At the moment when we need citizens who appreciate what science can do for human warfare, we lack the teachers for the task. Our institutions are overflowing with students. About all our schools have to offer them is inadequately prepared teachers, poor equipment, low teachers salaries, and a dearth of laboratory experience. These factors all conspire to restrict still further the flow of essential personnel, thus thousands of science talented youth will not receive proper instruction.

There were only two hundred forty-nine qualified to teach physics graduated from our colleges in 1956. Only one-half of these will reach the classroom if past experience is a good indication. The other half will be diverted to other occupations by more attractive employment opportunities, drafted for military service, or for other reasons will not be teaching. One hundred twenty physics teachers are clearly far too few to supply the needs of the twenty-five thousand high schools in America.

The widening gap between supply and demand is only in part due to the decline in size of the graduating classes since the peak of 1950. During the past five years the total number of graduates has declined thirty-nine per cent, but the number prepared to teach physics (high school) has dropped seventy-four per cent. These figures when related with the fact that colleges are enrolling more students every fall, even to the point of overflowing, must surely indicate that students are taking other courses.

Although the pinch is most severe in physics, a similar situation prevails throughout science and mathematics; the supply of high school teachers has declined more rapidly than the total number of college graduates.

High school principals, faced with a small supply of science and mathematics teachers, use teachers inadequately prepared, or they may drop courses that their students want and need. Either course will mean fewer students in the years ahead will enter college with a developing interest in science and mathematics.

The shortage cannot help but affect unfavorably the rate of production of future scientists, and the quality of their training, because many students develop their interest in scientific careers at the high school level.

The shortage of science teachers poses serious consequences for technological progress in the United States. All branches of science will be affected, therefore, science as a whole has an important stake in the improvement in teaching at the high school level.

During recent decades the high school has changed from an educational institution chiefly designed to train a few students for college admission to one designed to give terminal training to large numbers of students who are not going to college.

Attempts have been made to remedy weaknesses in our schools by adding new courses. It is possible that the new courses were needed, but it is probable that an increased insistence on higher scholastic standards is the real need.

How well satisfied are high school students with the curriculums of their schools? High school students show a surprising lack of desire to pursue new curriculums and methods of work that call for the use of initiative, originality, and the ability to plan their work. They, too, have found security in the daily routine assignments from textbooks, and in a testing program that places a premium on the memorization of facts and information. Even in extra curricular activity programs where students have an abundant opportunity to live in a truly democratic atmosphere all too frequently active participation is limited to a relatively small percentage of the student body.

Fortunately, there is a brighter side, for once high school students become accustomed to a more dynamic type of education, they readily assume responsibility for helping plan and carry out their own programs. Too bad they must wait until college to receive this experience.

Our accelerated educational programs suggest that teaching in general, and science in particular is being, and perhaps must be streamlined to keep pace with the material developments. Certainly improvements in teaching and teaching methods as well as skills must be made frequently in order that the capabilities of our youth be cultivated to their fullest. If our material progress is to continue, it is essential that our budding scientists be trained to a high degree in as short a period as possible. To do this properly we must take the time to establish clear cut understanding of relationships that still exists between causes and effects. It is not enough that we teach technical facts that explain how to perform certain intricate scientific procedures, important as such teaching may be. It is infinitely more essential that we teach the fundamental principles upon which our procedures are based and the scientific method of approach to the problems if our scientists, and other citizens are to learn the reasons that underlie these procedures. There is an old saying "The man who knows how will always have a job, but the man who knows why will always be his boss"[1], that suggests again the importance of fundamentals.

[1]P. L. Crummy, "Science Teaching for Tomorrow" <u>The Science Teacher</u> Vol. XII, p. 20, No. 3.

CHAPTER VI

METHODS OF IMPROVING OUR TEACHING AT THE HIGH SCHOOL LEVEL

Special skills are quickly learned if the fundamentals are thoroughly understood.

The great teachers of science are great not so much because of their profound knowledge of the subject matter as because of their ability to sustain interest in their subject, and their insistance upon a high quality of work. Perhaps the basic requirements in all sciences is accuracy. Accuracy is not a thing that can be secured without effort. It is the result of careful work. The teacher of science does well to insist that his, or her students be careful as well as accurate. If they can be taught the habit of accuracy they will have been trained for any eventuality of tomorrow, and will have learned to appreciate living today.

If our teaching is to be most significant, therefore, it must give a thorough training in the principles and methods of our field. The present school condition has demonstrated to us the importance of ideas. It is our job as teachers of science to train the citizenry in a great search after truth, and in a readiness to revise ideas that are found to be incorrect.

The scientific method is applicable to solving many of life's problems, not merely to those associated with the classroom. Essentially, it is a careful, analytical way of ascertaining real truths in any given situation, and it has attained widespread recognition as a worthwhile procedure in educational circles through out the world.

You don't have to be a "natural" to be an excellent teacher, but lots of effort is required under the most favorable conditions. We see, therefore, that good teachers are both born and made.

It is generally agreed that the development of proper study habits is essential for pupil success in the secondary school. Yet studies show that thousands of pupils literally have no conception whatever of study habits. How can this be true when our schools are making earnest and concerted efforts to improve the pupils? Freshmen handbooks include sets of study rules and suggestions. Group guidance courses may be required using as a textbook the guide for better study habits.

In many cases, a vigorous counseling program may be instituted in an effort to give individual guidance and personal supervision of the study habits to the pupils.

There is one result that will be noticeable to all who follow this procedure, and that is a distinct diminishing of student failures.

CHAPTER VII

CONCLUSION

The objective of this study was to determine the values of teaching high school courses in biology, chemistry, and physics, and to suggest methods of improving our school system.

From the results of the study it was found that the teaching of biology was beneficial to the majority of students. The only exceptions being the students with above average talents. A student of high intellect was found to do well in college courses regardless of his previous training in biology.

The investigation concerning high school courses of chemistry and physics resulted in the following conclusions:

(1) A course in chemistry at high school level is an asset to high school students who intend to continue the study of chemistry in college.

(2) A course of high school physics without any high school chemistry contributes little to the success in college chemistry.

(3) A course in physics and a course in chemistry at high school level contribute more to success in the first semester of college chemistry than a course of chemistry alone.

(4) Both high school chemistry, and physics contribute more to success in the college chemistry course than a course in either of these high school subjects alone.

It should be emphasized that the most effective means of teaching science in high school is through a continual change in structure and pattern of the subject matter, by being informed.

New and improved methods, and techniques will increase the value of high school science. Careful selection of methods and techniques is extremely important if full realization of the goals of secondary education are reached.

Better planning and counseling in high school will result in more successful college freshmen. Perhaps the most damaging advice given is to advise a student not to take a certain course in high school, because it can be taken in college. The substitution of minor subjects for basic courses may easily lead to frustration for the student when he goes to college.

Modern science teaching is deeply concerned with two things: (1) Training the student of today to accept responsibility, (2) developing scientific habits of thought. These basic goals support all teaching whether it is in a specific field of science or not.

The school has its own job to do, and the nation is threatened with disaster if the school fails to do that job well. Many vital needs of mean cannot be satisfied except through the extensive and rigorous application of intellectual means. No agency but the school can provide the systematic, disciplined, training required. That is, and has always been, the primary function of the school system.

A teacher who really knows his business, and who is willing to pay the price in devotion, toil, and fatigue will do a good job of teaching even under adverse conditions. It is very ambitious of us to strive for perfection, and to make it the goal of our hopes, and endeavors, but it will be tragic if we resign ourselves to doing nothing in the hope that perfection will be handed us on a "silver platter".

This is the time when teachers throughout the country should be increasing the public's understanding of the role that they play in today's progress.

As a good teacher, and a good citizen the reason for accomplishing the objective extends deeper than the psychological feeling of wanting to be recognized as a vital and integral part of scoeity. It extends deeper because the future of this country depends in a large measure on whether the public understands, or does not understand how the science teacher fits into the economy.

For one thing, a lack of understanding would lead to a deteriotion in our educational system. If parents can see little or no connection between mathematics and science courses, and the benefits they constantly receive in the form of newer and better products, they will soon force their boards of education to dilute or drop these "tough" courses. With mathematics and science playing a minor role to atheletics, and "life adjustment" courses; tomorrow's potential scientists will not have the inclination, or the opportunity to prepare for the profession. Should the supply of scientists diminish, it will slow down the progress of America.

The task ahead means constant effort. Accomplishment will mean an understanding in the mind of the public of the importance of the science teacher's profession. With the proper understanding, will come the proper recognition. Failure will mean a decline in the quality and quantity of future science teachers and a decrease in the level of learning and living.

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