An evaluation of the Louisville course of study in chemistry in relation to the educational and vocational interests of girls as discovered among pupils of the Louisville Public Schools from September, 1935 to February, 1937.

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An Evaluation of the Louisville Course of Study in Chemistry in Relation to the Educational and Vocational Interests of Girls as Discovered among Pupils of the Louisville Public Schools from September, 1935, to February, 1937.

A Dissertation
Submitted to the Faculty
Of the Graduate School of the University of Louisville
In Partial Fulfillment of the Requirements for the Degree
Of Master of Arts

Department of Education

By

Pauline Kollmann Stein

Year

1937
Pauline Kollmann Stein

An Evaluation of the Louisville Course of Study in Chemistry in Relation to the Educational and Vocational Interests of Girls as Discovered among Pupils of the Louisville Public Schools from September, 1935, to February, 1937.

Written under the direction of Dr. R. A. Kent, President of the University of Louisville.

Read and approved by

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_________________________________________ Reading

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_________________________________________ Representative of the Department of English

Date__________________
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CHAPTER 1

Introduction

The Problem and the Plan of the Study
Chapter 1

Introduction

The Problem and the Plan of the Study

"The motto of chemistry, as of all the empirical sciences, is savoir c'est pouvoir, to know in order to do. This is the pragmatic test of all useful knowledge." No motto could more nearly express the evolution of the author's philosophy of education as it has been developed through twenty years of experience in teaching chemistry to girls. Eventually, thoughtful teachers become inductive, centering their interest more and more in the reactions of their pupils and less in static requirements of academic curricula. Constantly they check the vitality of their subject matter with the honest responses of their students and the actual functioning of their learning in real life. It is this questioning attitude in the teaching profession that brings about revisions of standards and courses and demands dynamic curricula.

From 1930 to 1935 the author had the privilege of working on a curriculum committee appointed by the Superintendent of Schools of Louisville to formulate a new course of study in chemistry for the senior high

schools of Louisville. Regarding the work and purposes of this committee the Assistant Superintendent in charge of Secondary Education commented: "The first product is tentative.----The second draft of any course is modified as a result of experimentation with the first. It represents not only the work of the members of the committee but embodies the best thought of all classroom teachers plus the suggestions of the administrative staff.-----

While our chief object in this work is seriously to attempt to provide the teacher with subject matter, devices, and procedures which will aid in carrying out the objectives of high school education, we believe that an almost equal value of curriculum revision lies in the process of the making. Those who are helping are rekindling their intellectual life and in many instances gaining a viewpoint impossible to obtain in any other way. This purposeful thinking will have permanent value in future years because of renewed interests in the problems of education. This, with increased pride in our schools, will carry over to the lasting benefit of the youth who are already citizens of Louisville.----Only by testing and noting the outcomes over a period of years can the effects of a course of study be scientifically determined." This revised course of

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1. Binford, H. E., Foreword to the Course of Study in Chemistry.
study has been used by the author since the fall of 1935. Curiosity about the usefulness of subject matter and its application to the needs of individual lives is often baffled because valid data for scientific generalizations are frequently scattered and one must make tentative conclusions from impressions only. In this study the author has made an effort to accumulate exact data over a period of three semesters by which she can make a somewhat more scientific evaluation of the course of study in chemistry even though her conclusions may be limited and tentative.

The author has made no effort to evaluate courses of study in chemistry in other cities or rural districts. The present study is confined to a consideration of the suitability of the Louisville course to the vocational and educational interests of the students to whom it is offered. Since the suitability of a course depends to a great extent on the selectivity of the population to which it is to be given, the author has also attempted to show what factors obtaining in Louisville schools might affect such a population. To this end she has studied the intelligence of the students under observation by means of a study of their I.Q.'s and also of their socio-economic status as determined by the occupation of their parents---two factors which are considered by the National Survey of Secondary
Education to be highly important. Practically her only criterion for the determination of success of pupils in the present course is grades given by the teachers. It is generally conceded that many other factors, notably health and emotional maladjustment, also affect scholastic achievement as shown by grades but no attempt to make a study of these factors is being made in the present work.

The author hopes that the findings of this study may be of help to chemistry teachers and to curriculum advisors in its effort to test the value of the course of study in chemistry in terms of its actual application to the educational and vocational needs of the pupils, thereby calling attention to certain definite limitations which she hopes, in time, may be remedied.

Since one of the recognized methods of accumulating evidence of interests and usefulness is through individual statements, the questionnaire method has seemed to the author to be the best approach toward measuring the carry-over of the subject matter into life interests and needs. As is always true of the questionnaire method, its validity is dependent upon the honesty and accuracy of responses, and one can only hope that the average results are fairly scientific. One way of assuring scientific results through the questionnaire method is through spread and number;
therefore this study has made use of 303 opinions, representing all the girls who have studied chemistry in the three public high schools for girls in Louisville from September, 1935, to February, 1937.

With the permission of the Assistant Superintendent in charge of Secondary Education, Dr. W. T. Rowland, Jr., the author has had access to the files of the files of the Louisville Girls' High School, of the Atherton High School for Girls, and of the Shawnee High School for Girls for the tabulation of information concerning grades, ages, and I.Q.'s. As an introduction to the study an inquiry has been made into the history of teaching chemistry to the girls of Louisville from 1856 to 1937. This eighty years of evolution in the teaching of chemistry, beginning as a formal study of pure science and developing toward a laboratory course in applied science, forms an inspiring background for further investigation.
Chapter 2

A History of the Study of Chemistry in the Louisville Public High Schools for Girls
Chapter 2
A History of the Study of Chemistry in the Louisville Public High Schools for Girls

Since the Louisville Girls' High School was the first public high school for girls in Louisville, a history of the study of chemistry for girls in Louisville is to be found among the records and from the graduates of that school. Long before this school was founded, however, the teaching of various branches of science to girls was advocated. As early as 1792, according to Woody, one Erasmus Darwin published an article entitled "Plan of Female Education" in which that gentleman suggests

"---as in male education the tedious acquirement of ancient languages for the purposes of studying poetry and oratory is gradually giving way to the more useful cultivation of modern sciences, it may be of advantage to ladies of the rising generation to acquire an outline of similar knowledge." 1

The new idea was apparently fruitful. In 1798 Thomas Smith, in a lecture before the Chemical Society of Philadelphia said: "I shall now present you with the last and most pleasing revolution that has occurred in chemistry.

Hitherto we have beheld this science entirely in the hands of men; we are now about to behold women assert their just though too long neglected claims, of being participants in the pleasures arising from a knowledge of chemistry---." A survey of subjects offered by 162 Female Seminaries (1742-1871) showed that 112 offered chemistry. None of these was a public school. Other surveys of seminaries and academies showed that in 1749-1829 30% of 55 girls' schools studied offered chemistry 1749-1871 70% of 162 1830-1871 90% of 107 In fact, chemistry was well established in seminary courses after 1825, so well that Woody quotes the American Journal (about 1825) as saying: "---at the present time the mania for studying the higher branches is so great that it often happens that chemistry, philosophy, and logic are demanded before the pupil can properly parse or even spell her own mother tongue---" which quotation makes us ponder over present conditions! All this general interest in chemistry among the private academies would lead us to expect to find it in the curricula of the first public high school. This first public high school was established in Boston in 1821. Its course of study included science, "geography in the

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first year," etc., but chemistry is not mentioned. Not until five years later, in 1826, was chemistry put into the course of study. But this early recognition of chemistry as a useful science for girls occurred in Boston, the East. In the South, an appreciation of chemistry for girls was much slower. Woody, in a chapter headed "Education of Girls in the South to about 1800," outlines several curricula for girls in academies, but in none of them is chemistry mentioned.

When the Louisville Girls' High School - then the Louisville Female High School - first opened its doors in 1856, chemistry was included in the curriculum, although the faculty was composed of only three teachers and a principal. The records of the Board of Education are not complete, nor are they written in detail. No outline is given of any course of study but one can get an idea of the thoroughness of the curricula by the type of examinations demanded for final graduation from the school. These examinations were both written and oral according to the report of the board of trustees at the close of the school year 1859. This report states that the girls were "thoroughly examined by many competent examiners, their own instructors and reputable instructors of private and public schools. The examiners were requested to ask

1. Woody, *op. cit.*, pages 238-300
2. *ibid.*, Appendix.
questions freely and to adopt their own mode of asking them." The only particular mention of chemistry in this report was a request for a full time science teacher, the duties of the incumbent who divided his time between the male and female high schools, being too arduous for the time allowed him. The Louisville Times, in a history of the schools of Louisville published on the occasion of the centennial of the public schools of Louisville, relates: "That examinations were held the final test of scholarship in the period just before the war between the states, was evident in the report submitted in 1860 to the board of trustees by Geo. W. Morris, chairman of the committee on high schools-----In that year, the Male High School as well as the Female High School followed the same style of examination; first a written test which the pupil was required to complete 'without leaving the room, or consulting person, book or paper upon the subject,' second, an oral examination----. The oral examinations were conducted before the patrons of the school and the questions were put largely by the gentlemen of the audience." Records on file at present show that no chemistry was taught in 1864, nor is it again mentioned in the available curricula until 1877.

This gap in the records of the Board of Education must,

1. Annual Report of the Trustees of the University and the Public Schools to the General Council of the City of Louisville for the School Year Ending 1859.
2. The Louisville Times, April 24, 1929.
3. Annual Reports of the Board of Trustees, Louisville, Years 1860-1880.
of necessity, be bridged by personal interviews with older graduates of the Louisville Female High School. The author has interviewed two women who were graduated from the school during that period, one, Mrs. Mary Seymour Bliss of the class of 1863 and another, Mrs. Amelia Borntraeger von Borries of the class of 1867. Both Mrs. Bliss and Mrs. von Borries remember quite clearly their courses in chemistry. Both of them reported that the teacher lectured and did some few demonstration experiments while they sat decorously back and watched and listened. The course, they felt, was meagre and more or less superficial. Neither one had any memory of the time given to the course, i.e., number of hours per week or length of the classes. Their reports correspond somewhat with Woody's quotation from a catalog of the South Carolina Female Institute of that period. "In chemistry a course of experimental lectures is delivered by a professional gentleman, each of which is intended to illustrate the daily lesson given out and explained by the teacher. On account of the heat occasioned by performing the experiments, this branch will be pursued only during the winter term." This seems to have been the type of course in chemistry generally offered about that time. Graves, in speaking of these earlier courses in science, comments: "In all cases, however, instruction

was given through textbooks, and, while experiments were frequently used for demonstration by the teacher, there was no laboratory work for the student. Moreover, a tendency to overload the curriculum with sciences was much increased during the seventies by the demand of the legislatures in several states that candidates for teachers' certificates pass an examination in several sciences. The high schools endeavored to furnish the necessary training to prepare for these examinations, and until toward the end of the century the course in sciences were numerous and of rather superficial character. He continues: "Within the last twenty years, however, the schools have come to limit each student to a relatively few courses taught by thorough laboratory methods."

Because of the very meagre documentary evidence, an attempt was made to bridge the gap between 1867 and 1900 by sending questionnaires to fifty women who were graduated from the Girls' High School during that period. From the results of these questionnaires (there were 31 responses) the history of the period was chiefly compiled. In 1889, the first available date, chemistry was given for one semester only and was compulsory. Five periods a week were given to it. It was still a lecture course at that time but the necessity for individual laboratory work was

1. Graves, op. cit., pages 414, 415
apparently beginning to be felt because although the teacher actually did the experiments as demonstrations, the better pupils were allowed to assist her. In 1893 the same teacher must have sensed the interest and avidity with which girls do experiments. The time allowed by authorities was still five hours a week but she, personally, required the girls to remain after school one afternoon a week to do the experiments themselves. This is the first mention of any individual laboratory work done by the students. The graduates from whom this information was gathered were rather vague concerning the content of the course at that time. Both, however, remember that chemistry, a requirement for graduation, was given in the sophomore year and was included in those subjects in which examinations were required for college entrance. It is quite evident that not much was being done to bring to the notice of these girls the fact that chemistry and its problems were matters of every day life because one woman made the humorous comment that it was years before she realized that chemistry could have any connection whatever with her life outside the classroom. The annual report of the Louisville School Board of 1896 gives the first available data concerning the purposes and objectives of the course in chemistry for that period. Included in the report is a statement by Miss Kate Palmer, teacher of science: "To develop the ability to think and to judge by the pupils themselves is
constantly kept in view. Observation and experiment are the backbone upon which it all depends.

"The experimental work in chemistry is confined, at present, to the school hours. Such class work is not so valuable as laboratory practice, where the individual is thrown on her own resources, and both reason and judgment are called into action, but it serves to make the pupils realize the true nature of what the textbook states."

According to another report it seems that in 1898 chemistry was given to a freshman class for one hour a week, presumably with the hope of creating an early interest in science (perhaps an early ancestor of the modern exploratory courses). At any rate one particular little freshman of this class was so confused by the abstractions of the course that, instead of acquiring a life interest in the science, she developed a permanent aversion. The 1897 reports of the School Board substantiate this impression. Elementary chemistry was offered two periods weekly for five months during the first semester of the freshman year and was then discontinued until the second semester of the third year when an advanced course was offered. The number of hours a week for the advanced course was not reported.

1. Reports of the Louisville School Board. School Year ending June 30, 1896.
While chemistry was included in this kind of survey course for freshmen in 1898, it must also have been offered later as a full time subject in the senior year because graduates of 1891 through 1897 report a compulsory senior course taken five hours a week for two semesters.

It was apparently at this time that the first real laboratory for individual work was provided. In his annual report to the superintendent, Mr. W. H. Bartholomew (principal of the Girls' High School) wrote to Mr. E. H. Mark: "The chemistry laboratory also was bountifully provided for. The students of this department took on new interest and kept it up until the close of the year. The arrangements are such that the personal efforts of at least 40 pupils can be enlisted and directed by the instructor during the hours devoted to this branch of study. In previous years because of limited provision for teaching the subject, students were slow to choose it, but now I do not hesitate to say, because of ample facilities for teaching it, many will be induced to take it. Our grateful thanks are extended to the School Board for the abundant provisions which it has made for teaching the science subjects of our course of study." (June 26, 1897)
The most illuminating fact about these reports is that interest in chemistry developed in direct ratio to the pupils' opportunity for individual laboratory work. Although college entrance requirements were still being used as criteria for the subject matter and seemingly very little was being done to include industrial or applied aspects of the subject, in 1899 individual laboratory was becoming more and more the accepted procedure.

The annual report of the Louisville School Board of this year (1899) states the objectives of chemistry: "Our course is confined mainly to General Chemistry, with as much Qualitative Analysis as possible. The Atomic Theory and the Theory of Quantivalence are thoroughly taught.

"The Laboratory is used to call into action the observation and judgment of the pupils and to instill into them habits of accuracy and neatness. Order in arrangement and conciseness in expression are insisted upon in every step taken in the laboratory."

Between 1900 and 1906, as a direct result of the growing interest in individual laboratory work, an elective one semester course was offered which included the minimum number of lectures and centered around qualitative analysis.
The author is personally qualified to report much of the development in the teaching of chemistry to the girls in the Louisville public schools within the past twenty-five years since she, herself, has been connected with the chemistry department of the Louisville Girls' High School since 1910. Between 1908 and 1910 seven fifty minute periods a week were given to chemistry. These were divided into two double laboratory periods and three separate lecture periods. The subject was taught as a pure science with its ultimate goal still the passing of rigid college entrance examinations. At that time it was required of all girls for graduation so that there was no escaping difficult mathematical computations or the long tedious memorization of material forgotten as soon as college entrance examinations were passed. In 1911 the rigidity of the old high school requirements was somewhat relaxed, and a system of electives was introduced. Although the completion of a laboratory science was still a requirement for graduation, an attempt was made to offer some choice of these sciences. It was suggested that instead of one year of physics and one year of chemistry as graduation requirements, a choice might be made between the two, and a girl might select the whole two years of physics or the whole two years of chemistry. This plan was not at all popular with the students and was abandoned almost immediately so that in 1912 there
was a tendency to spread the interest in science to both physics and chemistry - one year of each. Girls were no longer required to take both courses, however. Since colleges and universities required the completion of only one laboratory science, girls might choose between chemistry and physics and pursue either subject for one year. The granting of this choice showed the greater popularity of chemistry among the girls because the enrollment in chemistry grew larger and larger while that of physics, to which girls seem to have an aversion because of the mathematics content, became so small that after a few years physics was dropped entirely from the curriculum of the girls' schools. It was realized that under these conditions, i.e., not preceding chemistry with physics, it would be necessary to include much of the physics course to make a well rounded chemistry course. For this enlarged course in chemistry, seven periods a week were found to be inadequate and the chemistry time was lengthened to ten periods per week, two consecutive periods daily being scheduled. In the mean time the instructors in chemistry were facing the ever growing national problem of a rapidly increasing and changing high school population which necessitated in 1923 the formation of the Atherton High School for Girls and in 1929 the Shawnee High School for Girls.

The great majority of girls were no longer preparing for college and it became evident that something would have to be done to adjust the chemistry course to the differentiated life interests of girls whose education would probably not go beyond the secondary school level. In 1920 a combination three term course, Chemistry-Physics, was added to the regular courses offered by the chemistry department. This course was a more simplified presentation of these subjects with special stress placed on the phases applicable to household interests and was particularly advised for those girls who were interested in home economics. Although this special correlation of chemistry to home economics is becoming a popular idea now (1937), the plan was apparently too advanced and modern in 1922; in any case, after only two classes had carried through the combination Chemistry-Physics course, it was abandoned temporarily because it was not popular among the student body. Another effort was made in 1922 to discover a more satisfactory adjustment of the subject matter of chemistry to the needs of those pupils not going to college and at the same time to provide a college preparatory course for the minority. Colleges and universities, especially in the East, were still requiring special subject matter too difficult and entirely useless to the majority of our students.
According to this plan the chemistry pupils were divided into two groups, the college and the non-college. In college groups the demands of the college entrance requirements were closely followed. With the non-college group an attempt was made to teach what Downing aptly calls "consumer chemistry" as contrasted with "producer chemistry." "Consumer science is not concerned with the whole field of any particular science but only with those few principles of it which are most often needed in solving the common problems of everyday life. It demands skill in the use of the deductive method of thinking by means of which known principles of science are applied to particular problems, and it requires a large amount of practice in such application to develop the requisite skill. The appropriate reactions to some of the most important of these problematic situations may well be first ingrained as habits and later shown to be logical deductions from important principles." This is in contrast to "producer science" in which a person wishes to do research work or become a specialist in his chosen field. Colleges and universities, Downing continues, have erred just as the high schools have in teaching the producer type almost entirely so that "---college students, taking science as a part of their general educational preparation for life, have been put

into the same classes with prospective research students and have been given surveys of science fields by research instructors, much if not all of the material of the course being far removed from life-needs. ——Then students trained in these institutions have gone out to teach in the secondary schools, and so the producer science, diluted considerably, has been doled out to high school students. Usually, if the secondary-school science teacher sticks to the job long enough, he begins to question whether a survey of the field of chemistry, physics, or biology, with the latest theories and technical details, is appropriate material for high-school pupils, and he gradually shifts, as best he can, to the more desirable consumer science." This shifting finally culminated in the elimination, in 1929, of college preparatory chemistry as such from the regular course of study and the time given to chemistry was cut from ten hours a week to seven hours a week, allowing only four periods to laboratory work. From that year any girl wishing to enter college was coached privately by the teacher (without pay!). The other students were given the more modern type of work. Various newer methods of teaching crept in. Individual differences, which had naturally been noticed for a long time, were

taken more and more into consideration. Besides the regular course in chemistry, a special course called Sanitary Chemistry was introduced about this time (1924). This was a one semester course with no laboratory work. It consisted primarily of the chemistry of home, health, and sanitation very simply given and was designed to meet the needs of those girls whose type of high school work left no time for a laboratory science but whose education needed rounding out with some knowledge of the chemical principles involved in understanding healthful living. Other girls who were more interested in understanding chemical principles and who had the time to pursue the subject farther were offered the usual advanced course consisting chiefly of qualitative analysis. This procedure follows the usual trend throughout the country during that time. The National Society for the Study of Education states that high schools rarely specify either chemistry or physics as required but that many schools require one and more often two terms of a laboratory science. Most college entrance requirements also include one or two units of a laboratory science without specifying which science. "Many large city high schools offer special chemistry courses in addition to the general introductory course. These other courses include, most often, some type of applied chemistry or qualitative
most useful for the life interests of her group of girls.

In 1932, not at the suggestion of the curriculum committee, the time for the course in chemistry was again cut, this time to five periods a week. The author believes and has reason to believe that all members of the committee agree with her that this time allotment is much too short. It is the present course of study in chemistry, the work of the committee, which the author attempts to evaluate in relation to the educational and vocational interests of girls.

This brief history has partially indicated the trend of high school chemistry from the old academic curricula, dictated by the college, to the modern curricula, indicated by the vocational needs and broader life interests of girls. Eighty years represents a long and significant period of experimentation in teaching science to girls. Louisville is justly proud of the fact that five years before the civil war her schools were in the forefront of those recognizing the importance of a broad and through education for women. This heritage of vital criteria, accumulated over eight decades of testing and changing in terms of a varying and increasing high school population, forms an invaluable background for deliberative consideration of what the school is doing at present toward adjusting its chemistry curricula to the needs of modern girls.
Chapter 3

Chapter 3


Intelligence quotients and chronological ages of students enrolled in certain courses of study are always of particular interest to one who is attempting to evaluate these courses. Unless most of the pupils enrolled in a course can get enough out of it to make a passing grade it seems fairly obvious that the course is not suited to the abilities and interests of the students enrolled in that course. It seems necessary, therefore, to assemble some exact data on the scholastic success of girls enrolled in the chemistry courses offered by the three girls' high schools from September, 1935, to February, 1937, as a partial means of evaluating the course of study in relation to the educational interests of the pupils. In this study scholastic achievement is determined by teachers' grades and individual ability by the intelligence quotients as recorded in the school files.

Although teachers' grades are generally accepted as the formal criteria of success in school and although, at present, no adequate substitutes for measurement of scholastic standing is established, much has been said against
the validity of teachers' opinions of pupils' success as shown by grades. Koos and Kefauver recognize the danger of the unavoidable human element involved in grades: "Marks on scholarship should be based upon achievement alone.---it is practically impossible to interpret a mark without knowing the standards of the teacher giving the mark." Regarding chemistry grades in particular, Kelly comments: "Work which satisfies a teacher of chemistry in one accredited school would be considered far from satisfactory by another teacher of chemistry in another accredited school. In high schools there is enough difference between the standards of schools as a whole, that, measured by the achievement of the school groups in later school work, a mark of 70 in one school means more than a mark of 81 in another school having the same passing standard by points."

"School marks have been the symbol of success and failure to generations of pupils who have struggled with the problems and tasks of the class room, and to their parents who, indifferent at times to most phases of education, seldom have neglected the report card.---Marks originated as purported

2. Kelly, Frederick James, Teachers Marks, Their Variability and Standardization, page 2.
3. Ibid., page 122.
measures of scholastic achievement. However, evidence has accumulated during recent years to establish definitely that a mark in any given subject is often a composite of many factors, the least of which may be achievement in the subject matter of the course. All of which would seem to indicate that it might not be desirable, even if possible, to exclude the human element in teachers' grades; in fact, Otis thinks: "There is no reason—why teachers' marks should not be taken into consideration--; and indeed it is very desirable to do so whenever possible, since the judgment of a competent teacher as to the ability of a child will always add something of value to the information that is obtained about him from the tests alone. There are various personal traits that cannot be measured by tests, which, nevertheless, affect the child's ability to succeed in school."  

In spite of the problematical aspect of teachers' grades as a measure of scholastic success, the author has attempted in this study to check those recorded grades against the intelligence quotients of the students enrolled. This seems to be an accepted procedure for at least a tentative evaluation of the difficulty or adaptability of a course of study even though just what the intelligence test measures is likewise a controversial subject. Freeman's

definition is broad: "Intelligence is not a thing or a force which men have, but a certain level of functional excellence which they display when they are actually put into a wide variety of stimulus situations." Concerning the validity of intelligence tests, Koos and Kefauver observe: "The term 'intelligence test' has clothed this type of measure with something of the mysterious and has caused the uninitiated to credit it with powers of measurement it does not possess. The test represents only a sampling of the learnings or behavior reactions of normal children, facility in which correlates significantly with judgments of teachers and other evidences of brightness." Griffith believes that the intelligence is a purely statistical matter and is in no way an objective description of any inherent power.

The files of the three girls' high schools in most cases record only one I.Q. for each girl. It would seem that this might not do justice to the individual but Baldwin and Stecher quote Terman as concluding from reexaminations that in general the superior children of the first test are found superior in the second, the average remain average, and the inferior remain inferior, and nearly always in approximately the same degree. They remark that: "Inspection

of the variations in each child's I.Q. shows that the original I.Q. is only approximately constant upon successive examinations. While many of these changes are well within the five point limit of safety, a sufficient number show deviations of such magnitude that extreme care should be exercised about making any dogmatic statement in regard to what a child's future status will be. For example, Girl No. 9—whose I.Q. in the first test was 111, obtained on four subsequent tests 116, 139, and 138. A careful study of this case showed no difference in the method of examination and no unusual physical condition aside from the adolescent physiological acceleration.

"No doubt, these fluctuations in general mental achievement were modified more or less by such factors as time of day, health conditions at the time of the examinations, fatigue, interest of the child in a particular examination, and changes in the home and school environment. Similarly conditioned changes in attitude on the part of the examiner might also have their effect." Since, however, the degree of changes in successive examinations for groups is relatively small, and a pooled classification tends to destroy any individual fluctuations, it is believed that the use of the recorded I.Q.'s reflects fairly the intelligence of the groups in this study.

1. Baldwin and Stecher, op. cit., pages 55-36
It has long been observed that the I.Q. is only partially prognostic. Intelligence tests have never measured that elusive quality of personality called push or drive or determination; in fact; these tests do not discover qualities of personality at all. Psychologists agree that mental energy and good study habits have as much effect on scholastic achievement as native intelligence. Thus far no test has been formulated for detecting intellectual honesty, a quality of mind which is the very life of science. Probable learning rate is perhaps a better term than intelligence quotient. Griffith says: "Among the factors that have been analyzed out of the total complex which makes up actual success in school work we may mention (1) the amount of previous preparation (2) the intelligence of the learner (3) the character of his study habits (4) his ability to evaluate as opposed to the mere learning of such material without evaluating it, and (5) his degree of perseverance or of motivation.----The relation between the various factors mentioned above are such as to show that good study habits are about as influential as intelligence, but not quite so influential as the last two factors, vix., good judgment and motivation." Since it is generally accepted that the intelligence test does

not measure so many qualities that make for achievement, one should not trust its prognostic value too freely. Surprising variations do occur among cases in which the qualities of character are definitely stronger or weaker than pure intelligence. All other things being equal, however, one can expect a child with a high I.Q. to do better than a child with a low I.Q.

The intelligence quotients used in this study are results of the Otis Self-Administering Tests used officially in the high schools of Louisville.

The data which have been collected have been organized according to Terman's classification of the I.Q. The range of teachers' grades for each of Terman's groups together with the median grade of each group has been worked out as well as the chronological age range for each group and the median of these ages. It was also found of importance for purposes of comparison to learn the general age range for each group and the median of these ages. It was also found of importance for purposes of comparison to learn the general age range and general I.Q. range for all pupils who were studying chemistry during the three semesters under observation. The actual numbers of pupils and percentages of failures were also obtained and listed for all groups under observation.

TABLE 1

Records for 303 Girls Enrolled in Chemistry in the Three Girls' High Schools from September, 1935, to February, 1936

I.Q.'s, Chronological Ages, and Teachers' Grades

<table>
<thead>
<tr>
<th>Group</th>
<th>I.Q. Range</th>
<th>Classification</th>
<th>Median I.Q. of Group</th>
<th>Range of Teachers' Grades</th>
<th>Median Grade of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Above 140</td>
<td>&quot;Near&quot; genius or genius</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>120-140</td>
<td>Very superior intelligence</td>
<td>125</td>
<td>79-98</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>110-120</td>
<td>Superior intelligence</td>
<td>114</td>
<td>75-97</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>90-110</td>
<td>Normal, or average intelligence</td>
<td>104</td>
<td>60-95</td>
<td>84</td>
</tr>
<tr>
<td>5</td>
<td>80-90</td>
<td>Dullness, rarely classifiable</td>
<td>86</td>
<td>60-92</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>70-80</td>
<td>Border-line deficiency, sometimes classifiable</td>
<td>79</td>
<td>75-79</td>
<td>76</td>
</tr>
<tr>
<td>7</td>
<td>Below 70</td>
<td>Definite feeble-mindedness</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Read Table 1 - Group 1 - Among the 303 girls enrolled in the chemistry course, none had an I.Q. above 140 which Terman classifies as "near" genius or genius. Group 2 - of the 303 girls, 31 had I.Q.'s ranging from 120 to 140 which Terman classifies as very superior intelligence. The median I.Q. of this group was 125. Teachers' grades for the group ranged from 79 to 98 with a median grade of 93. The chronological ages of the group ranged from 15 to 18 with a median age of 16. Of this group of 31 girls, who represent approximately 10% of the total number of girls enrolled, all, 100%, passed. Group 3 - of the 303 girls 86 had I.Q.'s ranging from 110-120 etc.
<table>
<thead>
<tr>
<th>Range of Chronological Ages</th>
<th>Median Age of Group</th>
<th>Number of Cases</th>
<th>Percent of Passing Cases</th>
<th>Number Passing</th>
<th>Percent Passing</th>
<th>Number Failing</th>
<th>Percent Failing</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15-18</td>
<td>16</td>
<td>31</td>
<td>10%</td>
<td>31</td>
<td>100%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16-18</td>
<td>17</td>
<td>85</td>
<td>28%</td>
<td>85</td>
<td>100%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16-18</td>
<td>17</td>
<td>171</td>
<td>56%</td>
<td>166</td>
<td>97.0%</td>
<td>5</td>
<td>2.9%</td>
</tr>
<tr>
<td>16-19</td>
<td>17</td>
<td>14</td>
<td>4.6%</td>
<td>8</td>
<td>57.2%</td>
<td>6</td>
<td>42.8%</td>
</tr>
<tr>
<td>17-18</td>
<td>17.5</td>
<td>2</td>
<td>.6%</td>
<td>2</td>
<td>100%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
TABLE 2

Highest, Lowest, and Median I.Q.'s, Chronological Ages, and Teachers' Grades

<table>
<thead>
<tr>
<th></th>
<th>Highest</th>
<th>Lowest</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q.</td>
<td>133</td>
<td>79</td>
<td>109</td>
</tr>
<tr>
<td>Age</td>
<td>18</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Grade</td>
<td>98</td>
<td>60</td>
<td>86</td>
</tr>
</tbody>
</table>

Read Table 2 - The highest I.Q. recorded for the 302 girls enrolled in Chemistry was 133, the lowest was 79, and the median I.Q. was 109. Chronological ages of these 302 girls ranged from 16 to 18 years with a median of 17 years. The teachers' grades in chemistry for the 302 girls ranged from 98 which was the highest grade to 60, the lowest. The median grade was 86.

A close study of Table 1 brings out many interesting points. Among the students studied none had an I.Q. which would indicate genius (above 140) nor was any in the group classed as feeble-minded (below 70). Ninety-four per cent were found to be in groups classified as normal or above. These findings do not seem surprising in view of the fact that the studies made by the National Survey of Education report that the median I.Q. for high school students is "somewhere between 105 and 110" and if pupils in the trade schools are included with those in high schools, the median I.Q. is approximately 100. Even including the six per cent

who are classed among the dull and border line, the median I.Q. of the students under observation is 109. A median I.Q. of 109 appears to be high even on the 105-110 scale but since chemistry is offered in the eleventh and twelfth grades and since the Survey studies have indicated that the I.Q.'s "of each next higher grade are slightly but definitely higher than those of the preceding class or grade," it is not unusual. This higher I.Q., according to the explanation offered in the Survey report, is believed to be due to selection and to the elimination of those with lower intelligence quotients. The explanation is borne out by the results of the present study since there are only sixteen cases or 5.2% of the pupils included in the study that fall below Dr. Terman's classification of normal. The pupils under observation, then, constitute a representative cross section of the higher grades of the secondary school population of the United States.

The lowest median age (16) was found to be in the group classed as very superior (I.Q. 120-140) as was to be expected. The explanation seems simple. Most school work is planned for the normal child so a child of very superior intelligence would naturally progress much more rapidly.

---

A child who progresses normally along the school route would reach the eleventh grade at the age of seventeen which is the median age of the pupils in this study for all groups.

Teachers' grades seem consistent with the intelligence of the pupils since the rise in the median grades of the groups is in direct ratio to the rise of the I.Q.'s of the groups. The data concerning teachers' grades are in line with the conclusions of the general research on the problem, i.e.: In general the younger pupils with higher I.Q.'s received the higher grades while the older pupils with lower I.Q.'s received the lower grades from teachers. In this study, however, there are some interesting digressions from the above generalizations. The lowest grade in chemistry during the period studied is 60, the lowest I.Q. is 79; but neither of the two pupils with a 79 I.Q. made the 60 grade, it was made by a pupil with an I.Q. of 101. One pupil with the I.Q. of 79 made a grade of 79 while the other 79 I.Q. made a grade of 73. The findings regarding the higher I.Q. group showed interesting digressions. The pupil with the highest I.Q. (133) did not make the highest grade (98); she made 88. The highest grade (98) was made by a pupil with an I.Q. of 120. The two students who had I.Q.'s of 131 made grades of 92 and 95. The failures were not found among the lower I.Q.'s but among
Concerning the grades of the pupils with higher I.Q.'s, Powers says: "It is indeed likely that it (intelligence) is not so large a factor in successful attainment of marks as it should be----. Pupils of mental ability approximating that of the median are about as likely to score well on the achievement tests as are the pupils of superior mental ability. This suggests that class progress is set to the median ability and that superior pupils are not stimulated to use their talent." Powers further points out the necessity for adapting instruction to the individual differences of pupils and for setting higher standards for those of larger ability. He states that "in general, pupils who make higher scores on the intelligence tests are able to make most rapid progress in school work," and that "when such a condition prevails as the one just described, it implies that we are failing with our most capable pupils." Koos and Kefauver in commenting on factors causing failure observe: "A second form of failure of equal importance, but not generally so recognized, is in cases where students of high intelligence do low grade work. Regrettably, there are many such students. This failure of students to achieve on a level

comparable with their ability is a form of failure even though the marking system may not so label it."

Case studies of the two pupils with I.Q.'s of 131 indicates no handicaps in environment which might account for their apparent lack of maximum effort; therefore it would seem that the above observation of Powers and of Koos and Kefauver might apply here and that the chemistry course might have lacked the necessary stimulus for these superior I.Q.'s. In a third case study (I.Q. 133 - grade 88) the following conditions prevail: The girl was majoring in English and foreign languages, minoring in social studies and art. She was influenced in taking chemistry because she "needed the credit for college entrance" and says she is only slightly interested. A contributing cause for her little better than average rating in chemistry is probably a lack of general interest in science. Her educational interests are not along scientific lines since her whole program of studies is planned in another direction. Chemistry is apparently a means of fulfilling college requirements. In a chapter on the "Psychology of Science Teaching" the National Society for the Study of Education quotes Anita Laton: "Learning is more efficiently done when interest becomes inherent in the material to be learned."

1. Koos and Kefauver, op. cit., page 465
A further study of the case shows that the girl was underprivileged economically which misfortune might partially account for her lack of interest and effort. Another significant fact listed in her questionnaire was that her father belonged to the group of unemployed. Such conditions were probably referred to by Koos and Kefauver when they observed: "Social and emotional maladjustments sometimes disturb the student's program, developing feelings of inferiority, and generally lowering his efficiency." ¹

Failures in the dull group mounted to 42.8%. Since 42.8% constitutes only six cases and since the data at hand show nothing unusual in any of the six cases, it was concluded that these results were to be expected.

The case studies revealed very little concerning the 2.9% of the normal group who failed. For the 2.9% of failures representing the five pupils in the normal range, the available data are inadequate for any sort of scientific conclusion. An underprivileged economic status might be a partial explanation for the failure of one of them since the person who supported her was listed as unemployed. For the other four the information is too indefinite for scientific use. Since the percentage of failure is so small it seems reasonable to conclude that the cause of failure must be attributed to the pupil or to the teacher but not to the course of study.

¹ Koos and Kefauver, op. cit., page 472
A more interesting case study than failure is the study of the success of the two students with low I.Q.'s (79). In one case the data offer nothing concerning environment or character to account for scholastic success beyond that expected from a lower intelligence. Even though the author has no proof, the results (I.Q. 79, grade 72) would seem to indicate that there must have been something in character such as tenacity or something in home environment such as the motivation offered by a parent to account for scholastic success beyond the ability of an almost border line intelligence. The results in this case bear out in an interesting way the opinions expressed in the introduction to this chapter: that there are many qualities which make for success in school life which cannot be measured by any intelligence test as now set up; that at best the intelligence tests are merely very general prognostic devices and that scholastic success as measured by teachers' grades is frequently as good a prognosis for success in after life as I.Q. rating. The other case study shows that the pupil with the lower I.Q. (79) and the grade of 79 was strongly motivated by a definite vocational interest; she had set her heart on becoming a nurse and realized that a thorough knowledge of chemistry was an invaluable prerequisite for becoming a good nurse. Her
educational interests were also in line with science as indicated by her majors and minors, English and science, home economics and accounting. Although the questionnaire revealed that she lived in a poorer neighborhood and that her father was a laborer, her chronological age (18) would seem to show that both she and her family were ambitious for her to acquire vocational training and to become economically independent. These factors even when found in the family of a laborer frequently make for strong drive and determination and count tremendously toward success in school and in after life. Again we have indications of powerful characteristics beyond the measurements of intelligence tests.

The study of the relation of the I.Q. to success in chemistry has indicated that the pupils who were included in the study are a slightly more selected group than the general school population. American secondary education has grown with such startling rapidity during the last two decades, both in numbers of pupils enrolled and popularization among persons in all walks of life, that degrees of selection of the pupils enrolled in any particular course are of the utmost importance in forming or evaluating that course. So much of the value of the course depends on its fitness or suitability to the pupils to whom it is offered that it seems expedient to make a study of as
many factors as possible which might affect the selectivity of groups. Many educators have come to the conclusion that three selective factors seem operative in high schools. These are intelligence, socio-economic status, and ethnic origin. The degree of selectivity for the group of girls under observation has already been ascertained. Griffith says: "whether it adheres to the doctrine or not, every social group is made up of layers or levels of persons who fall naturally into classes. These classes are an inevitable product of the way in which most societies are organized.---It is a plain matter of fact, however, that in most social groups a difference in class means a difference in cultural, economic, or social level.----So far as a single person is concerned, he is surrounded by an environment which may have some effect upon his psychological quality." The study of the socio-economic status of the pupils under observation is now being undertaken to determine the degree of selection from another viewpoint. The author has collected no data on ethnic origin.

Perhaps the best and most widely know studies of the question of socio-economic status are those of Counts.

These studies were made to determine the degree of democratization in the secondary school. By democratization is meant "the extent to which children of different socio-economic and intellectual levels attend the secondary school." In his first study, made in 1920, Counts concluded that the secondary school was still a highly selective institution and that its pupils were a highly selected group. Such occupations as the professional, managerial, etc., were still represented in decidedly greater proportion than groups like personal service, labor, etc. The second study, made in 1930, disclosed striking increases in the proportionate representation in the high schools of all occupational levels in the total population. The socio-economic status, then, would probably have as much, if not more, influence on the vocational interests of students as perhaps any other factor. It is Griffith's opinion that the ---"socio-economic status is a condition which tends to perpetuate itself. That is, children who are brought up in unfavorable environments will be prevented, by the very nature of their training, from getting out of the low occupation class." ¹ High intelligence with a high socio-economic status frequently indicates the selection by pupils of a college entrance curriculum in the secondary school. High intelligence

¹. Griffiths, op. cit., page 213.
with a low socio-economic status would most probably eliminate the possibility of college training and make desirable vocationalized and other non-college preparatory curricula which would lead to an earlier financial return. A combination of low intelligence and a low socio-economic status would mean a more democratized curriculum while a low intelligence with a high socio-economic status requires a still greater degree of democratization. The National Survey of Secondary Education reports finding a high relation between intelligence and socio-economic status. Griffiths came to the same conclusion. In speaking of the army intelligence tests given during the war, he comments:

"---there was a general indication that the average intelligence score gained from men in different occupations rose evenly from those occupations which demand the simplest and roughest type of unskilled labor through the ranks of skilled labor, the trades, clerical workers, and the professions." Certainly the intelligence spread (79-133) discovered in the pupils who are under observation in this study pointed toward democratization. It is now of interest to discover whether the socio-economic status of these same pupils shows a like trend.

2. Griffiths, op. cit., page 204.
According to the National Survey of Secondary Education, one of the most commonly used indexes of the socio-economic status of pupils is the occupation or means of livelihood of the father. "It has been found by various investigators to be perhaps the most valuable single item of information in determining the socio-economic level of an individual." Counts believes that: "Occupation is the central fact in the lives of the great masses of people. It is the interest that occupies the time and energy of the ordinary person for the major part of his waking hours. In large measure it determines the place of his residence, his associates during the working day, and his more intimate acquaintances and friends of the leisure moments. If pursued for years, it will set its mark on his physical nature and will stamp his mind with its special pattern. It will determine what he does, what he thinks, and his outlook on life." Classification of occupational groups because of the number and variety of occupations is a difficult process. The classification used in this study follows as closely as possible that used by the National Survey of Secondary Education which, they say, more nearly resembles Counts's than any other. The occupations have been

separated into five groups: professional, semi-professional, skilled, semiskilled, and unskilled. These are, of course, rough groupings. The scale follows.

A Socio-Economic Scale

1. The Professional Group
   1. Large owners and proprietors.
   2. The professions.
   3. Executives.

2. The Semiprofessional Group
   4. Middle owners and proprietors.
   5. Semiprofessional workers.
   6. Managerial workers.

3. The Skilled Group
   7. Skilled small owners.
   8. Supervisory workers.
  10. Clerical workers.
  13. Printing trades.
  14. Transportation and communication workers.

4. The Semiskilled Group
   15. Manufacturing, mechanical, and production workers.
   16. Transportation and communication workers.
   17. Semiskilled owners and proprietors.
   18. Small agents and managers.
   19. Public service.
   20. Personal service.

5. The Unskilled Group

6. Occupation Unknown
   22. Unknown and unclassified.

In the study made in 1932 by the National Survey of Secondary Education it was discovered that the academic and scientific curricula have larger proportions than

1. National Survey of Secondary Education, Monograph No. 4, op. cit., pages 40, 41
the other curricula from the upper levels, and the household and industrial arts have larger proportions from the lower economic levels than the other curricula.

**TABLE 3**

The Socio-Economic Status of 303 Girls Under Observation in This Study

<table>
<thead>
<tr>
<th>Professional</th>
<th>Semiprof.</th>
<th>Skilled</th>
<th>Semiskilled</th>
<th>Unskilled</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>15</td>
<td>4.9</td>
<td>18</td>
<td>5.9</td>
<td>13</td>
<td>4.4</td>
</tr>
</tbody>
</table>

The data concerning the pupils who were studying chemistry from September, 1935, to February, 1937, present an interesting lack of agreement with the data reported by the National Survey. The greater number of these students come from the lower levels, 44% from the skilled group, 41% from the semi-skilled group, and 1.9% from the unskilled group. Only 4.9% are daughters of professional men while 5.9% are drawn from the semiprofessional group. The total percentage for the upper levels, 10.8%, is far overshadowed by the percentage for the lower levels, 87.9%. The 1.6% belonging to the group whose occupation was classified as unknown includes those who were listed as unemployed. Under ordinary circumstances it is very probable that unemployed persons would not belong to the professional group.
The divergence between local distribution and the national distribution described in the National Survey may be due to the nature of the curricula offered in the Louisville schools. In these schools there is no differentiation made between scientific, industrial arts, commercial, academic curricula, etc.; the work here is done entirely on the major-minor system and chemistry is an elective course open to all pupils who are prepared to enter the junior year of the senior high school. In many cases girls whose whole curriculum is made up of commercial subjects take chemistry as an elective and it is frequently the only academic subject pursued other than those prescribed by the graduation requirements of the schools. Whatever the cause, it seems evident that the results obtained from the study of the socio-economic status of the pupils show that a greater degree of democratization has been brought about by this factor than was suggested by the I.Q. It would also seem that the more intelligent of the group, in efforts made either by themselves, their parents, their teachers, or their guidance counselors, are making a very definite effort to better themselves either educationally (planning to enter college) or vocationally (taking up nursing, technician, etc.).
One may conclude, then, that so far as I.Q. and socio-economic status are concerned, the fact that most of these girls make passing grades suggests that the course in chemistry is at least not too difficult in content, perhaps not difficult enough in consideration of the fact that girls with higher I.Q.'s are not stimulated to their best efforts. From an educational standpoint the course may be said, to some extent, to fail. When, however, girls with higher I.Q.'s do not work up to their limits and pupils of very low I.Q.'s make fairly high passing grades, it is quite possible that the fault lies partially with the administrative necessity of providing for the ever-increasing number of the average and inferior who have crowded into the high schools during the last two decades. It would seem that the whole system of secondary school education tends, perforce, to democratize itself, to adjust its curriculum and to direct its teaching efforts to the masses of more or less underprivileged pupils, underprivileged both mentally and socially, thereby leaving the superior pupil frequently unprovided with sufficient stimulus for her ability. This condition has had a slow and inevitable development as a result of
the enormous enrollment in high schools and one of the most difficult problems of secondary school education is to amplify curricula and provide sufficient time and teaching energy for a more complete development of individual differences, particularly as manifested among the minority - the superior pupils.
CHAPTER 4

An Analysis of the Responses of 303 Girls to a Questionnaire Concerning the Study of Chemistry
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An Analysis of the Responses of 303 Girls to a Questionnaire Concerning the Study of Chemistry

The questionnaire method used in this study was the outgrowth of prolonged curiosity on the part of the curriculum committee to discover the real interests and needs of girls in the study of chemistry. During the various meetings of this committee, vital questions constantly arose which seemed superficially simple for an instructor to answer but in reality were questions of considerable depth and importance and could be answered by the pupils alone. Even though the author is fully aware of the temporary and inaccurate aspects of responses from adolescents it seems fairly apparent that an approach through student opinion is the only scientific method of finding out the actual life applications of the chemistry course and of adjusting it according to these findings. After setting up guards against the usual slips in the questionnaire method, which guards will be explained in detail later, 303 students of chemistry in the girls' high schools of Louisville from September, 1925, to February, 1927, were asked to fill out a carefully developed questionnaire reporting such information as would give definite help to the committee in determining criteria for improving the vocational and educational value of chemistry to the
girls of Louisville. These girls were asked to analyze to the best of their ability the major contributing causes toward their selection of chemistry, their degree of interest in the subject matter of the course at present, their approval or disapproval of the method of presentation, and their actual intentions regarding the use of their learning in life situations. As stated above, the author recognizes that the validity of this method of investigation is dependent upon whatever degree of honesty and accuracy can be inspired in the pupils who are answering the questionnaire, upon the spread and number of questionnaires administered, and upon the personality and ability of the persons administering the questionnaire. The author feels that careful guards have been set up against these three possibilities of errors and that for reasons stated below the dangers involved have been reduced to a minimum. Since the problem of inspiring honesty and an interest in the scientific accuracy of responses from pupils is largely the result of the personality of the teacher administering the questionnaire, it seems of considerable significance to the author to state that she knows personally all of the teachers who administered these questionnaires for her and that they used the questionnaire as a logical outcome.
of a course which they had just finished teaching, therefore, whatever interest in scientific honesty and accuracy each teacher inspired in her group was not the outcome of the advice of an hour but the product of her own indirect methods in creating a scientific attitude in her pupils. Moreover, every teacher of chemistry in the girls' high schools of Louisville administered the questionnaire to all of her pupils. By way of assurance each teacher saw to it that all the pupils understood that their answers to these questions could have no possible bearing on their scholastic standing and that their real opinions might be of service to those responsible for the chemistry curricula and indirectly to those taking chemistry in the future. In the author's opinion, this group of teachers represents a rather highly selected group as to personality and ability and therefore she feels that a better than average honesty and accuracy is shown in the responses to the questionnaire. As to spread and number, the author has stated above that all girls who were enrolled in chemistry in the public high schools in Louisville during the period from September, 1926, to February, 1937, answered the questionnaire. A copy of the questionnaire follows:
QUESTIONNAIRE FOR CHEMISTRY STUDENTS

Name-----------------------------Age (count your nearest birthday) ---
English Unit-------Chemistry Unit-----

a. What are your present majors? 1.----------2.--------

b. What are your present minors? 1.----------2.--------

c. Who or what influence you to select chemistry as an elective?

-----------------------------

d. Do you find chemistry (1)---very interesting?
   (2)---interesting?
   (3)---slightly interesting?
   (4)---uninteresting?
   (5)---very uninteresting?
   (6)---boring?

e. Give a brief reason for your answer to d.

-----------------------------

f. Check the topics in which you are most interested with o.
   Check the topics in which you are least interested with x.

1. --Metric system.
2. --Kinds of Matter.
3. --Molecules and Atoms.
4. --Effect of Heat and Pressure on Gases.
5. --Gases.
6. --Analysis and Synthesis.
7. --Formulas and Equations.
8. --Structure of the Atom.
9. --Metals.
10. --Non-Metals.
11. --Acids, Bases, Salts.
12. --Ionic Theory.
13. --Electrolysis and Electroplating.
14. --Our Environment-Natural and Artificial.
15. --Chemistry in Industry
16. --Chemistry in the Home.
17. --Radium and Radioactivity.
18. --Qualitative Analysis (Chem. 2)
19. --Qualitative Analysis (Chem. 3)
20. --Quantitative Analysis (Chem. 2)

g. Do you prefer to do individual laboratory work or to
   watch the teacher do the experiments? (Underscore your
   preference)
h. Give a brief reason for your answer to g.

i. What impressions of your course in chemistry stand out most vividly?
1. __________________________________________________________
2. __________________________________________________________

j. Describe any everyday use you have been able to make of your knowledge of chemistry.

k. Do you intend to make use of your chemistry after you leave high school for:
(1) --Eastern college entrance? (13) Name of college ______
(2) --Other colleges or universities? (14) Name of college ______
(3) --Nurses' training?
(4) --technician training?
(5) --industrial work?
(6) --cultural purposes?
(7) --home purposes?
(8) --agriculture?
(9) --medicine?
(10) --dietician?
(11) --teaching?
(12) --other purposes? Please be specific. ______

l. Home address.______________________________________________

m. Name of school____________________________________________

Do not write in the spaces below:
1. __________________________
2. __________________________
3.a. __________b. __________c. __________

(This part of the questionnaire was filled in by the author from the files of the three schools.)

1. The I.Q.
2. The occupation of the pupil's parent.
3. a. General average in chemistry 1.
   b. General average in chemistry 2.
   c. General average in chemistry 3.
The author has been unable to discover any study undertaken to determine why students choose chemistry as an elective from the comparatively large number of other available electives. Those who are familiar with the methods used by high school students in selecting courses recognize that such choices result in considerable confusion to the students. Generally speaking, the greater number of high school pupils have no definite aim excepting, as they express it, "to be graduated from high school," meaning the acquisition of a high school diploma. Seldom do high school pupils choose a course because of interest in the subject matter per se; it is required, or their friends liked it, or the hour is convenient to the schedule, or the teacher is pleasant in other school activities in which they have been associated with her. A more accurate knowledge of the pupils' reasons for selecting chemistry should tend toward a greater degree of precision in evaluating a course of study for them. The author has made an attempt to determine such reasons from the 303 questionnaires sent to the chemistry students of the three girls' high schools. The broader distribution of the results of this inquiry is shown in Table 4.
TABLE 4

Percentages of Girls Indicating Each Reason as the Most Important One for Choosing to Study Chemistry

<table>
<thead>
<tr>
<th>Reason</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VOCATIONAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to prepare for certain job or field of work</td>
<td>48</td>
<td>15.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to work in a laboratory</td>
<td>5</td>
<td>1.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Vocational</td>
<td>53</td>
<td>17.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EDUCATIONAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to go to college</td>
<td>30</td>
<td>9.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire for certain type of mental training</td>
<td>2</td>
<td>.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyed previous science courses</td>
<td>29</td>
<td>9.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curiosity</td>
<td>13</td>
<td>4.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had to have a laboratory science for Eastern college requirement</td>
<td>2</td>
<td>.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed a science to complete a minor</td>
<td>12</td>
<td>3.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total educational</td>
<td>88</td>
<td>29.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER REASONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenced by school advisor</td>
<td>17</td>
<td>5.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenced by parents' advice</td>
<td>5</td>
<td>1.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenced by other relatives' advice</td>
<td>19</td>
<td>6.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenced by friends' advice</td>
<td>25</td>
<td>8.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to be with friends</td>
<td>21</td>
<td>6.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only subject that would fit schedule</td>
<td>15</td>
<td>4.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal interest</td>
<td>25</td>
<td>8.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credits</td>
<td>16</td>
<td>5.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gossip</td>
<td>2</td>
<td>.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading books</td>
<td>3</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to have certain teachers</td>
<td>12</td>
<td>3.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unclassified</td>
<td>1</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>162</td>
<td>53.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
One is impressed, after even a cursory survey of the reasons given for selecting chemistry by these students, with their naïveté. There is little indication of intelligent appraisal of the contents of the course or its probable personal value. Only 15.84% of the students electing chemistry — and this is the largest percentage influenced by any one reason — were influenced by a desire to prepare for jobs or definite fields of work. Since this vocational interest was the greatest shown, it is of importance to examine the suitability of the course of study from this angle. McKown says: "Naturally, no record of a pupil's likes and dislikes and occupational preferences should be considered complete and permanent. The pupil's first preference will very likely have little merit, because of his inexperience and his lack of ability to give serious consideration to them. As he learns more about the various vocational opportunities and also more about his own qualifications and possibilities he will be the more able to select intelligently." A well planned course in chemistry should be the means of weeding out those pupils

who are unsuited to their vocational ambitions and of encouraging those whose ability is well adapted to their vocational interest. In a more detailed analysis of another table, the author will discuss the particular pupil interests in chemistry in relation to certain vocations.

The next reason for choosing chemistry, voiced in order of frequency, was a desire to go to college. There were 9.9% of the girls interested in preparing for colleges or universities, while .66% were especially interested in preparing for entrance examinations to the Eastern colleges. The need of meeting college entrance requirements suggests another angle for the evaluation of the course of study. A very small percentage, 5.61%, reported that they choose chemistry chiefly because of the direction of the school advisor. The National Survey of Secondary Education states that this small percentage of choice directly influenced by the school advisor is probably to be considered as a favorable condition. "It is a generally accepted principle in guidance that the program of guidance should help the pupil to define an objective and to give him the basis for planning an educational program preparatory to it. Pupils—should choose——
because it prepares them for their objectives and not because the counsellor advises it." Also according to the National Survey of Secondary Education the fact that so small a percentage, 1.6%, are influenced by their parents' advice is a decidedly unfavorable condition. Since a girl of sixteen (sixteen is the median age when chemistry is chosen) is rather young to know her own interests and abilities, a parent should be willing to offer whatever advice he is capable of giving. Of course, it is not clear from the bare percentage submitted in this study whether or not the unfavorable condition of meagre parental influence is the result of lack of interest on the part of the parent or on the part of the pupil. It is possible to assume that it may be the result of lack of educational background on the part of the parent. In any case, it is an undesirable condition, probably brought about by an accumulation of various economic and educational and personal causes which would probably be discovered as very general among the present secondary school population.

It appears that many of the reasons given for choosing chemistry as an elective are most naive; in fact, one girl said she selected chemistry because of "a slight misunderstanding on my part." It is regrettable, of course,

that any student should choose any subject just for credits or convenience; although these reasons were admitted by some students taking chemistry one, chemistry two, 14.7% of these girls became sufficiently interested to enroll in chemistry three, apparently for some deeper reason than convenience and credit.

If a survey of this sort could be continued over a longer period of time, undoubtedly it would produce noticeable enrichment in the chemistry curriculum and provide a more useful purpose to each and every student, "a useful purpose is one which has good results, one which makes some improvement in living."

It seems fairly clear from the girls' responses to the questionnaire that whatever influence contributed to their selection of chemistry, the subject interested an amazing majority of the students once they were enrolled. Out of the 303 girls taking chemistry, 296 or 97.6% of them expressed positive interest in the study of chemistry, varying from slightly interesting, interesting, to very interesting. The following table shows the distribution of these degrees of interest as well as three degrees of

lack of interest, varying from uninteresting, very uninteresting, and boring. Only seven girls, or 2.3%, of the 302 enrolled were not interested in the course.

TABLE 5
Distribution of Degrees of Interest and Lack of Interest Among 302 Girls Studying Chemistry

<table>
<thead>
<tr>
<th>Degree of Interest</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very interesting</td>
<td>167</td>
<td>55.3</td>
</tr>
<tr>
<td>2. Interesting</td>
<td>117</td>
<td>38.6</td>
</tr>
<tr>
<td>3. Slightly interesting</td>
<td>12</td>
<td>3.9</td>
</tr>
<tr>
<td>4. Uninteresting</td>
<td>4</td>
<td>1.34</td>
</tr>
<tr>
<td>5. Very uninteresting</td>
<td>1</td>
<td>.33</td>
</tr>
<tr>
<td>6. Boring</td>
<td>2</td>
<td>.66</td>
</tr>
<tr>
<td>Total</td>
<td>303</td>
<td>99.83</td>
</tr>
</tbody>
</table>

The number of pupils indicating a lack of interest in the subject matter of chemistry, seven or 2.3%, was so small that the author deemed it advisable to make case studies of three of these reporting the greatest degree of lack of interest. One of these students reported that she "hates everything about it" and was in constant fear of hurting herself or her clothes. She said the smells nauseated her. Everything seemed messy to her and the teacher went into "too much detail about trifles." She was preparing to major in foreign languages in an Eastern college and had to have enough chemistry to pass her "comprehensives."
But for the questionnaire, this condition would never have come to light. A rather fine personality trait seems to have cropped out because, although she admitted she was bored, that the study of science was an unpleasant necessity, she did not allow it to affect her scholastic standing. Her I.Q. was 121 and she was making a grade of 94. Incidentally, this was one of the author's own pupils. The other student who reported being bored had an I.Q. of 87 and was making barely passing grades. Possibly her boredom can be attributed to the fact that most of the really scientific subject matter of the course was far beyond her comprehension and it was only by rote memory that she was able to make a passing grade. The third girl who reported a very positive lack of interest in chemistry has since run away and married, which fact may or may not indicate that her interests were elsewhere.

The table below charts reasons for lack of interest in the study of chemistry:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is too difficult</td>
<td>4</td>
</tr>
<tr>
<td>I am afraid I will hurt myself</td>
<td>2</td>
</tr>
<tr>
<td>It is so dry</td>
<td>1</td>
</tr>
<tr>
<td>Total indicating lack of interest</td>
<td>7 2.3%</td>
</tr>
</tbody>
</table>

TABLE 6

Reasons Indicated by 7 Girls for Lack of Interest in Chemistry
One attitude is indicated by a large number of those interested in chemistry which should be of great encouragement to all teachers who prefer the individual laboratory method. A classification of the reasons for interest in the study of chemistry shows that the individual laboratory method heads the list as a motivating force. This strong preference of the laboratory method should be a rather broad hint to curriculum workers and teachers; in fact, it shows so plainly in all types of student activities that in a later table a special study has been made of the girls' preferring the individual laboratory method in contrast to the lecture-demonstration method. It is gratifying to observe that interest in the course seems to grow in direct ratio to the time spent. All the girls who were doing laboratory work in qualitative analysis (Chemistry 2) showed interest above the average. The author tends to infer from this 100% interest reported in Chemistry 3 that interest seems to grow with knowledge, which attitude, of course, is the objective of all real understanding of science. A rather unique case study of one girl who reported as a reason for her interest, "It strengthens my religion," would seem to imply a rather deeper understanding of universal law and order than is usual among adolescents. The author was sufficiently intrigued by this isolated reason to question the girl concerning the meaning of her
statement. She said that as a child she had always heard that science and religion were contradictory and that the more one learned of science, the less one believed of religion. She had found, she said, that this predicted result had not occurred in her. The study of the periodic table of the elements and of the structure of the atom had given her a picture of such supreme planning and order in the universe, from the smallest to the largest things, that she had become even more convinced of a God than ever before. The author feels that particular comment should be made of one student who expressed great interest and enthusiasm, especially over working in the laboratory, even though her achievement was only 75 as measured by teachers' grades and her recorded I.Q. was only 79. It would appear that at least occasionally high achievement may be attained although the student reports lack of interest (see pages 60-61) and positive interest may be reported even from pupils of low achievement. The following table charts reasons for interest in chemistry:
TABLE 7

Reasons Indicated by 296 Girls for Interest in Chemistry

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to work in the laboratory</td>
<td>76</td>
</tr>
<tr>
<td>Chemistry is so different</td>
<td>51</td>
</tr>
<tr>
<td>It makes me think</td>
<td>21</td>
</tr>
<tr>
<td>It broadens my mind</td>
<td>18</td>
</tr>
<tr>
<td>I learn so many things that were mysteries before</td>
<td>19</td>
</tr>
<tr>
<td>I learn so many useful things - it is practical</td>
<td>14</td>
</tr>
<tr>
<td>Outside things are so much more interesting now</td>
<td>13</td>
</tr>
<tr>
<td>It satisfies my curiosity</td>
<td>13</td>
</tr>
<tr>
<td>I am learning to rely on my own results</td>
<td>12</td>
</tr>
<tr>
<td>I understand nature better</td>
<td>11</td>
</tr>
<tr>
<td>I like to hear the teacher talk</td>
<td>11</td>
</tr>
<tr>
<td>There is such infinite variety</td>
<td>8</td>
</tr>
<tr>
<td>I love to know what things are</td>
<td>7</td>
</tr>
<tr>
<td>I can use what I learn immediately</td>
<td>7</td>
</tr>
<tr>
<td>Because it &quot;runs&quot; the world</td>
<td>7</td>
</tr>
<tr>
<td>Its wide application fascinates me</td>
<td>6</td>
</tr>
<tr>
<td>It is so much like a game</td>
<td>2</td>
</tr>
<tr>
<td>It strengthens my religion</td>
<td>1</td>
</tr>
<tr>
<td>Total showing interest to some degree</td>
<td>296 -- 97.6%</td>
</tr>
</tbody>
</table>

In summary, the author concludes that in all three girls' high schools, a combination of subject matter, method, and manner of presentation has tended to create an unusual interest in the study of chemistry.
An analytical study of the distribution of subject matter interests shows a strong predilection for practical application of learning and performance with the hands and a dislike of abstract mathematical content. (Items 1-6-12). This distaste for mathematics makes the author speculate on a possible disinclination among the majority of girls toward that type of thinking as was indicated in the history concerning the use of mathematics in the study of physics. (See Chapter 2, page 17.) Another general tendency is manifested by a preference for that subject matter which is a continuation of something the student has known before, a vindication of the old principle that interest and learning are better when a development is made from the known to the unknown. (Items 2-5-8-9-11-13) As was observed previously in another analysis, interest in subject matter increases with the broadening of the background, which condition was particularly shown by the responses of the Chemistry 3 students. In the table below, the pleasure taken in individual laboratory work again becomes evident indirectly because great interest is evinced in those units which demand much individual work. (Items 5-9-10-11-13-18) This condition is especially noticeable in items 18 and 19 which are wholly individual laboratory work.
The seemingly strange combination of evasion and interest concerning the subject Radium and Radioactivity (Item 17) may be explained by the fact that this unit was not included in all the classes. By devious methods through the ages men have discovered the eternal feminine interest in cosmetics of one sort or another and have too often exploited this urge. The 170 girls who studied this phase of the unit Chemistry in Industry appear to be entirely feminine in their responses as only 9 girls showed any lack of interest in the subject. The modern phase of this interest, the author has observed, centers strongly around the danger of exploitation and the girls tend to devour any literature informing them concerning harmful impurities and excess prices. Listed below is the table showing the distribution of interests in the subject matter of the Louisville chemistry course for girls:
TABLE 8

Distribution of Interests in the Subject Matter of the Louisville Chemistry Course for Girls

<table>
<thead>
<tr>
<th>Units Taught in Chemistry 1</th>
<th>Reports from 305 girls</th>
<th>No</th>
<th>Least Check</th>
<th>interesting</th>
<th>Most interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Metric System</td>
<td>14 236 23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Kinds of Matter</td>
<td>31 60 212</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Molecules and Atoms</td>
<td>80 102 121</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Effect of Heat and Pressure on Gases</td>
<td>57 77 169</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Gases</td>
<td>12 84 206</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Analysis and Synthesis</td>
<td>83 197 23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Formulas and Equations</td>
<td>13 105 185</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Structure of the Atom</td>
<td>8 33 212</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Metals</td>
<td>12 24 257</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Non-Metals</td>
<td>19 18 256</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Acids, Bases, Salts</td>
<td>31 71 201</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Ionic Theory</td>
<td>51 154 118</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Electrolysis and Electroplating</td>
<td>32 13 258</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units Taught in Chemistry 2</th>
<th>Reports from 170 girls</th>
<th>No</th>
<th>Least</th>
<th>interesting</th>
<th>Most interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Chemistry in the Home</td>
<td>14 37 119</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Our Environment, Natural and Artificial</td>
<td>5 12 152</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Chemistry in Industry</td>
<td>1 8 161</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Radium and Radioactivity</td>
<td>120 0 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Qualitative Analysis</td>
<td>2 0 168</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chemistry 3 Course

<table>
<thead>
<tr>
<th>Reports from 51 girls</th>
<th>No</th>
<th>Least</th>
<th>interesting</th>
<th>Most interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Qualitative Analysis</td>
<td>0  0  51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Quantitative Analysis</td>
<td>0  20  31</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There is a stupendous amount of literature to be found concerning the relative merits of the individual laboratory method of teaching chemistry versus the demonstration method. Curtis, in his *Investigations in the Teaching of Science*, quotes such studies from practically all the better known educational magazines: *School Science and Mathematics*, *Science Education*, *School Review*, *The Journal of Educational Research*, *The Journal of Educational Psychology*, etc. The National Society for the Study of Education's Thirty-first Year Book, in a chapter also written by Curtis, states that "probably more research has been devoted to this than to any other problem dealing with the teaching of science." Some experimenters conclude that the individual laboratory method is best, while others are convinced of the superiority of the lecture-demonstration method. The advocates of both, however, report that much can be said on both sides. Nowhere has the author been able to discover any studies which showed pupil preference. Since it is so mooted a question, it seems highly relevant from the standpoint of motivation and general educational psychology.

to determine which method is more liked by students and also to determine the reason for this preference. The results from the questionnaire are given in the following table:

TABLE 9

Pupils' Interest in Individual Laboratory and Demonstration Methods of Presenting Chemistry

<table>
<thead>
<tr>
<th>Method</th>
<th>Number of pupils who prefer method</th>
<th>Percent of pupils who prefer method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Laboratory</td>
<td>268</td>
<td>88.44%</td>
</tr>
<tr>
<td>Lecture-Demonstration</td>
<td>35</td>
<td>11.56%</td>
</tr>
</tbody>
</table>

The results bring out an overwhelming preference for the individual laboratory method. Of the 303 girls reporting, 268, 88.44%, decided in favor of this method, while only 35, or 11.56%, preferred the lecture-demonstration method. It is significant, too, that of the 35 girls reporting a preference for the lecture-demonstration method, none was either majoring or minoring in science. Nine of the 35 girls reporting a preference for the lecture-demonstration method were among the high I.Q. group. Six of these reported chemistry as a very interesting study and the other three reported some degree of interest. Of these nine, seven were majoring in foreign languages, one in social studies, and one in accounting. They were probably
interested in factual knowledge related to their educational interests, not at all interested in working with their hands; in other words, they were interested in acquiring attitudes of scientific thinking without the skills and habits that come with "Fingerfertigkeit." Five of the 35 girls who preferred the lecture-demonstration method were among the lower I.Q. group. One of these girls gave as the reason for preferring the lecture-demonstration method the fact that she was "just lazy," three said notes were easier to take when these notes were dictated (showing again that some pupils pass the course by means of rote memory, a method which all science teachers try very hard to discourage) and the other girl was afraid she would hurt herself if she handled chemicals and apparatus herself. All of these five girls, however, reported some degree of interest in the course. The other twenty-one girls who preferred the lecture-demonstration method were in the normal group of I.Q.'s. The fact that their educational interests were not in scientific channels probably explains, to some degree, their preference. The analysis of reasons given for preferences is listed in the table below:
TABLE 10

Reasons Given by 35 Girls for Preferring the Demonstration Method

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too messy</td>
<td>10</td>
</tr>
<tr>
<td>Notes much easier to take if dictated</td>
<td>8</td>
</tr>
<tr>
<td>More easily understood if explained as the</td>
<td>7</td>
</tr>
<tr>
<td>reactions go on</td>
<td></td>
</tr>
<tr>
<td>Always turns out right</td>
<td>5</td>
</tr>
<tr>
<td>Afraid they will hurt themselves</td>
<td>2</td>
</tr>
<tr>
<td>Cannot afford to pay for possible breakage</td>
<td>2</td>
</tr>
<tr>
<td>&quot;Just lazy&quot;</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>35 or 11.55%</td>
</tr>
</tbody>
</table>

Reasons given by 268 Girls for Preferring the Individual Laboratory Method

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>More interesting</td>
<td>56</td>
</tr>
<tr>
<td>More fun</td>
<td>41</td>
</tr>
<tr>
<td>Rather do than watch others - learn more</td>
<td>35</td>
</tr>
<tr>
<td>Learn more because you have to be careful yourself</td>
<td>23</td>
</tr>
<tr>
<td>Correct and expected results give a thrill</td>
<td>22</td>
</tr>
<tr>
<td>Understand better because can go at own speed</td>
<td>15</td>
</tr>
<tr>
<td>Satisfaction of doing things personally</td>
<td>12</td>
</tr>
<tr>
<td>Learn to handle delicate things more carefully</td>
<td>12</td>
</tr>
<tr>
<td>Love to handle apparatus</td>
<td>11</td>
</tr>
<tr>
<td>Learn value of patience and time</td>
<td>9</td>
</tr>
<tr>
<td>So much like a good game</td>
<td>3</td>
</tr>
<tr>
<td>Pay more attention if responsible for results</td>
<td>7</td>
</tr>
<tr>
<td>Develops initiative in case of accident</td>
<td>5</td>
</tr>
<tr>
<td>Is convincing because one knows there is no &quot;trick&quot; in it</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>268 or 88.44%</td>
</tr>
</tbody>
</table>
Although the educational interests of girls reveal themselves over and over again, directly and indirectly, in the studies and charts previously recorded, the author has been interested to tabulate another phase of the general educational interests of girls as related to chemistry by the choices and arrangements of their majors and minors. Since English is a required major and social studies, a required minor, one major and one minor are necessarily eliminated as being of any individual significance as to personal tendencies. It seems suprising that of the total group of 303 girls electing chemistry, only 75 or 24.7% were majoring in science and only 150 or 42.9% were even minoring in science. Among those 75 who were taking science as a major, a strong preference for languages and mathematics was evident; in other words, those who chose science as a major were generally following an academic rather than a clerical or fine arts curriculum. The following table lists the major and minor choices of 303 girls enrolled in chemistry:
TABLE 11

Various Major and Minor Choices of 303 Girls Enrolled in Chemistry

<table>
<thead>
<tr>
<th>Subject</th>
<th>Majors 1</th>
<th>2</th>
<th>Minors 1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>303</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td>75</td>
<td>64</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Languages</td>
<td>109</td>
<td>48</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Social Studies</td>
<td>52</td>
<td>82</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>15</td>
<td>84</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td>5</td>
<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Clerical</td>
<td>22</td>
<td>5</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td>3</td>
<td>9</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Home Economics</td>
<td>22</td>
<td>8</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Read Table 11 - English is a required major of all girls in the senior high schools. Of the 303 girls enrolled in chemistry, 75 were also majoring in science, 64 chose science as a first minor and 66 chose it as a second minor. Languages were chosen by 109 of these girls as a second major, while 48 chose languages as a first minor, and 43 chose languages as a second minor, etc.

"To teach pupils to do well the things they need to do, one should discover by investigation the things people need to do." During the period of this investigation in all three of the girls' high schools of Louisville, there was a program of one sort or another to guide the girls in the direction of potential vocations and to impress upon them a fairly definite idea of the necessity of fitness and training. It is common knowledge that although adolescents may be definite in naming a vocation, their ideas are

frequently vague concerning their own abilities in relation to that vocation and uninformed about any sort of accurate preparation. The author is aware that various kinds of guidance programs are tried in different places and at different times; moreover it is Brewer's belief that every real teacher performs an invaluable service in indirect as well as in direct guidance. Since the author's experience is limited to the Louisville Girls' High School, she is attempting here merely to suggest a phase of a direct program of guidance used during the period investigated as it concerned the study of chemistry. Before a discussion is made of the chart showing vocational and educational intentions of chemistry students, a short outline of this particular guidance plan is included. The girls were invited to choose from a program of twenty-one lectures, given simultaneously, the vocation in which they were most interested and about which they were anxious to be informed. The speakers for this program were chosen not only because they were experts in their particular work but also because they were experienced in adolescent psychology. Of these twenty-one talks, six were related to the study of chemistry: Industrial Chemistry, Medical Technology, Medicine, Cosmetology, Nursing, and Home Economics and Dietetics. The natural aptitude and the

chemical preparation necessary to success in these six vocations as set up by these particular speakers, will be briefly reported by the author.

Industrial Chemistry

William E. Janes, of the firm of Janes and Breckler, Chemists, Louisville.

Mr. Janes pointed out that the most important preparation for industrial chemistry was a thorough foundation in essentials and an early start in obtaining these essentials. High School chemistry was an important beginning, he said, because it crystallized the student's interests and aptitudes or made the student fully aware of the lack of them. He divided the types of industrial chemistry into pharmaceutical, analytical, research, and chemical engineering. Of these, pharmaceutical required least chemical preparation and was a good field for girls. Analytical chemistry required a regular four year college course and frequently, depending on the type of analysis, demanded prerequisites of physics and mathematics. This type of chemistry, he continued, required honesty, accuracy, and dexterity in a student and the high school chemistry laboratory was an excellent place to discover whether these traits were present. Chemical engineering was not too difficult intellectually for women, he said, but the physical strain was such that few women could endure it. Research chemistry offered the widest field. Actual
Research required intellectual honesty, accuracy, dexterity, persistence, imagination, mechanical ability, and studiousness, not to mention long hours of gruelling labor. Many women are at present working in the field of organic and biological chemical research, especially on such problems as vitamins, digestion, hormones, etc. In answer to a question asking whether foreign languages were of any help, he stated that a thorough knowledge of chemistry and of foreign languages opened up another field, that of translating abstracts of foreign research work for libraries, magazines, and chemical societies. German he considered most valuable, closely followed by French and Spanish. He also suggested that where the intelligence was high but where a girl lacked dexterity or was too slow in the laboratory for either analytical or research work, there was another rapidly opening field. Many large industrial plants keep a chemical library for the use of their research chemists. These men and women have little time for reference work in the library but frequently need a full report on facts and background in a particular field. For this purpose, these plants employ librarians, chiefly girls, to furnish data on any subject a research chemist may need at the time. Armour and Company employ at least four of these reference librarians who need to be trained not only as librarians, but as chemists and linguists. In
summarizing industrial chemistry as a vocation for girls, Mr. Janes again emphasized the importance of a thorough high school chemistry course to discover a pupil's aptitude for work in the industrial field of chemistry.

Technician.

W. L. Williams, head of the clinical laboratory of the Louisville city hospital.

Mr. Williams emphasized the importance of a broader education including English and foreign languages, particularly German, "so that in a decision they don't have to run to somebody." He gave a most detailed outline of the scientific background necessary for really superior work in medical technology and gave as his opinion that those girls "with a foundation of physics are usually on a somewhat higher level as technicians." He explained very carefully and patiently to his audience that clinical work is mostly chemical and that in order to develop the attitude of a real scientist one must have rigorous training after high school in histology, immunology, serology, and pathogenic bacteriology, as well as in qualitative analysis, organic, and physiological chemistry. A knowledge of physics, he said, was a necessary preliminary to the X-ray work that an ambitious technician would eventually do.
The confidence which comes to a scientist from thorough training is invaluable as his profession opens up to him and the field of medical technology is unlimited in its possibilities for persons deeply interested in research. Few other vocations demand longer hours and more grind for a true scientist, but the satisfaction obtained is of that rare type which comes only to research workers.

**Medicine**

**Dr. Alice Pickett**

Dr. Pickett told the girls that thorough training in food and physiological chemistry was especially valuable to a girl who wanted to enter the profession of medicine; in fact, a girl whose ambition was in that direction should have a deep interest and a good foundation in all the sciences. She made further explanation concerning the personal characteristics of a girl who hopes to be successful in the field of medicine.

**Cosmetology**

**Mrs. Maude Martin**

Mrs. Martin did not cover the scientific phase of cosmetology but spoke more superficially of the practical and financial considerations for a girl who wanted to begin as an operator in a beauty shop.
Nursing
Mrs. Naomi Hall

To a high school girl who hopes to become a nurse, not only are skills of science important but also the attitude developed more or less indirectly by understanding and respect for scientific fact. Chemistry is one of the more important phases of science very closely related to the vocation of nursing and a girl who may become interested in some of the various branches of nursing such as public health nursing and dietetics must continue her training in more specific fields of chemistry.

Home Economics and Dietetics
Miss Mary Lou Howington

Although Miss Howington presented the vocation of dietetics in its general aspect as related to home economics rather than in its particular problems as related to chemistry, she did say, in answer to questions which were permitted after the talk, that organic, physiological, and the chemistry of foods were valuable preliminary courses for a girl who hopes to become a dietitian.

As a supplement to the information on vocations related to high school chemistry furnished by the six experts whose speeches have just been reported in this study, the author made inquiries from three official
sources regarding the chemistry content of state requirements for nursing, for cosmetology, and for medical technology. Excerpts from the answers she received are included below with brief comments from the author.

Nursing

Kentucky State Board of Nurse Examiners,
Miss Honor Murphy, R.N., Secretary-Treasurer.

"We require two years of science. Biology, chemistry, physics and nutrition are recommended, but the new students find the nursing course is easier when they have some knowledge of biology and chemistry. Chemistry is considered so important, that it is given the first semester and this science serves as a basis for the intelligent study of physiology, dietetics, bacteriology, pathology, hygiene and sanitation, practical nursing, and materia medica. In our schools the course is listed as 'general and applied chemistry,' and because of the nature of the nurses' work, the application of the science is stressed. A course includes the following topics:
Physical and chemical changes
Energy
Kinds of matter
Atomic theory, valence, symbols, formulas, and chemical equations
Oxygen and catalytic agents
The element hydrogen
Oxidation and reduction
Water and related studies
Solutions
Ionization - the explanation of chemical action in solution
Acids, bases, and salts
Metals and non-metals
The element nitrogen
The element carbon and the hydrocarbons
Carbohydrates
Fats
Proteins
Vitamines and milk
The chemistry of digestion
The chemistry of blood and lymph
Chemical changes in the tissues.

With the exception of the last two items, provision is made for offering all of these topics in the high school chemistry course of Louisville. Of the units offered, there must necessarily be a selection from time to time because the time allotment is insufficient to include all of them during two semesters.

Cosmetology
Rules and Regulations Governing the Teaching of Beauty Culture in the State of Kentucky as Adopted by the State Board of Barber and Beautician Examiners. (As revised October 28, 1936)

Since, according to the rules governing the teaching of beauty culture, only an eighth grade education is required of a beauty operator, it is obvious that she may learn whatever chemistry is necessary through some other means than a regular high school course. The statement is rather vague
about what the examiners expect an operator to know about chemistry:

"Chemicals:
    Antiseptics; arrest activities of organisms.
    Germicides; destroy organisms.
    Preparation of various chemical solutions used for sterilization.
    Methods of applying the various types of sterilization to beauty culture practices"

and "Limited amount of chemistry pertaining to beauty culture."

"A limited amount" is not defined in the requirements and one has only to guess from the circular what part of the extremely broad field of knowledge is expected of the beauty operator. The average girl with only an eighth grade education would be quite unable to inform herself concerning the chemistry of cosmetics. The minimum requirements of the beauty operator as defined by the State Board of Barber and Beautician Examiners appears not to be the problem of the high school curriculum makers.

To the teacher of cosmetology who, according to the State Board must have "at least a high school education or an education equivalent to high school," there might be some opportunity for the high school chemistry curriculum makers to offer assistance. Since mention is made of the necessity of a scientific understanding of personal hygiene and all types of sanitation, and of "related scientific subjects," the girl interested in cosmetology might find the scientific bases for these learnings in the high school curricula.
"Prerequisites for this course are high school graduation and one year college credit in chemistry and one year in biology; or high school graduation and graduation from an accredited school of nursing." All official requirements, of necessity, represent the minimum, so that it is to be expected that the speech delivered by Mr. W. L. Williams would seem more inclusive and would deal with the ambitions as well as the requirements of a beginner. Of course, the author's interest is confined entirely to the high school curriculum in its preparatory significance to a later course in medical technology. The requirement of one year of college chemistry without any mention as to the type of chemistry, would lead the author to suppose that a year of high school chemistry which included a firm foundation in essentials and enough applied chemistry to test the pupil's personal aptitudes, would be most beneficial.

According to a publication of the American Council of Education which lists the entrance requirements of 680 American colleges and universities, including all those

mentioned by the girls answering the questionnaire, only five of these colleges require science for entrance, and none of these five specifies which science must be offered. Only Vassar requires entrance examinations and these examinations are of the comprehensive type; a student may offer four subjects, three of which must be passed before admission. Since of the 122 girls under consideration, only one intends to take the comprehensive entrance examination for an Eastern college, whatever deficiencies appear in the chemistry course must be supplemented by private coaching from the regular chemistry teacher. This policy has been followed for some time with the very few girls who enter Eastern colleges. As indicated in the history of chemistry in the Louisville Girls' High School (Chapter 2, page 20) the number of pupils concerned with rigid college entrance requirements has tended to become smaller as compared with the ever-increasing number of those secondary school pupils, who, if they go to college at all, enter universities with a broader choice of prerequisites and no entrance examinations.
A list of colleges and universities selected by the girls answering the questionnaire follows:

**TABLE 12**

Science Requirements of Colleges and Universities which 122 Girls Reported As Those They Would Probably Attend.

<table>
<thead>
<tr>
<th>Name of School</th>
<th>Science Requirement</th>
<th>Number of Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Alabama</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>Barnard</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Berea</td>
<td>One</td>
<td>1</td>
</tr>
<tr>
<td>Bryn Mawr</td>
<td>One</td>
<td>1</td>
</tr>
<tr>
<td>University of Chicago</td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td>University of Cincinnati</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Columbia</td>
<td>One</td>
<td>2</td>
</tr>
<tr>
<td>Cornell</td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td>Peabody</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td>Goucher</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>University of Illinois</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>&quot; Indiana</td>
<td>One</td>
<td>2</td>
</tr>
<tr>
<td>&quot; Kentucky</td>
<td>None</td>
<td>22</td>
</tr>
<tr>
<td>&quot; Louisville</td>
<td>None</td>
<td>51</td>
</tr>
<tr>
<td>Mt. Holyoke</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Northwestern</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Randolph Macon</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td>Rollins</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Swarthmore</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Transylvania</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td>Vassar</td>
<td>One and examinations</td>
<td>1</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>122</strong></td>
</tr>
</tbody>
</table>
TABLE 13
Vocational and Educational Intentions of Chemistry Students After Leaving High School

<table>
<thead>
<tr>
<th>Vocational Uses</th>
<th>Number of Cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Technician</td>
<td>2</td>
<td>.66</td>
</tr>
<tr>
<td>Medicine</td>
<td>29</td>
<td>9.97</td>
</tr>
<tr>
<td>Nursing</td>
<td>6</td>
<td>1.98</td>
</tr>
<tr>
<td>Dietician</td>
<td>68</td>
<td>22.44</td>
</tr>
<tr>
<td>Agriculture</td>
<td>7</td>
<td>2.31</td>
</tr>
<tr>
<td>Beautician</td>
<td>2</td>
<td>.66</td>
</tr>
<tr>
<td>Teaching</td>
<td>7</td>
<td>2.31</td>
</tr>
<tr>
<td>No response</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Educational Uses</th>
<th>Number of Cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern colleges</td>
<td>2</td>
<td>.66</td>
</tr>
<tr>
<td>Other colleges and univs.</td>
<td>120</td>
<td>39.63</td>
</tr>
<tr>
<td>Cultural</td>
<td>9</td>
<td>2.97</td>
</tr>
<tr>
<td>Home</td>
<td>48</td>
<td>15.84</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>.99</td>
</tr>
</tbody>
</table>

Because the author was interested in making some sort of test to measure the residue of chemical learning among the group of girls under consideration, a section was included in the questionnaire on the everyday uses each girl might suggest for the chemistry she had learned. Purposely no check list was furnished because the girls' voluntary suggestions were considered the vital elements of this type of measurement. Inasmuch as the spontaneous application to everyday life occurs to pupils, by just so much, it would seem, the curriculum functions beyond the text book and the classroom. This particular approach occurred to the author as another phase of educational and vocational
interests, although these interests as expressed below may not be formalized as shown in the previous charts on educational and vocational intentions. In order to clarify the somewhat scattered suggestions and to eliminate the many repetitions that necessarily occurred, the author has organized the chart under larger group uses, including related uses. At least three every day uses for her chemical learning were reported by each of 299 girls, all but four of the 303 enrolled. Under cleaning, for instance, were mentioned the cleansing action of soap as related to the time necessary for the chemical action of soap, no necessity for rubbing; the effect of soaps, mild or strongly alkaline, on silk hose and the subsequent saving of money; prices of soap as related to the ingredients; value of safety measures in dry cleaning, that is, the use on textiles of noninflammable solvents; water softening devices; the ease of cleaning silver by the chemical aluminum-soda method rather than with the laborious and unpleasant polishing agents; innumerable other specific uses which the individual had been unable to make at home. Since the questionnaire was administered in the early spring, the girls were apparently becoming garden conscious; the necessity of loosening the soil so that air might reach the roots of plants, the value of clover to the lawn for
nitrating the soil, fertilizers and their specific values to the plant, the making of non tarnishable plant labels by writing on zinc with antimony compounds, types of metal for good garden tools, and the value of paint and white wash for protecting fences, trellises, etc., were listed.

The cost of home heating is evidently a vital problem even to girls as the immediate association of their learning about hydrocarbon seems to indicate: kinds of coal and their calorific value as related to the price, how to burn coal so as to get all its value, thereby preventing smoke; how to regulate the gas stove for the proper admixture of gas and air as the amount of artificial and natural gases in our supply varies, how to keep up the humidity of the home and so save coal and gas, safety devices concerning gas heaters and grates, ventilation, etc. Of even more interest to the author, and she might add, of more satisfaction, were the attitudes suggested as indirect learnings in chemistry. Any course in science that is leaving with its pupils more respect for unfamiliar things, more appreciation for what they cannot do for themselves, and a joy in learning is getting at the big objectives in teaching. In addition to these deeper realizations of the bigness of the universe and the dignity of knowledge, the girls reported that they had acquired better judgment in estimating the actual value of things advertised (see page 66),
more understanding of news (special mention is made of the Hindenburg disaster), and more interesting subjects of conversation. Concerning the statement "appreciate what I can't do myself" came report after report that the girls were recognizing for the first time to respect scientific work and scientists, the time, labor, patience and unselfishness necessary to make modern life as comfortable as it is. They were beginning to look at common household appliances, safety devices, transportation, entertainment such as picture shows and music, etc., with more knowledge of what brought them about and consequently with more appreciation. Of course, there is no way to discover exactly by mere statement the extent and depth of these concomitant learnings, but, at any rate, some valuable by-products have been left in the form of attitudes. A chart of everyday uses of chemical learning as defined by the pupils follows:
TABLE 14

Total Residue of Chemical Learning for Everyday Use as Reported by 305 Girls

Clothing
Textiles
Cleaning
Bleaching
Removal of stains
Buying

Heating
Kinds of coal
Furnace firing
Saving gas and heat
Buying

Foods
Cooking
Cooking utensils
Dishes
Refrigeration

Gardening

Cosmetics

Respect for unfamiliar things
Better understanding of advertisements
More appreciation of newspapers
Improved conversation
More appreciation of things
Joy of recognition
Appreciation of what one can't do oneself.
In making an effort to get spontaneous responses on vivid impressions of the chemistry course, the author realized the approach was personal, in fact, it was the personal element that she wanted to discover with the hope that a general analysis might be made of the reasons why certain phases left strong impressions with certain types. In order to leave the way as clear as possible for original impressions, the same general plan was followed as that used to find out everyday uses, that is, no check list was furnished but independent statements were requested. For the sake of analysis as to causes, it has seemed advisable to organize the impressions into four general groups: (1) those impressions which were broad, (2) those which showed a definite interest in science, (3) those which showed an interest in practical application, and (4) those which indicated merely an interest in the unusual. Every girl listed at least one vivid impression. Of course it is difficult to differentiate between the personality of the teacher and the actual subject matter of the course as causes of general interest, but it is permissible to assume that those girls who were vividly impressed by "how little I know," "Life is chemistry," "What sacrifices great chemists have made," and "order in the universe," have been left with rather broad cultural attitudes, such as were discussed under one group of everyday uses. It seems more likely that the teachers' interpretation,
whether direct or indirect, must have contributed largely to making these broad impressions vivid. The group who reacted vividly to the structure of the atom, the periodic law, the destructive distillation of coal, the activities of hydrogen and chlorine, and the possibility of separating apparently inseparable things would seem to have a positive interest in scientific fact and probably a later vocational use. The practical aptitudes of the group remembering vividly how to make and use soap, how to make baking powder, and how to test cosmetics would seem apparent. These practical learnings might have only an infrequent home use or they might develop into vocational values. The explanations for the vivid impressions left by the unusual in chemistry are easy to relate. All chemistry teachers know that there are certain sure fire approaches to an initial interest in chemistry to which practically no girl will fail to respond and also certain exciting phases which, of themselves, will spur lagging interest even though the motivation is of the most common variety, an interest in noise, color, and incongruity. Hydrogen will explode with a shriek when a mixture of that gas and air is ignited. This never fails to excite and thrill. Hydrogen sulfide brings interesting color changes. Metals are always thought of as stable and heavy.
When anything as heavy apparently as iron suddenly bursts into flame in oxygen, interest is keen. It is still more acute when the metal sodium not only floats on water but actually bursts into flame! The causes for the fourth group of vivid impressions are too obvious to be of diagnostic value in relations to any permanent educational or vocational interest, but the general trend of vivid impressions shows the type of material which should be retained to be used as a focus around which to teach other necessary though less thrilling subject matter. The following table summarizes the vivid impressions of their chemistry course reported by 302 girls:
TABLE 15

Summary of Vivid Impressions of Their Chemistry Course Reported by 303 Girls

Broad Impressions

Every thing we touch is chemistry
The patience and industry of great scientists
What sacrifices great scientists must make
How little I know
Life is chemistry
The order in the universe, large and small things

Impressions Which Show A Definite Interest in Science

So many different combinations from such a small number of elements
The effect of electricity on substances
Activities of hydrogen
How odors travel
Destructive distillation of coal
Air pressure
Decomposition of compounds such as mercuric oxide
Activities of chlorine
Writing of equations on paper and then seeing them actually work out
Ability to separate apparently inseparable things
Structure of the atom
The change of chemical energy into electrical energy
What can be obtained from coal tar
The periodic law
How a formula and an equation can mean so much

Impressions Which Show an Interest in Practical Applications

The making and use of soap
How to make and test baking powder
How to test cosmetics and their effect on the skin and hair

Impressions Which Indicate an Interest in the Unusual

The burning of iron in oxygen
Hydrogen sulfide precipitations
Metals that float and burn on water
Now that the accumulated facts of the questionnaire have been listed, charted, and interpreted within groups, the author will summarize the significant aspects of these results as criteria for the evaluation of the chemistry course of study in relation to the educational and vocational interests of girls. These five criteria are proposed in the form of questions which will be answered in the next chapter in relation to the Louisville course of study in chemistry:

1. Does the course of study prepare adequately for college entrance?

2. Does the course of study provide suitable preparation for the vocational intentions of girls?

3. Does the course of study offer practical guidance to individuals toward suitable vocations?

4. Does the course of study furnish interesting subject matter to the pupils?

5. Does the course of study employ preferred methods in presenting this subject matter?
CHAPTER 5

An Evaluation of the Louisville Course of Study in Chemistry in Relation to the Educational and Vocational Interests of Girls
Chapter 5

An Evaluation of the Louisville Course of Study in Chemistry in Relation to the Educational and Vocational Interests of Girls

Five criteria for evaluating the Louisville course of study in chemistry have been proposed as a summary of the results of the questionnaire which were reported in detail and analyzed at the close of Chapter four. The author called attention at the close of Chapter three to another problem which developed from the study of pupils' performance in relation to intelligence quotients. The problem was summarized as follows in Chapter three, pages 47 and 48: "When, however, girls with higher I.Q.'s do not work up to their limits and pupils of very low I.Q.'s make fairly high passing grades, it is quite possible that the fault lies partially with the administrative necessity of providing for the ever-increasing number of the average and inferior who have crowded into the high schools during the last two decades. It would seem that the whole system of secondary school education tends, perforce, to democratize itself, to adjust its curriculum and to direct its teaching efforts to the masses of more or less underprivileged pupils, underprivileged both mentally and socially, thereby leaving the superior pupil frequently unprovided with sufficient stimulus for
her ability. This condition has had a slow and inevitable development as a result of the enormous enrollment in high schools and one of the most difficult problems of secondary education is to amplify curricula and provide sufficient time and teaching energy for a more complete development of individual differences, particularly as manifested among the minority - the superior pupils." As a condensation of the problem stated above, the author proposes in question form a sixth criterion for the evaluation of the course of study:

Does the course of study supply sufficient inspiration and enrichment for pupils of superior intelligence?

This additional criterion is inserted as number two in the list of six established from this study as standards for evaluation. The complete list follows and the Louisville course of study in chemistry will be evaluated in relation to each criterion in the order of its proposal:

1. Does the course of study prepare adequately for college entrance?

2. Does the course of study supply sufficient inspiration and enrichment for pupils of superior intelligence?

3. Does the course of study provide suitable preparation for the vocational intentions of girls?

4. Does the course of study offer practical guidance to individuals toward suitable vocations?

5. Does the course of study furnished interesting subject matter to the pupils?

6. Does the course of study employ preferred methods in presenting this subject matter?
Although it is impossible to include in this thesis the Louisville course of study in chemistry, the author wishes to quote here the general aims, the organization, and the teaching technique as defined in the introduction to the course of study. This inclusion will complete the introductory background necessary for the evaluation.

General Aims

The general aims of chemistry in the senior high school are:

1. To give to the students a genuine appreciation of the improvement in social and industrial life brought about by the application of chemical knowledge.

2. To give the student an understanding of his physical environment which will enable him to use chemical principles for the solution of many of his daily problems.

3. To furnish the student with a background of experience that will enable him to read more intelligently and to critically evaluate his readings.

4. To furnish the student with a basis for interesting hobbies with which to make profitable use of his leisure.

5. To enable the student to participate intelligently and honestly in such community matters as smoke abatement, water purification, food inspection, etc.

6. To provide the student with information and experiences which will aid him in making vocational choices.

7. To develop in the student the attitudes of honesty, persistency, suspended judgment, relation of cause and effect, and initiative.

8. To develop in the student habits of order, system, careful observation, accuracy, and resourcefulness which will function in the ordinary affairs of life.

1. The Louisville Public Schools, A Course of Study in Chemistry, Louisville, 1935. (Unpublished)
Organization

In formulating this course, the committee departed from the usual organization of a chemistry course, in which each element is studied with its occurrence, preparation, properties, conduct, and uses. Instead, the first part of this course is planned to give an understanding of the fundamental principles. Reactions of certain metals and non-metals are used to illustrate these principles. The occurrence and uses of these elements are not mentioned in this part of the course.

The second part of the course begins with a unit on the matter in our environment, in which an attempt is made to give a picture of the matter occurring around us and the changes going on in it. A unit on the industrial development of this matter follows, then one on the matter in the home, and finally one on some of the more recent discoveries about the actions of matter.

Much of the work of these later units must of necessity be optional to meet the needs of the different schools since Louisville has segregated senior high schools. Much must also be optional to meet the needs of different groups, college preparatory or those completing their education with the twelfth grade.
All such material is marked with an asterisk (*). The material not marked with an asterisk does not, however, constitute the minimum essentials of a course since each group will be expected to cover a large part of the optional work.

This plan of organization is a more natural approach for the student and it is hoped will develop a better understanding of the principles and applications of chemistry.

Teaching Technique

In science the Morrison plan of instruction is generally conceded to be very effective. For this reason, the course is outlined in units. It is assumed each unit will be begun with a pretest and a preview, followed by various learning activities, and closed with a general review or recitation and a comprehensive test.

Many of the learning activities are indicated in the units as Suggested Activities. Others will suggest themselves to the individual teacher. Below are listed some activities commonly used by successful teachers:

- Directed study
- Individual experimentation
- Demonstration
- Class discussion
- Field trips
- Bulletin board displays
- Exhibits
- Special reports
It is hoped that each teacher who develops some good learning activity will make a note of it on one of the pages for constructive comment so that it may be included in the revision of the course."

The responsibility of the curriculum makers toward that part of the high school population which intends to go to college has been one of the changing problems of the Louisville secondary schools for girls. As described in the history (Chapter 2) the population of the Louisville Girls' High School was profoundly changed by the national influx of the less academic types into the secondary schools. The general tendency to democratize the curricula of the high schools resulted in an adjustment to the majority interest which was vocational. It is recorded in the history (Chapter 2, page 20) that, "This shifting finally culminated in the elimination, in 1929, of college preparatory as such from the regular course of study.------From that year any one wishing to enter college was coached privately by the teacher (without pay!)." This supplementary preparation given gratis by the teachers refers more particularly to those pupils who take the college entrance examinations for women's colleges. The classroom preparation is usually sufficient for satisfactory
and superior work in the broader curricula of the universities. In answer to criterion number one:

Does the course of study prepare adequately for college entrance?

the answer is yes for general university requirements and no for some of the Eastern women's colleges. Since, of the 303 girls considered in this study, only two plan to enter Eastern colleges for women, it is the opinion of the author that the present plan of supplementary work is necessary, even though it places an extra burden on the teacher. This same plan has been followed in other departments of the girls' high schools, in English, mathematics, and languages. There appears to be no other solution for preparing so small a minority in "special subject matter too difficult and entirely useless to the majority of students."

(Chapter 2, page 18)

A course of study which fails in any part of its opportunity to inspire the pupils of higher intelligence, does not fulfill its aims. The reasons for such an insufficiency may be so complex as to lie beyond the teacher and the curriculum advisers; in fact, the administrators themselves, to whom we are inclined to refer final responsibility, are frequently subject to baffling conditions such as the predicament of an intellectual aristocracy among a
democratic majority as described at the close of Chapter 3.
Whatever the cause or causes, the answer to criterion number two:

Does the course of study supply sufficient inspiration and enrichment for pupils of superior intelligence?

is negative. "One may conclude—-that the course in chemistry is—-perhaps not difficult enough in consideration of the fact that girls with the high I.Q.'s are not stimulated to their best efforts." (Chapter 3, page 47). Of course, any experienced teacher recognizes her personal responsibility for supplying enrichment to such individuals as she has the time to contact but it would seem that a whole group probably needs more than individual suggestions, meaning that a course should be amplified to provide sufficient challenge for their ability. One of the controversial methods of attempting to solve this problem is homogeneous grouping. Within the limits of this study the author does not presume to define the causes or to offer a solution to so broad a problem as the situation of superior I.Q.'s vastly outnumbered by those of average and lower intelligence in the secondary school population of today.

The third and fourth criteria for this evaluation test the course of study in relation to the vocational interests of girls. The first phase of this question as stated in criterion number three refers specifically to
preparation for vocations. The author wishes to define quite clearly the meaning of preparation as it concerns the high school level of learning. She assumes that a high school course of study should provide only an introductory foundation in general attitudes, a few initial understandings, and a few specific skills. In describing the present chemistry course (Chapter 2, page 22) the author says: "The present chemistry course, as worked out by the curriculum committee, is divided into two distinct parts. During the first semester an attempt is made to develop modern scientific concepts through carefully chosen subject matter. The second semester consists of a number of optional units, each dealing with some particular phase of applied science. The individual teacher is left to select those units most useful for the life interests of her group of girls." Of the vocational intentions indicated by the 305 girls included in the study and listed in Table 13, page 86, all the vocations except agriculture (which field represented only .66%) were represented in the program of speeches reported in chapter 4, pages 75-79, and the official bulletins reported in Chapter 4, pages 80-83. According to the analyses of these requirements reported in Chapter 4, the present course of study qualifies
in its fundamental preparation for six vocations, namely: industrial chemistry, medical technology, medicine, cosmetology, nursing, and home economics and dietetics.

By way of specific references to the subject matter of the course of study in relation to the initial understandings necessary to each of these vocations, the author submits the following topics and pages in the official outline of the course, Louisville Public Schools, A Course of Study in Chemistry:

**Industrial Chemistry.**

What is chemistry? page 5  
What are the kinds of matter? page 6  
How is matter changed from one kind to another? pages 9-11  
How is matter made up? pages 12-15  
How do metallic and non-metallic elements act? pages 16-22  
How do acids, bases, and salts act? pages 23-27  
How does matter in our natural environment act? pages 28-34  
How do our industries use the matter in our natural environment to make more useful kinds of matter? pages 35-44  

This last topic takes up many specific industries and brings out in detail the type of information necessary for the foundation of an industrial chemist's education.

**Medical Technology.**

"In the laboratory where we study chemistry, we must know how to use heat, and how to filter, decant, evaporate, etc." page 5  

General laboratory technique which is so necessary a preparation for medical technology is acquired throughout
the chemistry course and is particularly learned in the qualitative and quantitative analysis work. This unit is now presented at the end of the second semester in chemistry as well as in the third semester but it was not yet outlined in the course of study as printed in 1935.

Nursing and Medicine.

The initial scientific subject matter topics which a high school course can offer for both nursing and medicine are so similar that the same references might well apply for both. Unit 8, page 28, takes up air in its relation to ventilation and respiration. Unit 8, page 47, outlines a study of the functions of perspiration and the skin in relation to materials which may be used on the skin. Disinfectants, drugs, and antidotes for poisonous ones are included in Unit 8, page 47, as are the food nutrients, page 50, chemical changes taking place in these nutrients during digestion and assimilation, page 50, and the functions of these foods in the growth of the body, page 51.

Home Economics and Dietetics.

The general concept of Unit 8 is: "Through chemistry man has increased the comforts of the home. The work of the home can be decreased by considering chemical laws and principles in handling the matter in the home." The materials offered in this unit, pages 45-49, include fuels, cement, glass, china, mirrors, scouring powders and soap, textiles, dyes, glycerine, laundering, stain removal, etc.
Cosmetology.

This topic is outlined on page 47, understandings 42 through 47. Functions of the skin, the preparation of face creams, powders, etc., and their effects on the skin, tooth powders, disinfectants, etc., are included.

In addition to initial understandings, the author included above a few skills and general attitudes as the introductory preparation expected of high schools for vocational requirements. There has not been indicated in this study any direct proof of skills acquired, but the grades of every conscientious teacher of science represent a minimum efficiency of such fundamental skills as accuracy, proper handling of apparatus, and careful observation. Since it is apparent from Table 1, page 31, that of the whole group of 50% girls only 11, or 3.5%, failed to pass the minimum essentials of the course and in addition to the very small percentage of failures, the median grade of the entire group was 86 as indicated in Table 2, page 32, it seems fair to the author to accept these significant facts as indirect evidence that the minimum proficiency in these few skills has been attained. Regarding the scientific attitudes, which are listed as part of the
preparation a high school should provide for vocational requirements, the author must present personal testimonials from the pupils as a measure of accomplishment in attaining one of the most important aims in any course of science. Table 14, page 90, and Table 15, page 94, indicate spontaneous pupil responses along this line and comments on the meaning of these results to the teacher and the curriculum advisers were made on pages 89 and 93. The conclusions of this phase of the study seem to show that a combination of subject matter and method was achieving positive results in scientific attitudes. By way of summarizing the three parts of the answer to criterion number three:

Does the course of study provide suitable preparation for the vocational intentions of girls?

the author concludes that the provision of subject matter is adequate, that the acquisition of fundamental skills by the majority seems apparent, and that the scientific attitudes among the group of 303 girls appear to be satisfactory; therefore, the evaluation of the course of study in relation to preparation for vocations is decidedly favorable.

"It is Brewer's belief that every real teacher performs an invaluable service in indirect as well as direct guidance," (Chapter 4, page 74) Although the author has reported in detail (Chapter 4) a program of guidance speeches
delivered to groups, she states in this connection:
(Chapter 4, pages 73-74) "It is common knowledge that
although adolescents may be definite in naming a vocation,
their ideas are frequently vague concerning their own
abilities in relation to that vocation and uninformed about
any sort of accurate preparation." The assistance given
by all good teachers, indirectly and occasionally directly,
during class room time cannot be measured, but the author
feels that any course of study would be greatly strengthened
by a definite extra time allotment of several hours toward
the close of each semester during which one teacher who
seemed best qualified for guidance work in chemistry might
confer with individual girls who would voluntarily come to
her with their vocational problems. It would seem in answer
to criterion number four:

Does the course of study offer practical guidance
to individuals toward suitable vocations?

that the opportunity for practical individual guidance could
be amplified if a teacher of chemistry qualified for guidance
assistance were allowed at least a minimum of extra time
for individual conferences concerning the subject of
chemistry only, in its relation to the vocational interests
of girls.
Since of the group of 303 girls enrolled in chemistry, the total number showing interest to some degree was 296, or 97.6% (Table 7, page 64) the author feels entirely justified in making definitely positive evaluations to criterion number five:

Does the course of study furnish interesting subject matter to the pupils?

It is, however, the ambition of all wide awake teachers and curriculum advisers to increase, where ever possible, the degree of interest. Table 5, page 60, indicates that although only 2.3% of the 303 girls reported a lack of interest, only 55% reported the subject as very interesting. In between these extremes of intense interest (55%) and positive lack of interest (2.3%), the table shows 38% interested and 3.9% slightly interested, a total of 41.9%, in whom the teachers and curriculum makers could awaken a greater degree of interest. In pursuance of this desire to increase the degree of interest among pupils in chemistry, the author made a study (Chapter 4, pages 68-71) of pupil preference between the individual laboratory method of teaching chemistry versus the demonstration method as a possible means of intensifying pupil interest. This study leads to a consideration of criterion number six:

Does the course of study employ preferred methods in presenting this subject matter?
Table 9, page 69, shows that of the 303 girls taking chemistry, 268, or 88.44\%, expressed a preference for the individual laboratory method and 35, or 11.56\%, expressed preference for the demonstration method. It would seem at least a tentative conclusion that the department of chemistry might motivate an increased degree of pupil interest by employing to an even greater degree the individual laboratory method of presentation since the preference expressed for that method among the 303 girls was so overwhelming. The extent of employment of the laboratory method has been one of the shifting problems of the curriculum committee, especially because of changes in time allotment. In Chapter 2, page 23, the author reports: "In 1932, not at the suggestion of the curriculum committee, the time for the course in chemistry was again cut, this time to five periods a week. The author believes, and has reason to believe that all members of the committee agree with her, that this time allotment is much too short." Moreover, in the preface to the course of study itself, signed by all the members of the curriculum committee, the following statement is made about the reduction of the time allotment in chemistry in relation to the acquisition of valuable skills, habits,
and attitudes: "At the same time it was discovered that when Louisville, in line with other large cities, reduced the time allotment in chemistry from seven to five periods a week, there was no longer sufficient time to give the students training in certain valuable skills and habits. The question arose as to which skills, habits, and attitudes were valuable, that is, might be expected to carry over into life situations. The committee then proposed to determine this before beginning on the formulation of a course of study. The best authorities in the field of test making were consulted and after a year's work on developing methods of testing the students for these skills, etc., it was seen that the problem might be expected to continue for several years. The committee then postponed further work on this problem until a course of study had been developed to meet the immediate needs of the city." If a more extensive employment of the individual laboratory method for which the girls have expressed so strong a preference is to be accomplished, a more generous time allotment will have to be provided for the study of chemistry.

The answer, however, to criterion number six:

Does the course of study employ preferred methods in presenting this subject matter?

is partially negative; that is, a more extensive employment of the preferred method already used would seem advisable on a basis of pupil preference and interest.
SUMMARY

It would appear from the six detailed evaluations of the Louisville course of study in chemistry in relation to the six criteria proposed regarding the educational and vocational interests of girls that:

1. The course of study in chemistry does offer suitable preparation for vocations, although the opportunities for practical individual guidance toward suitable vocations might be improved, probably by an increased time allotment.

2. The course of study in chemistry does prepare adequately for most colleges and universities, although it is necessary to offer supplementary coaching, free of charge, to the very few girls who plan to take entrance examinations to the Eastern women's colleges. The fact that only 2 girls of the 205 applied for these examinations seems to indicate that the present plan is satisfactory to the majority interests.

3. The course of study in chemistry seems to supply sufficient interest for the large majority of those enrolled, although it would seem that enrichment is needed to supply sufficient inspiration for the pupils of superior intelligence.
4. The course of study in chemistry might intensify the degree of pupil interest by an even more extensive employment of the laboratory method of teaching so overwhelmingly preferred by the girls enrolled. A more generous time allotment should be a preliminary to this adjustment.

The author hopes that the compiled data of this study may provoke thought on the part of curriculum advisers and that it may encourage all progressive teachers of chemistry to check more accurately their results.

The motto of chemistry as stated in the introduction might well be adopted by all teachers of science: "Savoir c'est pouvoir - to know in order to do."
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