Journal of the Minnesota Academy of Science

Volume 7 | Number 1 Article 21

4-1939

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and still others in light and photography. All of the students showed enough interest in photography so that they learned to develop and print their own pictures. As a result of these varying interests, students constructed the following equipment:

1. A photographic enlarger.
2. A photographic printing box.
3. A photographic print washer.
4. Mounting for an auto transmission.
5. Electrical apparatus for determination of "g".
6. Miniature wind tunnel.
7. Electrical equivalent of heat apparatus.
8. Ampere's law demonstration.
9. Conservation of angular momentum apparatus.
10. Audio beat frequency oscillator.

In conclusion, it might be stated that: (1) the opportunistic Physics laboratory permitted the performing of experiments by students according to their individual ideas; (2) students if given an opportunity have worked out many original experiments in the Physics laboratory; (3) students utilized many inexpensive materials for building up demonstration equipment; (4) students gained better understandings and skills when they used equipment with which they were already familiar; (5) students developed many manipulative skills in the laboratory; (6) a closer relation between theory and experiment was presented; (7) many skills in repairing and servicing of equipment were acquired.

THE COORDINATION AND THE INTEGRATION OF SCIENCES IN THE HIGH SCHOOL PROGRAM

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In the various new curricula, and frequently in the old, one hears many adjectives used and each is supposed to convey a description of the course or curricula. Probably the two most prominent terms are "integration" and "coordination". Other terms such as "orientation," "over-view", "introductory", and "survey" have become almost better known than the names of the old core subjects in many schools.

Without attempting to "quibble" over hair-splitting meanings of these words, they will be used and described in the discussion that follows. When one thinks of integrating two or more subject matter areas, it merely means that the content will be taught more or less simultaneously and that inter-relationships will be shown whenever and wherever possible. "Horizontal integration" is used by which to

refer to an integration of such areas as the natural sciences, the social sciences, English, and mathematics. In other words, such integration cuts across the whole subject matter curriculum. "Vertical integration" refers to the type of thing accomplished in many general science courses in which they succeed in showing the relationships between the various sciences, such as biology, chemistry, physics, geology, etc. The term "coordination" is usually used by which to describe the inter-departmental cooperation between the science and the mathematics department. It is not unusual to find the mathematics classes presenting ratio and proportion at the same time that it is being needed by the pupils taking chemistry and physics.

The present trends and modifications that are finding their way into our present day curricula come as a result of several things. When science was first finding its way into the secondary curriculum, during the growth of the Academy, it was represented by one course known as Natural Philosophy. This was something of a general course in that it largely contained physics, chemistry, and astronomy and to a less extent some botany, zoology, and geology. With the advent of a greater abundance of material, it was natural that the specialists should want this material presented in individual areas, so classes in chemistry, physics, zoology, botany, astronomy, geology, and psychology were introduced.

Now, strange as it may seem, there is something of a tendency toward general courses even above the junior high school general science level. A number of universities and colleges have introduced general courses that survey the field. For example, they have courses in the Survey of the Physical Sciences and the Survey of the Biological Sciences. This is a type of vertical integration for there is little or no attempt to relate this material to history, economics, English, or to any of these other more remote fields. These courses have proved very successful to both the students who do not intend going on into science as well as to those who have continued with it. The success of these courses has served as somewhat of a challenge to our college-type high school science course. It seems only natural that if the survey type of course is to be either a logical terminal course or perhaps an introductory one, it probably should be offered at the secondary level rather than expecting the college to do it.

A survey was made of a number of high schools throughout the country in an effort to ascertain just how much interest there was in many of these newer trends. There appears to be considerable interest but relatively few schools are actually making any progress. It is easy to understand why the progress is slow for there are practically no tools available. The textbook people are slow in bringing out suitable textbooks and relatively few schools have staffs in which time can be given to the actual building of curriculum materials.

The American Book Company in 1937 released a glorified general science textbook that goes by the name, "Senior Science." Its

name implies that it is designed for the senior grade level and has been on trial by its authors in Cleveland for some time. This text skims practically the whole battery of sciences and cannot treat with any of the more "meaty" principles. As a consequence, most of the schools that use it allow only pupils of low intelligence to elect the course. They definitely do not consider it as college preparatory.

Henry Holt released two books by Wilson in 1936 and have named them "Descriptive Physics" and "Descriptive Chemistry." Each is a condensation of a more or less traditional textbook but the author has removed all of the chemical equations and the usual mathematical formulas. It is intended that each book constitute a half year course and apparently one is not a prerequisite for the other. It should be understood that Wilson has made no attempt to integrate these two fields and the books are mentioned only because it is a bit unusual.

One would expect the other textbook companies to release usable material for the new trend but this has been noticeable by its complete absence. As far as can be ascertained, at least two companies have material in preparation and the others seem to be carefully scrutinizing the field and the direction in which it is headed. There are many teachers and textbook experts who claim that new material is needed and that it should be different than the traditional texts and yet considerably different from Senior Science or the Descriptive pair of texts.

University High School is proceeding cautiously in the direction of a revamped curriculum. This same cautious attitude is reflected in the type of textbooks that have been released in the last few months. Lyons and Carnahan have released *Chemistry and You,* the American Book Company has just released *Chemistry and Its Wonders,* and Ginn and Company have recently published *Chemistry At Work.* Incidentally, these books should not be called traditional texts in Chemistry for upon examination of them, it is easy to see that neither one has wandered far from the conventional form except to introduce many new applications in an effort to make chemistry practical for the pupil.

It is interesting to see what some of the schools are already attempting to do. As might be expected, different schools have gone to various extremes. A member of our curriculum committee visited Lincoln School in New York. Here, they have been using horizontal integration from the seventh grade through the twelfth for about ten years. Their main objective seems to be to train the pupils so that they will have a knowledge and appreciation of culture and its growth through the ages. The pupils at each grade level appear to have three hours of each day given over to the broad unifying course that cuts across all subject matter fields except mathematics and the arts. Four teachers from the specialized fields are in con-

stant attendance at each of these three hour sessions, and they are responsible for the material to be covered.

There is no very apparent tie-up between the various grades and while the pupils make use of textbooks, study outlines and syllabi were not in evidence. The immediate concern of all science teachers would be the treatment of their own subject matter field. While there would be considerable opportunity to introduce very elementary science at the lower levels and perhaps review it from time to time later, it is more difficult to conceive of anything beyond that being taught.

They may have anticipated this weakness for elective courses are offered at all levels and each subject matter area. For example, a pupil must elect one of these mathematics courses if he expects to acquire any concept of numbers for that area is not introduced into the integrated curriculum. It would seem that the same situation might possibly hold for those sciences above the level of elementary eighth and ninth grade general science. They have adopted rather broad areas (usually topics from the social sciences) that they use as integrating cores. For example, the eleventh grade proposes to study the rise of civilization during the Renaissance. It is certainly difficult to conceive of much science being taught around that nucleus.

With three hours a day being given over to the integrated curriculum, it leaves very little time to elected courses. This is the fact that makes one fearful that pupils might often leave such a curriculum with absolutely no concept of mathematics and probably only a scanty familiarity with the sciences.

It would indeed be interesting to follow up such experiments as this Lincoln school plan seems to be and actually determine what merit it has in terms of the more traditional courses.

Another extreme trend in integration is being attempted at the Evanston experimental school. At the junior high school level, the pupils of each grade have one teacher assigned to them. The teacher by necessity must admit certain weaknesses in the areas in which he is not a specialist but his function is to teach and integrate all of the subject matter ordinarily taught at that level. The philosophy behind this plan reflects the assumption that one teacher can best understand one group of pupils and also that it is more satisfactory for one person to handle the integration than for several to attempt it.

University High School had a Unified Curriculum for several years and during this time, it was possible to see many of the advantages and disadvantages of this horizontally integrated curriculum. This was carried on only at the seventh and eighth grades. The fact that it was discontinued is no reflection on the outcome of the experiment and the findings of the program.

In this curriculum, three hours a day were given over to the study of units that embodied the integration of four subject matter

areas, namely: natural sciences, social sciences, mathematics, and English. The remainder of the day included special remedial sections, physical education, as well as work in the Arts.

From the data that were collected, in terms of standardized tests, it was obvious that the pupils in this study were doing as well as those in traditional schools in all the fields with the exception of the social studies. In that area, the pupils did not appear to be doing so well in terms of the tests that were used.

One might conclude from the work done in this curriculum that a horizontal type of integration is practical for the junior high school level. The only field that had difficulty in integrating their material within the broad units, was mathematics and they found it necessary to have special remedial sections in which a certain amount of drill could be given without disturbing the whole unit.

A general curriculum committee at the University High School is composed of representatives from each subject matter area and they have been making such investigations that might better prepare them to plan the high school curriculum. The findings and experiences of this committee might well reflect some of the modern thought on some of these questions and should serve as an adequate summary of the usefulness of integration and coordination in the science field at the high school level.

Many of the experts in the field have advised rather strongly against a completely integrated program for they feel that it necessitates too much artificial integration. If material is to be related in order to allow for a better and more complete understanding of it, then surely, those elements should have a natural fusion. An example of artificial integration might be the case in which the English department introduced the "Wonderful One-Hoss Shay" into the Transportation unit.

One suggestion that has been considered for a possible solution at the junior high level is to have a period a day given over to each of the four major subject matter areas (natural science, social science, English, and mathematics). These would be organized in such a way that there would be natural coordination throughout as much as possible. The mathematics teacher would not attempt to teach science but he would probably make use of problems that demonstrated the usefulness of mathematics in science and in the social studies. The large units or areas under which all four would be coordinated have to be rather carefully selected so that there would be a great deal of interrelationship. Another novel feature of this plan would be to parallel these subject matter courses with one period each day being given over to a course at which the whole staff would be present and during which time, the really close and interesting relationships could be demonstrated and explained. This might be called an "orientation" course for it would tend to unify or orient the things being taught in four more or less independent courses.

The changes at University High are to be gradual so that they will work no hardships on the students and on the staff members. The science department is in favor of following a plan of vertical integration through the senior high school. This year, the first course in the transition has been introduced and it has been titled, a Fused Course in Physics and Chemistry. This course includes the most important principles of both physics and chemistry and excludes those highly technical topics that could easily be left to a special problems class. It is hoped that a problems course in chemistry and also one in physics may be introduced for those people who after having taken a year of the Fused course may go ahead for somewhat more specialization.

It is hoped that the former three years of general science extending from the seventh through the ninth grades may be altered so as to include a general survey of the physical sciences as well as the biological sciences, being careful to emphasize the physical sciences during the first part of the three year period and alternately stressing the biological aspects during the ninth year until this year might actually become a very elementary biology, and physiology course. Then with a tenth year course in biology, the science sequence will actually have what amounts to a two year biological sequence.

It has also been planned that the last ten or twelve weeks of the Biology class as well as of the Special Problems courses in Physics and in Chemistry meet together for purposes of discussing problems involving all of the sciences. Essentially, this would become an orientation part of the science sequence. Such orientation could very easily be accomplished because any of the students present in these courses would have had a fairly good background in both the physical and biological sciences.

EXTRA-CURRICULAR PROJECTS IN SCIENCE

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