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RESEARCH AND THE AMERICAN COLLEGE[1]

THERE are two zoological themes either of which I would like to discuss with you this evening, but instead of this I've decided to tell you something of a college which has recently been founded and of its ideal to promote research by leading a large proportion of its ablest pupils to adopt research as their life work.

This institution has fallen heir to 139 acres of land upon which are 17 buildings reasonably well adapted for continued use as laboratories, lecture halls, library, assembly halls and dormitories. It has $13,000,000 of productive endowment paying, as at present invested, 4.8 per cent. above the expenses of the care of the funds, that is $624,000 besides tuition fees, which amount to 500 times $200 or $100,000, making a total income of $724,000.

By provision of the charter the institution has no president, but in his stead is a chairman of the faculty who is also *ex-officio* chairman of the trustees. His successors are to be elected by vote of both faculty and trustees, agreement by each body being necessary. He is *ex-officio* a member of any committee of faculty or of trustees upon which he may desire to serve. This is in reality, though not in name, a return to the former condition of the New England college, a condition now abandoned in American colleges and universities with a few exceptions, notable among them Oberlin, in which the old tradition as to the presidency remains in force.

To the trustees is committed the investment and care of the funds of the college and the securing of additional funds. To the faculty is committed the determination of educational policies and all the educational administration of the institution, including the selection of members of the teaching staff, the library force and the secretarial and other assistants, except in the treasurer's office. The trustees estimate each year in advance the amount of funds to be available from all sources for the educational work of the institution and with this fundamental figure known the faculty plan the budget in detail, subject, however, to the approval of an executive committee upon which are an equal number of representatives elected by the

[1] Address of the chairman and president of Section F —Zoological Sciences—American Association for the Advancement of Science, Cincinnati, December 28, 1923.

faculty and by the trustees presided over by the joint chairman of faculty and trustees. This executive committee has authority to act for the trustees when they are not in session and for the faculty in emergency decisions that may need to be made during vacation periods when the faculty can not be convened.

But the matter of chief interest to us is the educational policy adopted by the faculty: (1) The number of students is limited to 500, the ideal of the college being quality not quantity of output; (2) the college has no teachers of less than professorial rank, except two classes: first, a very few are appointed to instructorships with the intention of advancing them to professorships within two years if they demonstrate ability as teachers and productive students in their field. They are all thoroughly trained and worthy of professorial rank except for experience. Second, there are laboratory and other assistants, but these do no teaching of any sort except jointly with and under the close supervision of professors. For example, in all laboratory work the pupils have constant association with the professors and are never under the guidance of assistants alone.

No teacher carries more than three full half-year courses, or their equivalent, during the year, that is, two full courses one semester and one course the next semester, and it is regarded as far preferable that not more than one full course or its equivalent should be carried at a time, except that seminar work or informal club direction, either field club or informal discussion club, may be undertaken. The institution is so jealous for the quality of its teaching that it demands that no member of its faculty shall undertake to do more than he can do as well as it is in him to do it. No quiz masters or readers of themes, laboratory notes or examination papers other than the professors in charge of the course or section are allowed, and all courses are so subdivided that not more than 25 or preferably 20 students are in any course or section. It is regarded as essential that the professor directing the course or section shall himself get the reaction of the student in all his written and other work so that he may know when and where and how the student is getting hold and how best he may be guided.

There is in the institution very little cut-and-dried work of the prevalent college sort. Personal consultation between teacher and pupil takes the place in large measure of the lecture or recitation method. There are almost no courses which require a specified amount of ground to be covered in a specified number of weeks. In many courses there are not daily class meetings, but the pupil does much of his work more or less by himself, but guided by means of very frequent personal interviews with his teacher. There is not in the whole institution a laboratory course in which there are supplied laboratory directions guiding the student's every motion. Student initiative and independence are highly prized and everything possible is done to conserve and promote them. This is clearly seen to be incompatible with teaching *en masse,* and in consequence the individual method is chosen whenever possible, and it is surprising to see to what extent it is possible to carry out this ideal. With a faculty more than twice as large as in any other college in the country with the same number of students, and with no professor carrying more than two courses at once and usually but one course at a time, such individual work becomes possible.

In the subject receiving major emphasis a bit of what might fairly be called research is done and there are several departments in which the professors have the students use research methods in part of their work almost from the beginning. This has proven so successful in toning up the whole quality of the students' work that the endeavor is now made to have nearly all sophomores and in especially promising cases to have freshmen get a taste of this type of work. In this way students who early in their course give evidence of special ability may do all their college work with that fine attitude which can come only to one who has once caught the spirit of productive scholarship, the spirit of research. A mere taste of this sort of work in a single department is enough to whet the appetite of the student in all his work.

Personal consultations between teacher and pupil are necessitated by another provision. The institution has absolutely abolished the whole system of grades. No grades are ever given the student for any examinations or for any work of any sort. No record of grades is kept by the college. A professor can not by merely giving a grade shirk a personal interview with a pupil deserving commendation and encouragement because of the excellence of his work, and there is no available method except personal conference for halting and redirecting the pupil who is going wrong. The teaching in this institution is genuine and real, and the professor who shirks this part of his job is likely to be asked by a committee of his colleagues to change his ways or withdraw.

I have said that no record of grades is kept by the college. This is true, but very full records of a much more valuable character are kept. Each teacher in every course fills out for each pupil a card which is filed in the college registrar's office. This card carries the instructor's annotation as to the work accomplished by the pupil, stated in three ways: First, telling the nature of the work done and the ground covered; second, telling of the degree of success in the work, its quality; third, estimating its equivalence in units of college work, one unit being 1–120 of a

normal full college course; and in addition there are annotations under such captions as industry, keenness, initiative, independence, inventiveness, judgment, versatility, breadth of vision, logical power, persistence, etc., and there are other remarks as to the student's relation to the work of the course and his revelation of his own qualities.

Throughout all the college work every effort is made to avoid the deadening effect upon both pupil and teacher of too much system and too stereotyped courses. The individual and individual relations are emphasized to the highest possible degree.

But the chief feature in the institution we haven't yet mentioned. It is the fact that every professor and each of the few instructors is expected to be productively active as a student in his chosen field. Not only is faithful and enthusiastic teaching demanded; equal stress is laid upon research, upon productive scholarship and growth. The teachers must be men of real devotion to their chosen fields, and this is emphasized as essential to successful teaching and to the creation of the most stimulating college atmosphere. The research is regarded as an essential part of the service of the college, as a vital part of the service for which salaries are paid. All realize that nothing else is so effective in inspiring college students to choose research for their life work as is contact with a teacher genuinely devoted to research, to creative scholarship. It is not the magnitude of the teacher's research or its far-reaching technical importance that counts most here. It is the spirit of genuine devotion to a field of study that gives the contagion, and this spirit somehow gets across to the pupil in many cases from teachers whose personality may seem to be very lacking in inspirational power.

This college gives each of its teachers half or more of his time and energy free from teaching and for use in research. It frowns upon the use of this free time for anything but productive scholarship, even the long vacations must not be used for teaching in other institutions rather than for research or for recuperative preparation for research. The whole atmosphere of the college is such that free time means to the members of its faculty freedom for research.

Though the college pays professorial salaries running according to grade only from $3,000 to $5,000 a year, the freedom from the swamping effect of too much teaching and the opportunity given for productive study and growth have been a great inducement and have enabled it to secure excellent men for its faculty. It is a college with a faculty of university grade in research and much better than university quality in teaching.

The effect upon the student body has already in these few years been noteworthy and there is indication of an increasing effect. The students have been carefuly selected for admission, only those being taken who seem, on the recommendation of their preparatory course instructors, to be likely to respond worthily to the special opportunities the college offers. The institution, through its salaried group of athletic leaders, has succeeded beyond its expectation in promoting gentleman's sport for sport's sake and has largely avoided the highly professional type of intercollegiate team contests for the glory of the school. Practically every student follows one or several athletic sports, but it is found that many of the ablest men refuse to give the time required for training for college teams. When the college was organized the policy of no intercollegiate team athletics was considered but was not adopted because of its being such a departure from American precedent. Intercollegiate athletics as it exists was recognized as about the most highly professionalized athletics in the country and of a sort to give much less of value for the college life and the after-life of the student than does gentleman's sport for sport's sake. Within the last year there has come up again the proposal to abandon intercollegiate team contests and the sentiment of both students and faculty seems to be swinging in that direction.

Intellectual interests are well to the fore in the student life and in a thoroughly wholesome way. There are no so-called grades in the college life, and the students in their studies work for interest in the subjects themselves to a far greater degree than in other colleges. Phi Beta Kappa has not been admitted because of the fear that it may help emphasize false standards of honors in place of work for the interest of the work itself. Sigma Xi, on the other hand, being devoted to the active promotion of research, has a very strong chapter with divisional meetings for the several sciences as well as general meetings.

But perhaps the best indication of the grip the real work of the college is getting upon the students is seen in two facts; first, the large number of its graduates who go into research in the universities—about one fourth choosing research as their profession, many of those going into medicine, for example, going in for medical research as well as medical practise, and this in spite of almost no encouragement to such research in the medical schools. There have also come complaints from some who have gone into law and engineering that there is no encouragement to and little opportunity for research in the schools giving training in these subjects. Indeed, there is in the country but one graduate school of engineering, and that is occupied as yet more with the sciences fundamental to engineering than with engineering itself. A second indication of the vitality of the students' interest in their work is shown by the fact that every year the professors have a good many graduating students coming to them in a difficult quandary because they

have developed so much interest in each of several subjects that they wish to go on to advanced study in each field though they know they must choose but one. And these subjects are in no larger proportion the sciences than the so-called humanities, a phraseology, by the way, which seems to me to have little, if anything, of real underlying distinction. College work which so grips the student that he wishes to go on to advanced study in several different lines is college work that counts. It is the sort of college work we should aim at. I have myself seen just this effect in one college, and I know from experience the deep satisfaction which the teacher has in working in such an institution.

But why have I told of this college and why have I used as title for this talk the phrase "Research and the American College?" Because of the effect which this type of college can have in the promotion of research both in its own work and in its stimulus to the work of other institutions. There has been for some decades in America an increasing emphasis upon research and there is now an increasing cooperation among scientists in attack upon research problems. The intricacy of interrelation between the sciences is becoming more clearly realized. The isolated student is helpless before many of the problems of greatest interest, and only the broadly trained student can appreciate his problems in their broader and more fundamental aspects. Scientific knowledge and its ramifications are so increasing and problems for solution are being disclosed in such great numbers that we need, and shall need, more and more research men of proper training.

It is this last phrase which defines the real theme of our discussion this evening—more research men, proper training for research. I believe that the key to the situation in America lies in the American college. It is in general true that if men are to turn to research as their life work they must receive their inspiration in the junior or senior year in college, and it is also true that university training, unless founded on college work of the right sort, can seldon properly prepare a man for worthy research. This is especially true because breadth of knowledge and catholicity of interest are essential to the soundest, strongest productive scholarship. The roots of research success penetrate deeper than the university into the soil of the college and from this source derive a great part of the nutriment necessary to growth of research. Inspiration and training are the words that focus the ideas that I have tried to present: inspiration to the choice of creative study as a life work and such training as will preserve and increase the student's initiative and ingenuity and independence.

Such inspiration and such training are not found to-day in the usual American college to any such degree as they should be. How can this condition be remedied? I believe a very practical initial step towards the desired result would be the securing, by transformation or by new foundation, of one or more colleges something such as I have described and letting them have their natural stimulating influence upon other institutions; colleges in which the number of students is small (no institutions have ever reached really worthy success in mass teaching), in which the number of the faculty is large, so that the teaching may be individual or with small groups, so that the teacher may do his own teaching work without dependence upon readers and unsupervised assistants and especially so that each teacher may have time and energy for his own research, and the teachers should all be thoroughly trained and worthy of professorial rank, except perhaps for experience in the cases of a few of the younger men. The two chief points are limitation of the number of students and increase in the number of the faculty, and this of course calls for large endowments. But success in any such attempt must come, if at all, from a realization of the value and importance of research.

What is research in the broad? Is it not the search for truth as to the realities in the midst of which we live and to which we must relate ourselves? And isn't this a fair half of the larger life? Search for truth, on the one hand, and loyal living of the truth, on the other hand. Isn't that about the whole of worthy life on its higher plane?

And in this search for truth the scientific method of observation and experiment is the real method. I would define science to include the whole field of testable reality, the realities of existence and relation which can be expressed in meters and grammes, and those realities in whose adequate expression qualitative descriptions must be used. All the realities in the midst of which we live and to which we must relate ourselves lend themselves to study by observation and experiment and call for such scientific research if we are to have an increasingly sound relation to them. Qualitative tests of truth are as valid as quantitative tests, though requiring a different type of exercise of judgment. Spiritual realities are as real as are material realities, and they very possibly are scientifically more fundamental, belonging to a substratum out of which material realities emerge. Trueness is conformity to reality, and beauty is a real criterion for testing the reality or falsity of relations in matters which for the lack of a less abused word we call spiritual. These definitions include, therefore, the whole field of college work in our discussion, no subject which deals with realities being omitted. Research in human life in all its aspects as well as research in chemistry and physics is needed: testing truth, testing realities of

relation, is needed in all fields if we are to be able properly to relate ourselves to the realities in the midst of which we live. Scientific research is no narrow thing. The scientific motive and the scientific method properly apply in all phases of human thought and action. The field is a vast one and its intricacies increase in geometrical ratio as our knowledge grows and our vision widens. Perhaps the phrase "productive scholarship" or "creative scholarship" would be less liable to misunderstanding than the word "research." I would use the three as almost synonyms.

In closing may I be allowed a word of caution against misinterpretation of the attempt to emphasize scientific research in college? This does not at all mean, as so many seem to think, emphasis upon the so-called utilities. So-called practical motives are a poor inspiration and an unsafe guide in research. Let me quote a paragraph from a former discussion of this theme:

> The motives to research may be as varied as are the characters and interests of the men engaged in the pursuit. But the urge which seems the most productive of the highest grade work is that of the fun of the game, the pleasure in the research itself, the love of truth and its pursuit. Ulterior motives of personal profit or even the desire to promote the progress of civilization and the well-being of society, all have an element of danger. They are likely to persuade the student, perhaps unconsciously, to control the direction of his search, turning it into so-called profitable channels. But no man can know where lie the great undiscovered truths. Truth itself is a safer guide into the unknown than is any man's guess as to the probable best line of approach to worth-while knowledge. The student who humbly follows where the subject itself seems to lead him, eager to follow whatever turn the investigation naturally takes, is the one most likely to find the richest deposits for his mining. Truth is too manifold, too unexpected, too great, oftentimes too profoundly simple, for any man's successful anticipating. From the most unexpected sources come discoveries that open great vistas far beyond the previous imagining of any man. The humble following of the subject itself and the suggestions that develop in the research is the method usually that brings to the largest results. Interest in the subject itself, the desire to know the truth, the pleasure, the uplift of soul, that comes with the gaining of some new vision into a hitherto unexplored field of reality, these are the safest guides, leading one to results in value far beyond fame or financial profit or some invention that shall increase the perhaps already too great complexity of human life. The instinct for truth, the love of understanding for its own sake is ingrained in the human soul.
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> And to it may safely be made the strongest appeal in inducing students to enter upon the life of research. The fun of the game, the worth of the game for its own sake, makes a keener appeal to men of the finest type than does the thought of possible dollars to accrue or possible fame to be attained.[2]

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ATOMIC NUMBERS VERSUS ATOMIC WEIGHTS

IN the first report of the International Commission on the Chemical Elements the following statements

[2] Several persons who have heard or read this paper in manuscript have referred to the college described as Utopian. It is really not so far removed from realization as one might think. In Oberlin College since 1836 the faculty have had complete control over educational policy and methods, over budget, over appointment of teachers and other members of the staff, and in reality, though not in legal form, have had as much determining influence as the trustees in choice of president. Oberlin's president functions not as an autocrat, but as chairman of faculty and trustees. Oberlin has a "Presidential Committee" composed largely of faculty members which is empowered to act for the trustees when the latter are not in session. Many colleges limit the number of their students. Five years ago when Oberlin received a gift of several million dollars the faculty voted that it should be the policy of the college to have more full professors than associate professors and more associate professors than instructors. She now has 51 full professors, 40 associate and assistant professors, 18 instructors (including gymnasium floor directors) and 7 laboratory and other teaching assistants. Numerous colleges encourage individual work for honors, mostly by seniors. Oberlin now has a committee considering increase of such individual work in the college. Swarthmore has no regular classroom work for honors students in the junior and senior years. Professor Hilton, of Pomona College, puts a good many of his first course students onto an original problem for about one quarter of their time and continues this method with more advanced students and with such success that the heads of the zoological departments of two universities have said to me that their best trained graduate students come from Pomona. For a good many years Goucher College never allowed her students to know anything about grades until after their graduation, though the registrar's records were kept in the form of grades. I am under the impression that no student ever made inquiry after graduation as to her grades. At least two colleges now keep for each student cards not only giving grades but annotated also somewhat as suggested in this paper. During the first 20 years of Goucher's work just 20 per cent. of her graduates went on to graduate study in universities requiring college graduation for admission. Half time teaching and half time for research is found, I think, only in a few collegiate departments of universities and in no independent colleges. The college pictured in this paper is a composite of features from a number of institutions but embodies no new feature except the combination itself.