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A BASIS FOR RECONSTRUCTING BOTANICAL EDUCATION

THE pages of a leading English botanical journal have, for over a year past, in every issue, contained letters and articles discussing botanical reconstruction and the need of it.[1] One of the foremost American universities has recently sent out a questionnaire asking for opinions and suggestions bearing on the reconstruction of general biological instruction within the college; and the National Research Council has invited constructive ideas as to what should be the content of an "intensive" course of study. The same topic is being discussed in addresses and magazine articles in America. Davis has recently called attention to the importance of the question in SCIENCE,[2] as has also Peirce, in his recent address before the San Francisco Bay Section of the Western Society of Naturalists.[3]

But how shall we decide the content of the introductory course? Something more is needed than mere personal opinion based on the peculiar experiences, and idiosyncrasies, and limitations of individuals. The question is larger than the subject of botany, for it includes the broad problems of educational policy and theory. First of all, then, certain basic principles must be formulated and, if possible, agreed upon. It is the aim of this paper to state, and briefly discuss, two or three of these principles.

One might think that, after all that has been said and printed on the subject, one need

[1] "The Reconstruction of Elementary Botanical Teaching," *New Phytologist*, 16, 241–252, December, 1917; 17, each issue, January–December, 1918.

[2] Davis, Bradly Moore, "Botany After the War," SCIENCE, N. S., 48, 514–515, November 22, 1918.

[3] Peirce, George J., "What Kinds of Botany Does the World Need Now?" SCIENCE, N. S., 49, 81–84, January 24, 1919.

hardly refer to the most fundamental question of all—namely, the purpose of education in general; yet every time the content of the curriculum is discussed, it becomes all too evident that many worthy people either do not keep that question clearly in mind, or else they wholly misconceive it. One can not go into details here—the question is too large. At the risk of being trite, it may be categorically asserted that the aim of education is not merely to give information, nor merely to teach somebody how to do something, and especially is the aim of education not confined to preparing young people to get a living, nor (more emphatically) to get a living only by commercial pursuits. This could not be better said than it was by Professor A. Caswell Ellis:[4]

> Certainly they [the laboring classes] must have vocational education to make efficient producers, but they are going to be "producing" only about six or eight hours a day. What preparation is the school to give for the other sixteen or eighteen hours each day and the twenty-four on Sunday?

I think it will hardly be extreme to say that this question is the supreme problem of present-day education. As Professor Ellis continues to say: "If we do not show more intelligent recognition of this problem than we have in the past then the production of isms and impossible Bolshevist dreams during the leisure hours may more than offset the material production of the working hours." And even if the individual is not inclined to be an agitator, or a public menace in any way, he has himself to live with sixteen or eighteen hours a day, and he exerts his conscious or unconscious influence on others whether he will or not; and he may become a member of the local government, or a member of the board of education, or, if worse comes to worst, even a school superintendent, having a large voice in the organization of public education. Certainly it ought to be clear that the public school curriculum, and the content of each subject taught should be determined with such eventualities, as well as with vocational needs, in mind.

Not to dwell unduly on this first point, let us very briefly note that public education should always adapt itself to the needs and ideals of the age, seeking at the same time to help mold and formulate them. In what direction, then, let us ask, is social organization now tending? What is the modern spirit? Well, a new spirit and changed ideals have certainly been developing during the past two or three decades. One of the outward expressions of this fact is the reduction of the hours of labor from twelve a day to nine or eight.

One of the finest expressions of the new spirit is the address of John D. Rockefeller, Jr., before the War Emergency and Reconstruction Conference of the Chamber of Commerce of the United States, at Atlantic City, on December 5, 1918. "Men are rapidly coming to see," said Mr. Rockefeller, "that human life is of infinitely greater value than material wealth;" and "Modern thought is placing less emphasis on material considerations. It is recognizing that the basis of national progress, whether industrial or social, is the health, efficiency, and spiritual development of the people." The fourth article of his proposed industrial creed rightly affirms, "that every man is entitled to an opportunity to earn a living, to fair wages, to reasonable hours of work and proper working conditions, to a decent home, to the opportunity to play, to learn, to worship, and to love, as well as to toil." Every subject in the curriculum, therefore, should, in its introductory course at least, have its content decided with reference to this entire modern ideal.

But, unfortunately, proposals are now being made in some quarters to revise the botanical course of study in exactly the opposite direction, evidently with the idea that the chief purpose of studying the subject is preparation for a vocation. I would not, for a moment, wish to appear to be losing sight of the fact that there is a vocation of botanist, and many vocations depending, in whole or in part, upon a knowledge of botany. What I am objecting to is the tendency to lose sight of every other consideration, and to commercialize or vocationalize every subject from the introductory course to the doctorate thesis. The committee

[4] *Jour. Nat. Inst. Social Sci.*, 4, 135, 1918.

appointed some months ago in England by Mr. Asquith[5] said, none too emphatically: "Practical education is the only foundation on which idealistic achievements can be raised; to neglect the practical ends of education is foolishness; but to recognize no other is to degrade humanity."

In this connection I would like to urge the desirability of offering, in all of our colleges and universities, "cultural courses" in the various sciences, consisting only of illustrated lectures made as fascinating and broadening as possible, and supplemented by assigned readings and discussions. The aim of such courses should be to give those who have not yet decided upon their life work as well as those who have, a scholarly survey of the aims, problems, methods, history, and results of the given science, and a clear idea of its significance for daily life—personal and social. Such courses would have substantial benefits alike for those who took them and for those who gave them, and would undoubtedly be the means of revealing to many the direction in which their life work lies.

In the second place we should never forget that one of the important aims of education is to enable the individual to find himself; and especially important is it to keep this in mind in deciding on the content of introductory courses. They should be made as informing and broadening as possible. The student should be made to feel that the given subject touches his life, and to what extent—that a knowledge of it is of personal significance to him, that it is replete with fascinating unsolved problems, in the solution of some of which he may find his obvious opportunity for a contented and useful life.

And finally we should always remember that the introductory courses should almost never be planned on the sole supposition that the student is to take more advanced courses, but in full recognition of the fact that the first course may be the only one many students will ever take of any particular subject. With this in mind the course should be made as rich as may be in informational, cultural, educational values. If regard is had for these requirements the course ought to prove entirely satisfactory as a preparation for more advanced study.

From this point of view, undue emphasis should not be placed on details of technique, or minor matters of mere information, but on the broad generalizations that appeal to the imagination and challenge one's admiration, enlarge one's vision, and stimulate and illuminate one's thinking. Some glimpse should be given into the history of the subject, some acquaintance, however slight, with the great names of its makers; and especially should there be some introduction to the unsolved problems that continually challenge and beckon the explorer of the dark continents of knowledge. In brief, the introductory course, that *may* prove to be the last, should be so planned as to enrich the student's life as much as possible. If that given subject proves to be his main life interest, such a course will also prove to be a satisfactory introduction to more advanced work.

At this particular time there seems to be a movement for "intensive" short courses of study. This is no doubt a direct outcome from the program of the Students' Army Training Corps, when intensive short courses were made necessary by the exigencies of war. Osborn[6] has called attention to the fact that the view is likely to obtain with the administrators of student curricula that, if intensive courses are effective "in an emergency," they might well be useful at other times. The danger here is in losing sight of why intensive courses are "effective in an emergency." The need in an emergency is action—accomplishment. What is demanded is the possession of knowledge that may be quickly applied to meet the pressing need. To live a life of culture—of deep insight, broad

[5] Report of the Committee to inquire into the position occupied by the study of modern languages, etc. Issued as a White Book. Quoted from the *New Statesman* (London) by *World Wide* (Montreal), August 17, 1918.

[6] Osborn, Herbert, "Zoological Aims and Opportunities," SCIENCE, N. S., 49, 109, January 31, 1919.

outlook, and wide sympathies—may not, at such a time, be an urgent immediate need; nor is preparation for such a life possible under the stress of an emergency calling for the quick, effective solution of pressing practical problems; but in normal times this is one of the most (if not the most) fundamental needs, of society and of individuals alike. A course a study possible under the more leisurely circumstances of normal conditions may be made not only to minister to these larger and deeper requirements of the spirit, but, if properly planned and administered, will at the same time supply the information to be applied under the stress of an unforeseen emergency.

Herein lies the superior advantage of planning our public education, not solely with reference to utilitarian demands, but on a basis of broad culture. If we wish a conspicuous example of the pitiful and deplorable results of a system of public education organized chiefly with a view to securing practical efficiency, at whatever cost, we have only to look at the sorry spectacle of Germany during the past four terrible years. The great world conflict, recently terminated, has emphasized no fact more clearly than the need of pursuing truth for its own sake, as well as for specific ends and results, and of planning our educational programs with a view to having truth taught from the same angle.

As to investigation and instruction in "pure" botany for its own ends—what should be the rational attitude of several odd thousands of wounded soldiers (and their friends and families) whose very lives have been saved because a number of people (misguided and impractical, no doubt, in the eyes of some of their contemporaries) found wholesome pleasure and recreation in studying the structure, ecology and geographical distribution of sphagnum moss, without the slightest thought as to whether that information might ever have any use, except to give them and others intellectual and spiritual satisfaction, to widen a bit the circle of man's intellectual horizon, and to throw some ray of light on the course of plant evolution. Or what should be the attitude of thousands of aviators, the strength of whose aeroplane propeller blades could be insured only by the application of knowledge (of the structure of wood) resting in part upon investigations in pure botany.

The discovery of X-rays was not the result of trying to find a way to see bullets imbedded in human flesh, nor to ascertain the exact condition of hidden bones fractured by shrapnel; they were discovered in the endeavor of certain men of science to find out all they could about electricity, just because they preferred to spend their time that way than otherwise. Similar statements could be made with reference to the discovery of TNT; of the principle of electromagnetic induction, which underlies the telephone, now so vital in war as well as in peace; of the properties of chlorine gas, which made possible the rapid perfection of effective gas masks; of the classification, life history, and ecology of such insignificent objects as mosquitoes, on a knowledge of which is based a vital part of modern sanitary practise, which made it possible to reduce the death rate from disease to 17 per thousand in the present war (A. E. F.), as against *65* per thousand in the American Civil War; of bacteria and the modern science of bacteriology, without which aseptic surgery and antisepsis would be impossible, for Pasteur's early studies of germ life were made in order to demonstrate the fallacy of the current theory of spontaneous generation—or, in other words, to settle a question of pure science.

On the relation of pure to applied science it will be apposite here to quote Pasteur's statement, in his inaugural address as dean of the new Faculté des Sciences, at Lille. He said:

> Without theory practise is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. It is to you specially that it will belong not to share the opinion of those narrow minds who disdain everything in science which has not an immediate application. You know Franklin's charming saying? He was witnessing the first demonstration of a purely scientific discovery, and people round him said: "But what is the use of it?" Franklin answered them: "*What is the use of a new-born child?*" Yes gentlemen, what is the use of a new-born child? And

yet, perhaps, at that tender age, germs already existed in you of the talents which distinguish you! In your baby boys, fragile beings as they are, there are incipient magistrates, scientists, heroes as valiant as those who are now covering themselves with glory under the walls of Sebastopol. And thus, gentlemen, a theoretical discovery has but the merit of its existence: it awakens hope, and that is all. But let it be cultivated, let it grow, and you will see what it will become.

Preparation for war, therefore, as well as preparation for the vocations of peace, is inextricably bound up with the pursuit of pure science—of knowledge for its own sake. What would have been our preparation for the war just over if our educational system during the past generation, had been based on the practise of teaching only the applications of the science of twenty-five or fifty years ago, omitting or even making secondary the exploration of unknown fields in every direction, without continually raising the question of utilitarian values. As it was, the avoidance of that error was only partial, and the result of continual persistence on the part of "impractical" college professors, combating and resisting all manner of pressure and insistence on the pursuit of the practical, to the exclusion of the theoretical and fundamental.

But straight in the face of all this experience, our educators are now confronted with the old demand. Profoundly impressed with the important part played in military operations by the applications of scientific knowledge, many of our civil and military officials, men of business, and even educators of narrower vision are insisting that our science teaching shall be wholly or largely confined to the applied phases of the subject: botany, for example, must be *restricted* to what is called agricultural botany, or to plant pathology, or to preparation for forestry or pharmacy. Let us teach our children how to grow healthy crops; never mind (or make incidental and secondary) investigating and teaching the fundamental principles and concepts which underlie intelligent and successful practise. Such a program not only loses sight of the difference between mere information and education (the essential business of schools), but will ultimately defeat the very purposes which its advocates have at heart, viz., the efficient preparation of the nation to meet the demands of peace and war. It is a striking illustration of the folly of killing the goose that lays the golden eggs, for it is absolutely necessary to teach something besides the applications of science in the schools if we wish to educate successive generations of scientific investigators, and have any science to apply when the need for application arises.

Here also, should be emphasized the urgent need of having our courses of study outlined and administered by men of broad outlook and wide sympathies, as well as of deep insight, so that the program shall not be lopsided, and narrow, and disastrously inadequate as a preparation of young men and women, not only to take their places in the social fabric in times of peace, but to rise fully equipped and prepared to meet any emergency that may arise—whether of war, or pestilence, or crime, or other disaster.

For example, something is certainly wrong when the education of a city superintendent of schools has been such as to render him unable to appreciate the educational values or the social need of any studies except those that happened to interest him in his school days. Of course we must be careful here not to hold the educational system too fully responsible for the shortcomings of its products; creatures of the Almighty *have* been known to come short, in spite of education and favoring environment. It is a serious and disquieting fact to find the value of botany, zoology and general biology as high school studies, really and apparently sincerely called in question, as is now being done in the schools of Greater New York (and possibly also in other cities); especially when the proposition is to supplant them with studies chosen chiefly for their so-called "practical" nature, and from the point of view that the chief function of education is to pass on information, and the chief duty of public education to prepare boys and girls to secure and hold a position.

It was very timely for Professor Osborn, in

the address above cited, to point out the fallacy of basng introductory courses chiefly on one of the various phases of a science, whether the economic or not, to the exclusion of the others. It is breadth of contact that is needed by the pupil, a broad survey of the field, for it is just as true to-day as ever that the fundamental need is a liberal or liberalizing, education—the setting free of the mind and spirit from all that narrows and dwarfs—the correction of intellectual myopia. This is why I like the term *introductory course* better than elementary course. One may give an elementary course in plant physiology, or morphology, or taxonomy, or ecology, but neither of these would be an introduction to the science of botany.

Neither would a course be that dealt only with facts of structure and function, and the various ways in which such knowledge can be turned to commercial advantage, but paid little or no attention to the larger conceptions of interpretation, significance, cause, and spiritual values. It is undoubtedly a general tendency of scientific men to neglect or subordinate those phases of their subject, especially in its educational aspect. This is natural; it is partly because of their tendency to concentrate on facts and percepts, rather than on interpretations and concepts, that they became scientists rather than philosophers. But herein, also, lies in large part the explanation of why, to the non-scientific, the various sciences seem deficient as educational disciplines. To them something of intrinsic and supreme educational importance is lacking.

Now this deficiency is not inherent in the sciences; it is only inherent in many of those who cultivate them, and we have ourselves to blame in large part if school officials of classical training regard the sciences inferior as instruments of a liberal education. A similar deficiency would inhere in language and history, and even in literature if they were organized for school courses from the same point of view as the sciences so commonly are. The solution of this problem is easier and more obvious perhaps for the humanities; but zoology and botany may easily be organized for instruction so as to partake more fully of the qualities that mark the humanities. The main difficulty is that we somehow feel that our problem or duty is to teach somebody botany, rather than to utilize botany as a means of educating men and women. We need never fear that science and the advancement of science will suffer in the least by complete recognition of its function as an educational discipline.

But what then, you ask, is your proposal for an introductory course of study in botany? Professor Peirce, in his address above cited, modestly refrains from answering such a question in definite terms. He is so averse, he states "to anything which may even seem to dictate what intelligent, thoughtful, conscientious students and teachers should do that, even if I had a formula, I should keep it to myself." The present writer is constrained by similar inhibitions, so far as the details of a course are concerned. There is quite probably no one best course, but I feel certain that any course organized on the basis of the considerations to which attention has been called above, will be superior to any course organized in disregard thereto. But whatever its content in detail, it should and must, before it is over, open the eyes and mind of the pupil to those fascinating and liberalizing conceptions which are the finest fruit of scientific research and thought, presenting chiefly such facts as will enable him to consider them with some degree of intelligence. Among others are the conceptions of biogenesis, evolution, nature and theories of inheritance, reproduction and the development and significance of sex, natural selection, the struggle, especially in Darwin's day, for freedom of inquiry, the nature of life, the fundamental relation of plant life to all other life, botany in the service of man, the wonderfully enlightening subject of geographical distribution (in broad outlines), a practical acquaintance with scientific method and what the perfection of that method has meant to mankind as an instrument for the ascertainment of truth in all departments of knowledge, and glimpses, at least, of the history of the subject, not forgetting to empha-

size the fact that our present body of knowledge is the result of arduous, devoted labor, often attended with great personal sacrifice.

For purposes of a liberal education such ideas are vastly more important than mere information concerning economic uses and commercial processes, or the details of structure and function, and the latter, while essential, to a certain degree, as a foundation for the broad concepts above mentioned, should be presented, in the introductory course at least, as a means to the larger end.[7] If such a revelation as a course of this character will give does not prove a stimulus and lure to delve further into botany or general biology, nothing will, and student and teacher alike should feel amply repaid for the discovery that the student must seek his own life work and major interest elsewhere.

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THE RETIREMENT OF PROFESSOR EDWARD L. NICHOLS

ONE of the striking events of the Semi-Centennial Celebration of Cornell University —June 19–23—was the "Physics Conference and Reunion in honor of Edward Leamington Nichols upon the completion of thirty-two years service (1887–1919) and his retirement from active duty as head of the Department of Physics."

Briefly stated it consisted of a reunion of teachers and members of the physics seminary during the thirty-two years of his leadership in the department; of a meeting of the seminary—the last at which Professor Nichols should act as official chairman; and finally of a conference to discuss by what methods and through what means the department can be made of the greatest service to the university and to the country.

[7] This is in essential harmony with Professor Davis's more concise statement that the introductory course will "come more and more strongly to stand out as one that attempts nothing more than the grounding of fundamental principles and a selection of information with rather definite reference to its general and practical interests, or its broad philosophical bearing."

The reports at the final seminary were upon "Electromagnetic Induction," by Dr. S. J. Barnett; "The Vacuum Tube and the Development of the Wireless Telephone," by Captain Ralph Bown, and "Binaural Hearing and its Application to the Location of Air and Water Craft," by Professor George W. Stewart.

At the conference—presided over by Dr. P. I. Wold, Western Electric Co., New York City—there was a general discussion on physics as a profession, in which the following leading features were dealt with: (1) The demand and opportunities for the physicist; (*a*) in industry; (*b*) in government laboratories and departments and (*c*) in university teaching and research. This discussion was opened by Mr. E. C. Crittenden, of the U. S. Bureau of Standards. (2) The preparation required to meet this demand: (*a*) the undergraduate curriculum; (*b*) graduate training. This discussion was led by Dr. C. H. Sharp, of the Electrical Testing Laboratories, New York, and by Dr. P. G. Nutting, of the Westinghouse Research Laboratory, Pittsburgh, Pa. (3) The function of research in this preparation: (*a*) research by students; (*b*) research by faculty; (*c*) how can conditions for research be improved. Discussion opened by Dr. Wheeler P. Davey, of the General Electric Company, Schenectady, New York. How could a department—indeed the university as a whole—be so efficiently helped as by this method in which her loyal sons who have faced the world and won, come back to tell wherein their college had helped them and wherein greater help could be given to those who are to come after!

One of the pleasantest incidents was the reunion dinner, at which over two hundred and twenty-five of Professor Nichols's old students, colleagues and friends joined in the spirit of a devoted family to show affection and esteem for their retiring leader. The toastmaster was Ernest Merritt, student, colleague and friend, who succeeds Professor Nichols as head of the department. In the greetings given by the toastmaster and in all of the speeches there were three dominant