SCIENCE

VOL. LX OCTOBER 10, 1924 No. 1554

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

RECOGNITION OF THE INDIVIDUAL[1]

I DEEPLY appreciate this opportunity for laying before this association certain facts and theories of applied psychology which may have a bearing on the organization of engineering education.

The discovery of the individual and the study of his traits and needs in modern psychology has brought forth a maxim in which I wish to couch my proposition for engineering to-day: "Keep each student busy at his highest natural level of achievement in order that he may be successful, happy and good." This maxim is so pithy and cogent that we can afford to read it and reread it, accenting in turn each individual word, as each word of it stands for a principle and each word charges us with a responsibility. Thus, we may emphasize in reading, each, his, highest, natural, achievement, successful, happy and good.

An attempt to carry out that program will make it necessary to take into account: (1) The selection of the individual; (2) the placement of the individual at entrance; (3) the organization of individual groups; (4) the guidance of the individual; (5) the motivation of the individual; (6) the reward of the individual.

Mass production in education and recognition of the individual are two of the foremost problems in education to-day. They loom up large in contrast, because they seem to involve mutually contradictory problems. It is generally believed that mass methods stamp out the individual or, conversely, that recognition of the individual prevents the use of mass methods. But mass education is forced upon us, and the recognition of the individual with his personal traits, limitations, capacities and aspirations is coming to be a persistent demand.

Facing this situation, I am optimistic, believing that a *large* professional school is a good thing and that it is possible to so radically change from the traditional small college methods of instruction to the methods demanded for mass education that we shall be able to deal with students in very large numbers more effectively, more personally and with more precise recognition of the individual than was ordinarily achieved in the small professional school.

The new day in society and the new day in education is marked by the fact that instead of a mere hit-and-miss growth we are assuming conscious control of the evolution of educational tendencies, of the de-

[1] Address before the Society for the Promotion of Engineering Education, at its meeting in Columbus, Ohio, July, 1924.

velopment of the individual and of the shaping of the needs of society.

I. The Preliminary Selection of the Student: A College Qualifying Examination

The great tragedy of all higher education to-day is the maladjustment, failure and misdirection of the student entering college on the towering and surging wave of "education for democracy." From 5 to 50 per cent. of freshmen fail and are eliminated in the first year. These students are sent back to home and community disgraced and disheartened, and constitute not only an economic waste, but a gross maladjustment of human energies, hopes and ambitions.

For this there is a simple remedy, and that is to develop a nationally standardized college qualifying examination which shall be given at the end of the senior year in all high schools and preparatory schools as a basis of information with reference to fitness for college work. On the basis of this examination parent, pupil and teacher may make a rational estimate about the wisdom of going to college; and this examination, which is given merely for information, will be accompanied by expert analysis and advice in general principles of vocational guidance with reference to the outlook for persons of the various degrees of fitness for higher education.

Such an examination is being developed under a five-year experiment now in progress. Two thousand high school students are examined annually. Prediction of probable success is made and this is correlated with the actual achievement of those who go to college, wherever they go. Thus we shall have a quantitative measure of the degree of precision of our power of prediction. The preliminary findings are exceedingly gratifying in this respect.

This examination will also serve to educate the community to the slogan, "It makes a difference"; it makes a difference whether a student is or is not capable of doing college work. It will serve to encourage and select those who may not be fully aware of their high qualifications, and to discourage and eliminate those who are not fitted, not only on the basis of this examination, but on commonsense observation in daily life, when the principle is once recognized and becomes a part of the neighborhood commonsense. The student will make his decision about going to college on the basis of an inventory of his fitness for college, before he has burned the bridges behind him by actually going to the college or even announced to his friends that he was or was not going.

Now at this stage we can not distinguish between the engineering and other professional or liberal arts students. It is enough to know that that student who is fitted to go to college is encouraged to do so, and that one who is not fit is discouraged on the basis of specific information about fitness for higher education.

II. Placing the Individual: Department Placement Examinations

When the student enters the engineering school, he should be required to take a placement examination in each of the first-year subjects, such as English, chemistry, mathematics. This examination, administered by each of the departments independently, is designed to show: First, the degree of natural aptitude for the particular subject; and, second, the character of preparation in that subject. It will be so prepared as to furnish the most effective introduction to the subject in the form of practical exercises for the first two or three days of the course. It will be of the objective type and can be administered and scored easily, quickly and uniformly by cheap help so that, at the end of these exercises, the instructor will have in hand a rating for semester placement which shall be of as high predictive value as the experience of the entire first term in a heterogeneous group, provided the student is willing to work. The student will have had a most effective introduction to the subject. These examinations will be prepared in small pamphlets and bought by the students like text-books at about ten or fifteen cents apiece. It is desirable that national standards should gradually be developed and furnished in fresh editions annually from the hand of the most expert writer in each of the respective fields.

The use of such placement examinations is absolutely essential if we shall start our student rightly at his natural level for achievement, taking into account natural aptitude and character of preparation in the subject as a basis for determining the pace at which he shall be set to work and the character of his task. The present practice of squeezing into the same form those who are by nature and by training radically different in their equipment and ability for doing the work of a given subject is indefensible.

III. The Natural Grouping of Individuals: Sectioning of Classes

The most wholesome tendency in modern higher education is in the direction of individual instruction or, I should say, the privilege of individual work. In its organized form this takes the character of socialized group instruction, in which there is a natural give-and-take in the struggle for achievement, as in ordinary life, and the student is encouraged to pursue knowledge *actively* instead of having it poured into him as by our present methods. For this we are, however, not quite ready, except in the laboratory subjects, as it calls for a radical reconstruction of our curriculum. As a temporary measure, our

best procedure is to section classes on the basis of ability. After a careful study of all three methods in actual operation, I am convinced that any one of these three methods can be adopted effectively in fundamental courses without increasing the cost of education, and without the much dreaded conflicts between courses, while vastly improving the efficiency and naturalness of the educational process.

Sectioning on the basis of ability was in vogue in the best colleges of the country two generations ago, but was gradually dropped when elective courses were introduced, on the theory that it created conflicts. This theory of conflicts was exploded a few years ago by the discovery that if students, in a given course in which there are two or more instructors, are registered by the hour instead of by the number of the section in parallel sections, interchange of students at a given hour can be made at any time during the semester by the two or more instructors in that hour, without the slightest interference with other departments or other courses in the same department. To illustrate, let us suppose that there is a class of one hundred students in freshman mathematics, and that fifty of them may schedule at 8:00 o'clock and the remaining fifty at 11:00. Then the two instructors in each of these hours may agree that one shall have the better half and the other the poorer half of the class reciting at that hour, and that promotion and demotion between the two sections may be made, and shall be made, on the basis of achievement at any time during the semester. Such sectioning establishes a fair basis for praise and blame, introduces fair standards of achievement and creates a morale in the class. To the poor student it means kindness, comfort, justice and opportunity for relative efficiency and approbation. To the gifted student it is a means of finding himself and being motivated by effective competition, freedom from a dead load, stimulation of initiative and the joy of achievement. This method is now the approved method in the best elementary and secondary schools of the country, and all fundamental college courses are fast coming to that practice.

The method of sectioning combines well with lectures and demonstrations in large divisions, as the students at a given hour may meet in a large division for lectures. In laboratory work, it is however unnecessary, because here we can readily employ the method of the socialized group, allowing each student to work and progress at his natural level of successful achievement, the essential requirements being that about three times the ordinary amount of work shall be mapped out, and that the good students shall be so motivated as to distinguish themselves, both in quantity and quality of work, that the highest 25 or 30 per cent. of the grades shall be given for work clearly above that represented by the highest grade ordinarily given in the unsectioned group.

Sectioning on the basis of ability or individual freedom in the laboratory is, however, of no avail unless instructors adapt their methods and requirements to the radically different abilities now segregated. The procedure in each group, examinations, standards of achievement, sequence of courses for students at different levels, must all be adapted to the new situation. For each of the levels a different quantity of work is mapped out and a different quality of response must be required. At the lowest level there must be patient pedagogical drill on the fundamentals. At the highest level, the atmosphere of the scholar with its freedom, large scope and enthusiasms will prevail.

IV. The Guidance of the Individual: Natural Finishing Places

The societies here represented are primarily concerned with the standard engineering course which has a professional status, but in evaluating the setting of such a course, we must view it in relation to this fact, that the extension of the type of training represented by engineering should be varied in proportion to, first, the needs of society, and, second, the capacity of students for training.

If this is true, other natural finishing levels than that set for the professional course should be provided, some longer and some shorter. Corresponding to the various departments of engineering, there should be junior engineering courses (not necessarily by that name), preferably of two years of a combined trade and cultural character leading to a certificate which would motivate our skilled tradesmen who are reasonably educated for democracy. The automobile mechanic, the head carpenter, the plumber, the road builder and the hundreds of others who now face the alternative of four years or nothing, or a part of four years and disgrace, should in this school find the greatest opportunity that has ever yet been offered for the training of intelligent leadership among tradesmen.

I know there is a skeleton in the closet, but the situation must have an airing, for if we are going to extend higher education for democracy, it can not be done by merely increasing the standard professional group. We must provide other outlets which shall enjoy the favor of occupational sanction. This is different from the ordinary trade school or manual training high school. It is trade education as a part of higher education. I would have these students take the so-called classical high school course and acquire scientific foundations for trade skill at the college level.

While such a trade school will probably be independent of the engineering school, the latter must

function sympathetically in launching and sponsoring the former, and in the development of a good concept of education for skill in applied sciences beyond the high school level, particularly in promoting its certification.

Beyond the first degree in engineering, I would have various stages of specialized training in proportion to the needs for highly specialized experts and their capacity for training, even as far as five years of graduate work.

Now I submit that the lower the finishing place, the more men of that training we need, and the more qualify reasonably for it. In rough figures, we may say that for each engineer who takes five years' post-graduate training, five should take three years and twenty-five should take one year. For every professional engineer of the standard course, we should have from two to five times that many educated tradesfolk with a two-year certificate; for society needs a great many more men of the lower training than it does of the higher, and nature has provided a great many more for educability at the lower level than at the higher.

We as educators can not visualize this profile of distribution without feeling great responsibility for an inventory of our concepts of natural units for education in applied science. We can not guide the mass of youth who clamor for engineering education in the future without taking active steps to assist in the sorting or the progressive selection and elimination for different levels of training in applied sciences.

The recognition of this concept in the organization of training in applied science will have great value for the professional engineering course, in that it will furnish a means for progressive selection *for* and elimination *from* that course, thus securing a better grade of professional students and a motivation for those who are to do graduate work in engineering specialties.

V. Motivating the Individual: Spread of Assignment

The procedures for motivating the individual are countless and should be varied. They may vary with the character of the subject, the character of the instructor, the character of the institution; and it must always be kept in mind that different *levels* of capacity must be appealed to by entirely different principles of motivation. Let me but mention one: the setting out of a task in which there shall be room for spread in achievement in proportion to the spread of capacity in achievement. To take a concrete example, entirely arbitrary: if the standard for achievement in freshman chemistry for the first year is represented by one hundred exercises of a certain degree of difficulty from the old point of view, this must be abandoned and work covering from two to three times that amount must be set out as a possible and desirable goal for achievement, with the expectation that a very small percentage of the class may achieve that goal and that there will be a gradual distribution from this maximum achievement down to the point of failure. If it is announced that this three hundred unit basis represents the scope of the course and that grades will be awarded on the basis of achievement on *this* scale, taking into account the quantity and quality of work, then it will be found that more than 25 per cent. of the class when properly motivated will be distributed between the one hundred and the three hundred units of achievement: that is, above the level of the task ordinarily set for the class.

That this extraordinary enhancement of achievement actually does take place is illustrated in classes in which it has been tried by the fact that (again using figures roughly) where a modern type of examination is given to all levels of the class, and is so arranged that the poorest students can only answer the first few questions, and that the best students will have the real test of their abilities in answering the last and most difficult questions, it will be found necessary to change the passing mark, say, from 70 per cent. to some empirical figure like 25 per cent., assuming that we know and wish to maintain the old standard of fitness for passing. That is, what under the old conditions used to represent 70 per cent., or a passing mark, represents only 25 per cent. on the new scale. This is not lowering the standard of passing, but is raising the standard for achievement and basis for recognition of achievement on the part of the best students.

In my own classes in psychology, for example, all A's and B's (*i.e.*, about 25 per cent.) are given to students whose achievement is clearly beyond the standard of achievement which was expected before the principle of segregation was introduced.

This first principle of motivation, then, of setting out a larger program, furnishing the material for the performance, making it known that grades will be based upon achievement, and that achievement will be measured at the level at which the work has been done, is a principle which can and should be applied in all subjects. In setting out such a program, it should be clearly understood among the students that each will be kept busy at his highest natural level of successful achievement; that there are very great differences in the capacity for achievement; that each will be praised or blamed according as he achieves on the basis of his natural capacity, and that we have frankly given up the idea of bringing them all to the same level. It is important that no student shall be permitted to feel that he is doing extra work when he is actually working at a high level of achievement.

The laboratory, of course, lends itself very freely to this type of procedure, and while there are various methods of laying out the program, it will probably be found in general that the best way is to arrange for each level a series of exercises or tasks, increasing in the order of difficulty so that the whole class is kept together on topics from day to day, and that the spread of achievement will be represented by quantity and quality of work on each topic. This is opposed to the idea, often prevalent, of setting out a mediocre standard and allowing the good students to pass rapidly from topic to topic, thus gaining time. There is no topic in any subject that does not lend itself to various degrees of intensive and effective work, and it is a better test of a good student that he shall have done a higher amount and a better quality of work on every topic than that he shall have passed rapidly over a minimum requirement.

VI. The Reward of the Individual

The greatest reward for a good student is the joy of achievement. If we once liberate the good student, give him facilities and encouragement to work at his natural level of successful achievement, formal and outward marks of distinction will be of little consequence as compared with the deep satisfaction in doing this kind of work. To make this enjoyable, many institutions must, however, change their atmosphere so that both students and faculties will hail the superior student with approbation, instead of looking upon him as a "grade-getter" or a union scale breaker.

Nevertheless, the good student should be entitled to certain rewards. Aside from the privilege of being relieved from learning things that he already knows, doing things that he already knows how to do and marking time for the sake of the order of the class, certain natural rewards would be in place. Under the plan I have advocated, high grades will assume an entirely new meaning, and will in themselves constitute a much desired goal, a reward of honor which requires no special action of the faculty, because high grades under the conditions described will imply that the student has traveled in high sections, covered a much more extensive field and done a far better quality of work than is now ordinarily required.

If honors are to be awarded by the faculty in a professional school, I think that they should be awarded on the basis of ranking of a number of students who have good grades, taking into account, first, the grade; second, the special marks of achievement deserving of recognition, particularly a scholarly attitude; third, balance of activities, representing health, socialization and academic life, and fourth, personality, in the sense in which personality is judged when an engineer is to be employed.

Taking this broader basis into account would protect the institution from making the egregious mistakes that are often made when honors are awarded on the basis of mere school record.

In the above, I have proceeded upon the assumption that students shall be held together during the customary period of four or five years in the regular order of topics and shall all take the same time. This, I think, would be entirely justified when, in the new order of things, the good student can have during these years the most excellent opportunities for natural growth and self-expression.

There is, however, another possibility which I should advocate if we can not recognize motivation on the basis of ability, and that would be to adopt the method of individual instruction, which would enable the student to finish his course in a time somewhat proportionate to his capacity for work. There are many points in favor of this method, aside from the mere justice of it, and many of the difficulties which have seemed to stand in the way are mere bogies. However, if I had my choice, I should take the stand in favor of keeping the student in the engineering course to cover specific subjects in a specific time, and then differentiate the quantity and quality of the work to be done in each topic.

I have spoken as an outsider, as boldly as briefly, on some of the most vital subjects touching engineering education, and have deliberately tried to set forth the ideas in high lights and concrete form, in order that they may be tangible as a basis for discussion. Some of the things I advocate are already coming into general practice. All have been tried in some form. I have sought to find fault with existing conditions in a constructive spirit, and am glad to recognize that engineering draws as high a grade of students as any other profession and is probably better taught. I bring no revolutionary theory or simple solution, but it seems to me that the items I have mentioned are among the next vantage grounds that we might survey in engineering education.

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SHADED TOPOGRAPHIC MAPS

The latest advance in the art of mapmaking at Washington is seen in certain inch-to-a-mile governmental maps on which the relief, still shown by contour lines as heretofore, is rendered more apparent by the addition of shading. The device is not new: it has been employed, for example, on the 1:100,000 map sheets of Italy published some years ago by the Military Geographical Institute at Florence, and on certain maps of the Rocky Mountain region published by the Geological Survey of Can-