WHAT STANDARD TESTS IN SCIENCE SHOULD DO.[1]

By Elliot R. Downing.

It is a rather curious fact that we teachers of science have been among the last of the teaching fraternity to undertake the formulation of tests or objective standards for measuring the efficiency of our instruction, for the whole modern movement of measuring educational products is merely the application of the scientific method to education. If you were asked to pass judgment as a biologist on the relative rate of respiration of a plant and an animal or the relative intelligence of a horse and a dog, you would not for a moment be content with an opinion based merely on observation of their behavior, but you would hold yourself to some rigidly precise experimentation, the results of which would be capable of expression in exact and comparable terms—experiments that could be repeated by any other interested investigator. In other words, we have, as scientists, long ago passed the stage at which we were content with subjective opinions based on personal interpretation of phenomena, and we insist on objective standards that may be used with certainty by all in securing data for judgments. The standard test is merely the application of biometrics to the school. As educators, we are coming to subscribe to a principle that has long had our allegiance as scientists, that no science can be considered an exact science until it is capable of mathematical expression. It seems strange, therefore, that the science teacher, who is supposed to have achieved the scientific attitude of mind, has been almost the last of the school men to see that there are problems in the pedagogy of science and that the same scientific method on which he relies in science is the only one by which they can be solved. Possibly we have here only another illustration of the non-transfer of training—possibly the scientist is so impressed with the complexity of the problems that he is loath to undertake them.

In general we may anticipate that standardized tests will do for the teaching of science what they have done and are doing for the teaching of other common school subjects. To be specific, we may expect that the standardized test in science will

First, substitute objective standards capable of mathematical expression in their application for the varied subjective and therefore indefinite standards that maintain at present. Let me illustrate from a subject in which objective standards are

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available. The pupil whom Grade 4 teacher marks "superior" in writing, Grade 5 teacher may mark "poor" when he passes to her room because "superior" and "poor" have quite unlike meanings to the two teachers. Their standards are subjective. But now if the Freeman or Ayer handwriting scale is used as a standard the judgments of both teachers will coincide.

In many schools we have taken temporary refuge in the "normal curve" and the "expected distribution of variates" as a scientific basis for checking up our subjective judgments. It is a system that is reasonably accurate if our pupils are average pupils, but that fails if the class is exceptionally brilliant or stupid. Still, even with such extremes, the results are more nearly fair than when we rely merely on the unchecked opinion of the teacher whose final grade to a pupil is quite as likely to be influenced by a spell of indigestion and the consequent headache at the close of a semester as by the real performance of the pupil. We recognize that at best the method is merely palliative until such time as we do have standardized tests that will give us objective bases for judgment.

Second, the attempt to formulate standardized tests will force us to a clear definition of the aims to be achieved by science instruction, for you cannot work out a method of measuring a thing until you have a very exact concept of what it is you are trying to measure. Again let me illustrate from what is now past history in the testing movement.

The formulation of tests in spelling necessitated a clarification of purposes. The old spellers were made up in large measure of lists of words that were unusual and that were selected merely because they were difficult to spell. The spelling test forced a realization that spelling drill must be confined to words that are really needed in actual use and these were found by going over a mass of business correspondence and selecting the ones most frequently occurring. The object of instruction in spelling is not mental gymnastics but accuracy in the written words commonly needed.

The old penmanship copy books were full of flourishes—a redundancy of ornate elegance. The formulation of tests made it apparent that the criterion of good handwriting is its legibility, and that school drills must be devoted to accomplishing this in the least possible time and assure speed to the pupil as well.

When tests were devised in arithmetic it helped to define the purpose and consequently the content of arithmetic instruction. It became evident that cube root, partial payments and other subjects that we of an older generation puzzled over interminably gave nothing that was worth while in real life. Such clutter was discarded and the arithmetic work in vogue now on which tests are based deals with fundamental concepts, processes and problems.

We must then define our aims in science teaching in order to formulate tests. If we are attempting to develop ability to see and solve problems the tests must be devised to measure the amount of such ability the pupils acquire. If we are trying primarily to impart a fund of information, the test must be of quite a different type. If the aim is to give to the pupil an aesthetic and intellectual appreciation of the commonplace environment, then the tests must be such as will snow how far the instruction is successful.

Third, we must be even more specific. The appropriate aims must be formulated for each stage of instruction. The list of words selected for spelling drills in the first grade is quite different from that for the fifth. The teacher of primary reading is largely concerned with putting meaning into words, making sure that the mental imagery associated with symbols i correct. The sixth-grade teacher is more concerned with the grasp of ideas expressive of relations. The scientific method of thinking is a complex process made up of many elements. There is included in it the accumulation of sensory experiences, analysis, synthesis, the registration of facts, the perception of queer or perplexing relations, the formulation of a guess or hypothesis in explanation, observation to a purpose, possibly experimentation, reasoning, and the formulation of judgment. The process may be established as a habit, it may be made rationalized habit, it may be adopted as an ideal method of procedure. Shall we undertake to accomplish all these things at once, or are children particularly apt at some of the involved elements at certain stages of their development so that we can focus attention on certain elements at one level of education, on others at another stage?

If information is to be acquired it must similarly be determined what information is to be attempted at each level. This will depend on the pupil's interest, capacity, social needs, etc.

It is evident from even such a cursory view of the situation that the problem of the organization of science instruction is no mean one, that it involves the accumulation of a mass of information much of which we do not yet possess and that the principles involved must be worked out patiently as must those involved in any other scientific problem.

Fourth, the application of tests to science teaching will necessarily force us to a careful reconsideration of methods. When a well devised writing scale is applied to a school system and it is found that the results show the school in question scores much below the normal standard, at once the method of instruction must be carefully scrutinized to find out the reasons for the failure. Suppose that we could come to an agreement on ten or twenty important biological generalizations that should be clearly in the minds of pupils after the high-school course, such as a clearcut notion of evolution, Mendel's laws, the cell as the unit of structure and function, of the adjustment of organs to function, the adaptation of the organism to its environment, the differentiation of structure and the concomitant specialization of function, topics that are treated in the main in every textbook. Then suppose we could agree on some tests on these items and could standardize them. The results would facilitate the evaluation of the work of a given school or a given teacher. Such a standardized test would at once eliminate the ambiguity that pertains to grades now given. For the scoring would not represent the individual teacher's judgment of pupils' attainments on the basis of his personal ideas of what should be accomplished but would represent a grade of attainment capable of comparison with that of other teachers and other schools. Such a survey of present accomplishment on the basis of current texts and methods would be very worth while. The results would undoubtedly be a revelation of inefficiency, as the standardized tests have been almost universally. Such a test would have, too, only temporary value, for it can scarcely be doubted that the aims, methods, and materials of science instruction will change with revolutionary rapidity once we start the testing process. But its immediate value would be immense. It would force immediately investigation of the best methods to get these generalizations over into the minds of the pupils.

SMALL OUTPUT OF DRAINTILE.

Draintile is used principally in the improvement of farm lands in the Central States, where large quantities of it are laid annually. Notwithstanding the efforts to increase agricultural endeavors, its decrease in value in 1918 was $3,620,000, or thirty-three per cent. The output in 1918 was valued at $7,388,000, which, with proper allowance for increased cost, was probably the smallest output since 1903.