PSYCHOLOGY OF ELEMENTARY SCHOOL SUBJECTS

REED

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BY

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PREFACE

During the last ten years the foundations for the teaching and learning of the elementary-school subjects have changed from experience and opinion to experiment and science. This is true particularly of the subjects of reading, arithmetic, handwriting, and spelling. It is true in part for language, but only to a small extent for the subjects of history, geography, general science, art, home economics, and manual training. It is the purpose of this book to give teachers and those interested in the scientific study of education an introduction to the scientific studies which have given us this new foundation for the psychology of the elementary-school subjects. Most of these studies have hitherto appeared only in professional journals where they are inaccessible to the majority of teachers. They also lack organization, and give the reader the impression of a vast aggregation of facts having little connection with each other. Every so often it is necessary to summarize and interpret the accumulation of scientific research, to take our bearings anew, to find out how far we have progressed, and to take a view of the new fields which lie ahead of us.

This was done in 1916 by Professor Freeman in his "Psychology of the Common Branches." Because of the small amount of scientific literature existing at that time most of his discussion was necessarily limited to general principles. It was again done in 1919 by Professor Starch in the third part of his "Educational Psychology." Since then, separate books and monographs have appeared on reading and arithmetic, but no single book has brought to the reader the results of the researches on all or most of the elementary-school

subjects. I have tried to do this for the subjects of reading, arithmetic, handwriting, spelling, language, history, and geography. I am deeply indebted to my wife, who has labored constantly with me in the production of this volume, and to my teachers in psychology: J. R. Angell, N. E. Byers, Harvey Carr, J. McK. Cattell, E. L. Thorndike, and R. S. Woodworth.

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PSYCHOLOGY OF ELEMENTARY SCHOOL SUBJECTS

CHAPTER I

INTRODUCTION: THE LAW OF REPETITION

What the Psychology of Elementary-School Subjects Is

The psychology of elementary-school subjects deals with the formation of habits that give skill in their acquirement and all the factors that influence those habits. These factors may be divided into two groups — native and acquired. The former consist of brightness, mental age, sex, age or maturity, instincts and emotions, likes and dislikes, and special capacities and defects; the latter consist of repetition, association or meaning, and devices for making an activity satisfying. There are, besides, certain environmental or hygienic factors that influence the learning process, such as kind of print, paper, and other material used; the child's habits of feeding, working, playing, and sleeping; and the condition of the light, temperature, air, and cleanliness of his places of study and living. Questions which must be considered with reference to all habits are their strength and the specific habits which should be formed. These can only be answered with reference to the demands of the society in which the pupil lives and works. The psychology of elementary-school subjects is therefore dependent on a sociological analysis of the needs of the pupil's community.

The Influence of Native Factors

The influence of native factors on performances in school subjects is a matter of interest to every teacher, for he cannot be held responsible for a pupil's work in so far as it is dependent on that pupil's heredity. The teacher is responsible only in so far as performance is dependent on training. But how much of a pupil's efficiency at any given time depends on his heredity and how much on his training is a problem very difficult to solve. We know that hereditary factors make a difference and that some make more difference than others. We know that an older pupil usually reads, writes, spells, and adds better than a younger one, that a bright child learns more easily than a dull one; that a pupil who is near his maturity in mental age can do more difficult problems than an eight-year-old who is equally bright; that intelligence makes more difference in arithmetic and reading than it does in spelling and handwriting; that intelligence makes more difference in learning school subjects than does sex; and that boys are usually superior in arithmetical reasoning and girls in arithmetical computation; but exactly how much of a pupil's skill is due to each we do not know. However, our effort to find out as nearly as we can is worth while, for hereditary factors are limiting conditions, and acquaintance with them enables us better to select the right kind of teaching and to apply it where it will do the most good.

The Acquired Factors

The acquired factors may be conveniently discussed under three laws: the law of repetition, the law of association, and the law of satisfaction. These are of foremost importance to a teacher, for on the extent to which he makes effective use of these depends the skill that he succeeds in developing in the pupil. The law of repetition refers to the fact that practice makes perfect. Other things being equal, the greater the

number of repetitions a learner gives to a subject, the greater is his skill in that subject. The law of association refers to the fact that the ease of learning is increased by making it meaningful, and the law of satisfaction refers to the fact that the ease of learning is increased if it is satisfying. Since effective teaching and learning depend upon the proper use of these laws, we shall discuss each of them in more detail.

The Law of Repetition

Repetition forms habits. How it does may be seen by doing such a simple thing as saying the alphabet backward twelve times in succession and observing the time of each repetition. One student in doing such an experiment required 60 seconds for the first trial, 35 for the second, 20 for the fourth, 18 for the eighth, and 17 for the twelfth. When the same student repeated the alphabet forward an equal number of times, she required 5 seconds for the first repetition and 4 for the twelfth. Repeating the alphabet forward required much less time than repeating it backward, because the learner in question had had many previous repetitions in doing this task, and therefore the habit was well formed. Because she had little practice in saying it backward and much in saying it forward, twelve repetitions made a large increase in her skill in the first task and little in the second. This shows us not only that repetitions form a habit very rapidly at first, but also that they add little to a learner's skill when the habit is once well formed.

Such Experiments Justify Drill

In a simple experiment of this kind we see a justification for that old-fashioned teaching which required boys and girls to do a thing over and over until it was mastered. In spite of the fact that nothing is easier than to require repetition after repetition, the degree of skill obtained by this

method was only moderate. Although modern teaching is more varied and interesting, the results in the fundamentals of the elementary subjects are very little better. Very few graduates of the eighth grade can add problems of three digits wide and nine digits high with an accuracy greater than 80 per cent. A still smaller percentage can write a letter of a hundred words which is errorless in sentence structure, spelling, capitalization, and punctuation. Evidently there is need of more of the practice that makes perfect.

Repetitions should be Attentive

The kind of practice that makes perfect depends upon something else than the number of repetitions. The first of these is that repetitions must be attentive. Although most grown-ups have looked daily for over twenty years at the face of a watch dial with Roman numerals hardly any can draw such a dial correctly from memory. They will write IV instead of IIII, write VI between V and VII and leave out the second hand which takes its place, write the I's on the wrong side of the V in VII and VIII, write the V's upside down or maybe at right angles to the correct position. The reason for such errors is that people never examine the make-up of the face of a watch attentively, and consequently never learn it. Other instances of the effect of inattentive repetitions may be found by asking a pupil how many steps there are leading to his front porch or the upstairs of his house, the color of the houses which he passes by daily on his street, or the designs on the wall paper of the various rooms of his house. In very few cases will he be able to give accurate information on such matters.

Repetitions should be Intense

A second factor is that repetitions are more effective when they are intense or vigorous. This was shown in memory experiments made by Witasek and by Gates. Witasek inves-

tigated the retentive value of intensity by varying the proportion of passive and active reading in memorizing rows of nonsense syllables. The difference between the passive and the active reading was that in the former the subject read the rows, whereas in the latter he recited them from memory as much as possible and was prompted after he halted as long as ten seconds. A row was given a certain number of repetitions varying from 0 to 15. The effect on retention was measured by the time required to memorize a row by the recitation method one hour after the first series of readings. When a row was given eleven passive readings, the learning time was two hundred and thirty-six seconds, but when it was given six passive and five active readings, the learning time was only one hundred and forty-three seconds. When a row was given twenty-one passive readings, the learning time was two hundred and two seconds, but when it was given six passive and fifteen active readings, the learning time was only one hundred and thirty-three seconds. Although there were some exceptions, the results showed that the degree of retention was closely in proportion to the number of active readings. The same fact was shown in the experiment of Gates, which was better controlled, and in which both meaningless and meaningful materials were used. The former consisted of rows of sixteen nonsense syllables, and the latter of short biographies of one hundred and seventy words each. The effect of the intensity of the repetitions was investigated by varying the proportions of time devoted to reading and recitation, and its retentive value was measured by calculating the percentage remembered after four hours. When all the time was devoted to reading, 15 per cent of the nonsense syllables and 16 per cent of the meaningful material was remembered after four hours; when four fifths of the time was devoted to recitation, 48 per cent of the nonsense and 26 per cent of the meaningful material was remembered. The results for two fifths and three fifths of the time

devoted to recitation were consistent with these; that is, the amount remembered was proportional to the amount of time devoted to recitation. This is true for both meaningless and meaningful materials; but recitations count more for the first than for the second, no doubt because the effect of the intensity is modified by the effect of association in case of the meaningful material. Reciting is a better method of memorizing, because it is more intense and vigorous. This is true not only of the entire repetition but also of the halting, or difficult, points, which are given particular emphasis.

Repetitions should be Distributed

A third factor is that repetitions are more effective when distributed. The author found that an hour's addition yielded a gain of 37 per cent in speed when distributed in the form of one sitting a day for three days as against a gain of 12 per cent when the hour's practice was all done in one sitting. Similarly, Pyle found that forty-five hours of practice in typewriting yielded a speed of seven hundred words in the last half hour when the practice was distributed over two sittings a day for forty-five days; but when the practice was distributed over ten sittings a day for nine days, the speed in the last half hour was only five hundred and fifty words. Starch found that in substituting numbers for letters, one hundred and twenty minutes of practice yielded a speed of two hundred and sixty substitutions in the last five minutes when the practice was distributed over two sittings a day for six days, a speed of two hundred and fifty when it was distributed over one sitting a day for six days, a speed of one hundred and eighty when it was distributed over one sitting a day for three days, and a speed of one hundred and fifty when it was all in one sitting. Lyon found that it required one hundred and thirty-eight minutes to learn a row of seventy-two nonsense syllables when he did all the work at one sitting, but a row of equal length required only twenty-five minutes

when he read it once a day until learned. Such results justify the rule that the more distributed the repetitions, the more effective they are; but there are some exceptions due to the nature of the subject matter, the amount of the distribution, and the amount of the practice at one sitting. The reasons for the favorable effects of distribution are that it produces less fatigue, gives more first impressions, and gives the learner the benefit of increased strength in the neurones which have had their nutrition stimulated by exercise. Since subject matter and susceptibility to fatigue condition the nature of the distribution, it must be worked out for each school subject and for each grade.

Repetitions should be distributed according to the Difficulty of the Bond

Another problem in distribution is to give each habit an amount of practice in proportion to its difficulty. The investigations of Thorndike and Osburn in arithmetic have shown that the easy combinations such as $2 + 2$ and $5 + 5$ occur with a far greater frequency in textbooks than the difficult combinations such as $8 + 9$. Similarly, the investigations of textbooks in reading by Housh, Packer, and Gregory have shown that little and easy words occur many hundreds of times, while nearly half the words used occur but once or twice. The result of such conditions is that the performances are quick and accurate for the easy tasks, but halting and inaccurate for the difficult ones. If the frequencies for the different tasks could be made more even, a much higher efficiency could be obtained without any extra effort.

Repetitions should be motivated by a Record of Progress

A factor in making repetitions more effective is to motivate them by a record of progress. We shall see in later pages that enormous gains in speed in arithmetic and in reading were made by pupils after they once began systematic practice and