

NATIONAL ACADEMY OF SCIENCES

EDWARD LEE THORNDIKE

1874—1949

A Biographical Memoir by
ROBERT S. WOODWORTH

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Biographical Memoir

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E. L. Thorndike

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At the turn of the century, when psychology as an experimental science was very much in its beginnings but attracting a group of energetic young investigators, an outstandingly energetic, daring and even iconoclastic member of the group was the man who now, at the end of a very active career of fifty years, is recognized as the most productive psychologist our country has produced. Edward Thorndike started young and continued his scientific output until his death at nearly 75 years of age. His full bibliography counts up to over 500 titles of which over 50 are books; and almost everything he wrote was based directly on data, usually on new data; for it was characteristic of him to dislike any abstract discussion not tied closely to concrete facts.

His parents and grandparents were all natives of the state of Maine. His father, Edward Roberts Thorndike, a vigorous, fine-looking man of active mind and generous, impulsive disposition, first practiced law in Maine and then became a Methodist clergyman and a noted preacher in Massachusetts where most of his pastorates were located. He married Abigail Brewster Ladd, described as an extraordinarily intelligent and capable person, of marked artistic ability, deeply religious and of shy, gentle manner but with a will of steel. Her widowed mother, a woman of unusual ability and courage, was a helpful and much-appreciated member of the Thorndike household. Four highly gifted children were reared in this household, all of whom lived to make their mark in the scholarly world: Ashley and Mildred in English literature, Lynn in medieval history, and Edward in psychology and the science of education. Ashley was the oldest and Edward the next in order.

Edward learned to read at home but attended school regularly from the time he turned five years old. Beginning at the age of twelve he attended the high schools of Lowell, Boston and Providence. He made a superior undergraduate record at

Wesleyan University, 1891-95. His interest so far, conforming to his family background, was in literature and "general erudition" and not in science. Going next to Harvard for graduate study, he still made literature his major subject. Meanwhile, as a college junior, he had occasion to study certain chapters of the *Principles of Psychology* by William James and found that book the most stimulating he had ever read. At Harvard, accordingly, he attended James's lecture course, with the result that during that first year he made a decisive shift from literature to psychology. In the second year he undertook as his research project an experimental study of the instinctive and intelligent behavior of young chicks, a topic which he himself suggested though not at the time with any far-reaching plan—"not at all," as he said later, "because I knew animals or cared much for them, but because I thought I could do better than had been done." Since animals were not allowed in the laboratory he did the work in his own room and later in Professor James's cellar. He got results; the experimental method proved fruitful; and when he went to Columbia as a Fellow the following year, he was encouraged by Professor Cattell to continue this line of work. The resulting dissertation on *Animal Intelligence*, 1898, is a landmark in the history of psychology. It inaugurated the laboratory study of animal learning and demonstrated that animal behavior observed under experimental conditions could help solve the general problems of psychology. It was quickly paralleled at Clark University and followed up in many other universities, and the animal laboratory has ever since been an important factor in the development of scientific psychology.

Thorndike delighted to honor James and Cattell as his masters in psychology. Neither of them was responsible for this epoch-making investigation of animal learning nor for his resulting devotion to the experimental method. James was responsible for his initial attraction toward psychology as a natural science dealing with the "rich details of concrete human nature." Cattell was responsible for initiating him into the "quantitative treatment of mental facts," and Franz Boas at Columbia showed him the value of the newer statistical methods. Experiment and

measurement—these two were Thorndike's guiding stars throughout his career.

That first paper of his on *Animal Intelligence* is a landmark in more ways than one. Not only did it inaugurate the animal laboratory in psychology, but it also announced as its major result a new law of learning, additional to the old standard laws of association and important enough, though often combated by other psychologists, to become and remain the focal point of most subsequent discussions of the theory of learning. This new result could emerge because of Thorndike's novel form of experiment. Previous experimental work on learning—some of it excellent—had assigned the learner a poem to memorize, the Morse telegraphic code to master in sending and receiving messages, or some other fixed lesson to be learned. Thorndike placed his chicks, cats or dogs in a problem situation where alternative responses were possible and the first response was unlikely to be successful. The question was whether the animal, perhaps after much trial and error, would learn to do the right thing in the situation—and how rapid his learning might be. For example, a kitten was placed in a slatted box the door of which was loosely bolted, and a bit of fish was placed just outside as a reward. Usually a kitten would not touch the bolt except after making a number of more natural responses. But in a series of trials the unsuccessful responses would fade out and the correct response would occur more and more quickly. The "effect" or outcome of any response was thus a powerful factor in its elimination or establishment. As Thorndike used to phrase it, the law of effect stated that a satisfactory outcome of any response tended to "stamp in" its connection with the given situation, while an unsatisfactory outcome tended to "stamp out" the connection. Whereas previous theories had accepted repetition as the potent factor in learning, Thorndike laid at least equal stress on "effect," i.e., on success or failure, reward or punishment, satisfaction or annoyance to the learner.

Furthermore, the process of stamping in or out appeared from the data on cats and dogs to be gradual and not indicative of sudden insights such as may often occur in man. In a follow-

up study of monkeys (1901) Thorndike found more evidence of rapid learning, but it still seemed probable that what was learned was stimulus-response connections, and that the superiority of monkey to cat, and even of man to monkey, was fundamentally a greater facility in forming connections or associations. This was the germ of his "quantitative theory of intelligence."

After a single year of teaching at Western Reserve University he returned to Columbia in 1899 and undertook the task of developing a scientific educational psychology in Teachers College. He brought to this task his firm conviction of the value of experiment and measurement, and it can fairly be said, as it has been said repeatedly, that Thorndike more than any other man introduced scientific methods into the study of education. In this field, once more, he was the pioneer who opened the way for an immense amount of investigation. The further development of animal psychology he left mostly to others, devoting his own efforts to educational psychology. The law of effect he found directly applicable to education, since it indicated that mere repetitive drill would be ineffective. The child should obtain satisfaction from his correct responses, and his lessons should be such as would enlist a child's interest and awaken a zeal for immediate achievement. By experimental studies of children's specific difficulties in reading, arithmetic, algebra and other subjects Thorndike and his pupils worked out procedures for meeting the child on the child's own ground and for individualizing education.

A major contribution was his attack on the doctrine of "formal discipline," an attack dating from 1901 but repeated at intervals, always with fresh evidence. Traditionally, education was supposed to exercise and develop the mental faculties, so that the educational value of geometry, for example, lay in its power to develop the faculty of reasoning. Thorndike was suspicious of this doctrine from the start. He proceeded to test it by use of the "transfer" experiment. He would give a person intensive training in some narrow field and then test that person's abilities in a more inclusive field and determine how much improvement could be demonstrated beyond the limits of the special

training. The experiment showed on the whole a meager transfer effect which could be explained without the assumption of generalized faculties and abilities. The ability developed by training in one line of work was specific and did not spread to other lines of work except when what had been learned could be utilized in a concrete way. Accordingly he urged that school subjects should be valuable for their content and not merely for drill. He applied this criterion both to the detailed content of each school subject and to the curriculum as a whole. He did not rest his case entirely on this laboratory experiment. Much later (1924, 1927) he published extensive investigations of the after-effects of different high-school subjects. It appeared that the only justification for any subject was the intrinsic value of its subject matter to the student. A good student will gain from any subject that enlists his interest and wholehearted effort. "When the good thinkers studied Greek and Latin, these studies seemed to make good thinkers. Now that the good thinkers study physics and trigonometry, these seem to make good thinkers. If the abler pupils should all study physical education and dramatic art, these subjects would seem to make good thinkers. These were, indeed, a large fraction of the program of studies for the best thinkers the world has produced, the Athenian Greeks."

Both of his early experiments—the one on transfer and the one on animal learning—led up to Thorndike's celebrated theory of the specificity of abilities. A third approach which he soon adopted was statistical rather than experimental; it utilized Karl Pearson's correlation coefficient, then newly invented. If abilities are manifold and specific, an individual can be strong in some while weak in others, even within the range of such a "faculty" as memory or reasoning; but so far as ability is generalized, the correlation between different performances will be high. Large-scale investigations showed low correlations between abilities, as a rule, and so confirmed Thorndike in his specificity theory. He soon encountered strong opposition, however, from the British psychologist, Charles Spearman, who showed how the correlational facts could be interpreted as

indicative of one general ability combined with many specific abilities.' So began a controversy which lasted for several decades, enlisting able supporters on both sides, unearthing many important facts, and developing new statistical methods such as are now used in factor analysis. Thorndike adhered to his "quantitative theory" which held that the only general ability was the ability to learn associations or connections. A higher level of ability simply depends on more numerous and more subtle connections. In this as well as other controversies Thorndike revealed one of his most notable characteristics: he would hold up his end with all vigor and assurance, but without any personal animosity. Indeed the contestants joined in a co-operative effort to make sure of the relevant facts.

Very influential in the early days was Thorndike's *Introduction to the Theory of Mental and Social Measurements*, 1904, a textbook based on the view that non-mathematical investigators in psychology and education should be enabled to make intelligent use of statistical methods, understanding the principles involved and appreciating both the great need for quantitative study of human behavior and the inherent difficulties of such an enterprise. Without being himself a highly trained mathematician, he possessed a keen sense for the realities and probabilities. In his own researches he successfully attacked a whole series of ticklish statistical problems. Many of his students joined in promoting the cause of measurement in education: measurement of the individual child's capacity and readiness for the school subjects, measurement of the pupil's achievement, measurement of teaching effectiveness. Thorndike was especially active in the invention and improvement of tests. He worked out scales of achievement in arithmetic, reading, English composition, handwriting, drawing, etc., by which a child's progress could be objectively measured. He insisted on the need for tests scaled in equal units and based, wherever possible, on an absolute zero of achievement in each kind of ability.

The three-volume text on *Educational Psychology*, 1913-14, brought together his major research interests in the period preceding the first World War. The psychology of learning was

given full treatment, starting with the laws of learning derived from his animal experiments and proceeding to a critical analysis of all available data on the improvement of human abilities by training. In the section on the "original nature of man," which was based largely on his personal observations of young children, he sought to escape from the customary vague generalities concerning instincts and to substitute specific statements on innate connections between situations and responses. Another large section of the same book dealt with individual, family, race and sex differences and their dependence on heredity and environment, this being one of his long-continued interests. There was also an extensive treatment of mental fatigue and the work curve, representing an early line of research which he did not continue, except for his study in 1914-16 of the effect of room ventilation on mental work.

During the first World War, while remaining in civilian status, he was one of the most active and effective psychologists who participated in the personnel work of the Army. He contributed to the introduction of the group intelligence tests and tests for aviators. The psychologists of that day made a genuine contribution to the war effort and acquired much new technique and knowledge of testing. Thorndike was one of those who made good use of this experience for civilian purposes after the war. The Thorndike college entrance test was especially famous. Always responsive to the call of duty and opportunity, he engaged in a wide variety of scientific and educational enterprises. As he said in his brief autobiography (1934), "Within certain limits set by capacity and interest I did in those early years and have done since what the occasion seemed to demand . . . Probably it would have been wiser to plan a more consistent and unified life-work . . . but I am not sure."

From 1922 on, however, he was enabled to devote his energies to large-scale investigations in the Institute of Educational Research at Teachers College, with financial assistance from the large Foundations. He was now free to choose his lines of work, and he chose two main lines, mental measurement and learning.

In the work published in 1926 on *The Measurement of Intelligence* he made a determined effort to provide a measuring instrument that would meet the requirement of equal units reckoned from an absolute zero. The technical scaling methods are rather intricate, but the resulting instrument has stood up under continued use and expert criticism. This test scale, the "CAVD," combines four sorts of task: completion, arithmetic, vocabulary, directions. There are 17 levels of difficulty, ranging from the level of the three-year-old child up to that of a very superior adult. The child of three is nowhere near the absolute zero, being already 23 of those equal units above zero, more than halfway up toward the peak of intellectual ability. The peak, according to Thorndike's results, is not reached till late in the teens or early in the twenties, and the decline from the peak is very slow and gradual in the next two decades at least. In his studies of *Adult Learning* (1928) and of *Adult Interests* (1935) he showed that both the ability to learn and the interest in learning something new and valuable were still good enough in the forties to justify adult education as a means of enabling people to keep pace with their changing world.

In his renewed investigation of the process of learning (reported largely in the *Fundamentals of Learning*, 1932, and the *Psychology of Wants, Interests and Attitudes*, 1935) he rechecked his early theory by means of a whole array of novel experiments, designed to separate the results of reward and punishment, of satisfaction and annoyance. The law of effect stood firm in its positive phase but showed weakness in its negative phase. The "stamping in" of successful responses was fully as important as he had ever believed, but the "stamping out" of unsuccessful responses was a much less potent factor. Satisfaction, he concluded, brought into play a "confirming reaction" of the organism, but annoyance did not have a directly opposite effect. Punishment could do good indirectly by inducing the organism to shift from the punished response to some other response which might prove successful; but the learning was due essentially to the confirmation of the successful response. Punishment, as well as reward, could be informa-

tive, but reward and satisfaction operated not only at the conscious level of clear observation and definite selection of the successful responses but also at a much more primitive and physiological level. Reward, he found, could even at times reinforce an unsuccessful act that happened to occur close to a successful act—the “spread of reward” which we might also call the blunderbuss effect. In his subsequent applications of learning theory to educational and social problems, accordingly, Thorndike laid much greater stress on rewards than on punishments. “Except when and as it causes the person to shift to the right behavior and receive a reward therefor, the punishment has no beneficial effect comparable to the strengthening by a reward. . . . Psychology emphasizes the importance of making a community attractive to the able and good rather than unpleasant for those who are incompetent and vicious.” So he wrote in one of his last books, *Human Nature and the Social Order*, 1940.

Thorndike was unwilling to recognize any limits to the scope of quantitative science. In 1903, indeed, he admitted that the aim and goal of education were to be determined “not by facts but by ideals,” and that science was therefore concerned only with discovering the best route to the ideal goal. But his mature view was altogether different. In his 1934 presidential address before the American Association for the Advancement of Science he urged on the scientific world the view that values, being dependent on human wants, were facts of nature, lying properly within the scope of natural science, even though any adequate measurement of human values might be a difficult undertaking. An often quoted statement dates from 1918: “All that exists, exists in some amount and can be measured.” In the 1940 book just quoted he applied this postulate to values: “Any want or satisfaction which exists at all exists in some amount and is therefore measurable, how exactly . . . we cannot tell until we have tried.”

A characteristically extensive research of his later years (1937-1944) attempted to apply to cities the statistical methods that had served him well in the study of individuals. This was

another bold pioneering job. He assembled from the census and other sources the available data on the health, economics, educational and recreational facilities, etc.—nearly 300 items in all—for each of the over 450 cities in the United States having a population in 1930 of at least 20,000. He wished to determine the value of each city as a good place for good people to live. He selected 37 of the items as partial indicators of goodness and constructed a weighted composite of these 37 variables for his general index, G , of city goodness. The cities showed a wide and challenging range of G values. In the hope of discovering causal factors for this wide variation of G , he used the methods of correlation, including partial correlation and path coefficients. Many supposedly important factors, including the mere size of a city, proved to have little influence on G , but a large share of the variation, as much as 75-80 percent, could be attributed to the personal qualities of the citizens, to their income level, and to the combination of these two. Aside from the statistical skill and acumen of this investigation, its originality lay in the determined effort to obtain and use some defensible objective measure of the human value of a city.

Another of his latest enterprises might seem to lie outside the field of science but is nevertheless a fine example of his scientific methods. He prepared a series of English dictionaries for school use (1935-1948), ranging in level from the early grades to the secondary school. He had previously made an elaborate word count as a basis for determining which words, because of frequent use, deserved emphasis in the teaching of reading and spelling (*The Teacher's Word Book*, 1921, 1944). His dictionaries were based upon the principle of meeting the child's needs. Words and meanings should be included which were likely, according to the word counts, to be encountered and looked up in a dictionary. The definition (or explanation) of any word should be adapted to the probable background of a child who would look up that particular word. And the definition should never be formulated in more difficult or unusual words than the word defined. Also, the beginner's dictionary should include lessons on how to use a dictionary with satisfac-

tion. This work, now recognized as an important contribution to lexicography, shows the Thorndike traits of experimental and quantitative approach, unending patience, and practical good sense. It illustrates a fact mentioned in a comprehensive review of Thorndike's life work*, that he was "a great tool-maker." *Experimental and statistical tools for research, tests and teaching methods for practical application*, were among his most distinctive contributions.

Not a few of Thorndike's labors throughout his career were concerned with the psychology of language in its practical aspects such as reading, writing, learning a foreign language, and the frequency in usage of words and their meanings. He did not fail to make scientific use of these labors. Late in life he published some significant studies of phonetics and semantics and offered a psychological theory of the origin and development of language.

That Thorndike was a prodigious worker has been reported by his coworkers and is evident from his vast output. More than that, he was an efficient worker, quick to get started, free from internal friction, unhampered by meticulous pedantry, avoiding unnecessary work. He liked to work intensively and *continuously* until a job was finished. When he started to read a book—being himself an extremely rapid reader—he liked to finish it at a single sitting. He would relax for a few puffs of a cigarette and resume speed on the task in hand. When he tackled a new problem, he would quickly appraise the possibilities and adopt a tentative plan of attack, feeling perfectly free to shift to a more adequate plan after becoming better acquainted with the intricacies of the problem. The work he liked best was done in his own well-equipped study in long hours free from any danger of interruption.

Yet he was by no means a "lone worker" in the usual sense. He was an excellent collaborator, an effective committee member, responsive to proper demands on his time and sometimes taking the initiative in organizing a working committee. Though

*Florence L. Goodenough, Edward Lee Thorndike: 1874-1949. *Amer. J. Psychol.*, 1950, 63, 291-301.

he disliked speculative debate, he was fair-minded and even-tempered in discussion, tolerant of divergent views though always asking for "the evidence." As the head of a working organization he was considerate and generous of credit to his subordinates who regarded it as a privilege to work with him. As a teacher he showed the same qualities, and though his courses were rather strenuous for the students, his success was shown by the large number who followed his lead as investigators in the educational field.

His preference in social life was for a small circle of intimate friends rather than for any large gathering. The annual meetings of the national scientific societies he found unduly fatiguing. It was Thorndike who took the initiative in assembling a small group of colleagues and moving well out into the country to form the "Montrose colony" of Columbia families. Always a good earner, he made it a practice to spend freely for personal and family comfort and convenience and for other worthy and reasonable causes. As a friend and neighbor—and as a husband and father, the head of an admirable family—he was generous and always dependable, full of cheerful initiative, much loving and much beloved.*

*The high esteem in which Dr. Thorndike was and is held by his immediate colleagues and coworkers is admirably revealed by the appreciative reviews of his work contained in the *Teachers College Record*, 1926, 27, 458-586; 1940, 41, 695-788; 1949, 51, 26-45. These reviews provide the main source of information on his career.

EDWARD LEE THORNDIKE: VITA

- Born: Williamsburg, Mass., August 31, 1874.
Died: Montrose, N. Y., August 9, 1949.
Wesleyan University, Conn.: A.B., 1895; Sc.D., 1919; Trustee, 1934.
Harvard University: A.B., 1896; A.M., 1897; LL.D., 1934.
Columbia University: Ph.D., 1898; Sc.D., 1929; Butler Medal, 1925.
Other honorary degrees: Sc.D., University of Chicago, 1932, and University of Athens, Greece, 1937; LL.D., University of Iowa, 1923, and University of Edinburgh, 1936.
Western Reserve University: Instructor in Education, 1898-99.
Teachers College, Columbia University: Instructor in Genetic Psychology, 1899-1901; Adjunct Professor of Educational Psychology, 1901-04; Professor, 1904-40; Emeritus Professor, 1940-49; Director, Division of Psychology, Institute of Educational Research, 1922-40.
Marine Biological Laboratory of Woods Hole: Head, Department of Comparative Psychology, 1900-02.
Cornell University: Messenger Lecturer, 1928-29.
Yale University: Lecturer, Summer 1931.
Johns Hopkins University: Visiting Professor, 1931-32.
Teachers College, Columbia University: Kappa Delta Pi Lecturer, 1939.
Harvard University: William James Lecturer, 1942-43.
New York State Commission on Ventilation, 1913-22.
United States Army: Chairman, Committee on Classification of Personnel, 1917-18, and Member of Advisory Board, Division of Psychology, Office of the Surgeon General, 1917-18.
American Council on Education: Committee on Problems and Plans.
Motion Picture Research Council: Member of National Committee.
Carnegie International Examination Enquiry, 1938.
Lexicographic Advisory Committee, 1936-1941.
National Academy of Sciences: Member, 1917.
American Philosophical Society: Member, 1932.
American Academy of Arts and Sciences: Fellow, 1934.
New York Academy of Sciences: Fellow, 1901; Vice President, 1902; President, 1919-20.
American Association for the Advancement of Science: Fellow, 1901; Vice President, 1911, 1917; President, 1934.
American Psychological Association: President, 1912.
Psychometric Society: President, 1936-37.
American Association for Adult Education: President, 1934-35.
Society for the Advancement of Education.
Society of Naturalists.
Galton Society.
American Economics Association.
American Sociological Society.

British Psychological Society: Honorary Member, 1926.
 Leningrad Scientific-Medical Pedological Society: Honorary Member,
 1928.
 Comenius Educational Association of Czechoslovakia: Honorary Member,
 1929.
 Phi Beta Kappa.
 Sigma Xi.
 Kappa Delta Pi.
 Cosmos Club, Washington.
 Century Association, New York.
 Married, 1900, Elizabeth Moulton. Children: Elizabeth Frances, a mathe-
 matician; Edward Moulton, a physicist; Robert Ladd, a psycholo-
 gist; Alan, a physicist.

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KEY TO ABBREVIATIONS

Amer. J. Hyg. = American Journal of Hygiene
 Amer. J. Psychol. = American Journal of Psychology
 Amer. J. Pub. Health = American Journal of Public Health
 Amer. J. Sociol. = American Journal of Sociology
 Amer. Nat. = American Naturalist
 Ann. N. Y. Acad. Sci. = Annals, New York Academy of Sciences
 Arch. Philos. Psychol. Sci. Meth. = Archives of Philosophy, Psychology
 and Scientific Methods
 Arch. Psychol. = Archives of Psychology
 Brit. J. Educ. Psychol. = British Journal of Educational Psychology
 Columbia Univ. Contrib. Philos. Psychol. Educ. = Columbia University
 Contributions to Philosophy, Psychology, and Education
 Comp. Psychol. Monogr. = Comparative Psychology Monographs
 Educ. Forum = Educational Forum
 Educ. Rec. = Educational Record
 Educ. Rev. = Educational Review
 Elem. School J. = Elementary School Journal
 Eug. News = Eugenic News
 Harvard Educ. Rev. = Harvard Educational Review
 Internat. Mo. = International Monthly

- J. Abnorm. Soc. Psychol. = Journal of Abnormal and Social Psychology
 J. Adult Educ. = Journal of Adult Education
 J. Amer. Statist. Assoc. = Journal, American Statistical Association
 J. Appl. Psychol. = Journal of Applied Psychology
 J. Bus. Educ. = Journal of Business Education
 J. Educ. Psychol. = Journal of Educational Psychology
 J. Educ. Res. = Journal of Educational Research
 J. Exp. Psychol. = Journal of Experimental Psychology
 J. Gen. Psychol. = Journal of Genetic Psychology
 J. Hered. = Journal of Heredity
 J. Ped. = Journal of Pedagogy
 J. Philos. Psychol. Sci. Meth. = Journal of Philosophy, Psychology and Scientific Methods
 Math. Teach. = Mathematics Teacher
 Mech. Eng. = Mechanical Engineer
 Nat. Acad. Sci. Biogr. Mem. = National Academy of Sciences Biographical Memoirs
 Nat. Soc. Study Educ. = National Society for the Study of Education
 Ped. Sem. = Pedagogical Seminary
 Pop. Sci. Mo. = Popular Science Monthly
 Proc. Amer. Philos. Soc. = Proceedings, American Philosophical Society
 Proc. Nat. Acad. Sci. = Proceedings, National Academy of Sciences
 Psychol. Bull. = Psychological Bulletin
 Psychol. Clinic = Psychological Clinic
 Psychol. Rec. = Psychological Record
 Psychol. Rev. = Psychological Review
 Pub. Op. Quart. = Public Opinion Quarterly
 Quart. J. Econ. = Quarterly Journal of Economics
 Quart. J. Speech = Quarterly Journal of Speech
 School Rev. Monogr. = School Review Monograph
 School Sci. Math. = School Science and Mathematics
 School Soc. = School and Society
 Sci. Mo. = Scientific Monthly
 Teach. Coll. Rec. = Teachers College Record
 U. S. Bur. Educ. Bull. = United States Bureau of Education Bulletin
 Univ. Calif. Chron. = University of California Chronicle

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