Early Forerunners: Before 1900

The forerunners of educational technology can be seen in the polychromatic, lifelike bison sketched in the deep recesses of cave walls by Cro-Magnon artists. These animal paintings, often of astonishing precision and beauty, were Totemistic in the sense that they constituted a symbolic magic for the primitive hunter. But, aside from this function, these paintings marked the first step in man’s need and desire to communicate.

Primitive children were taught to observe, imitate, and participate in activities vital to the survival of the tribe. Dramatization and demonstration of tribal arts and skills constituted an essential part of their instruction. The oral tradition emphasized memory and training, and continued to be the primary method of instruction even after the development of a simplified and flexible alphabet led to the spread of writing and reading. The more advanced the culture, the more complex became the technology of instruction. The aim of each age or society has been to find the basic skills or subject content which offer promise of transferring cultural heritage to learner behavior. Each significant shift in cultural values over the centuries has led to new theories of knowledge and learning and to new technologies of instruction.

Methods Foreshadowing
Modern Educational Technology

Although historical instructional methods were not based on science as we understand it, they embodied many concepts that influenced the thinking, language, method, research, and development of subsequent methods or technologies. For example, some early educators (the Sophists) were aware of the problems associated with perception, motivation, individual differences, and evaluation and recognized that different instructional strategies achieved different behavioral outcomes. What is more, they analyzed modes of effective instruction and made hypotheses to take into account the factors disclosed by their analyses, just as current researchers do.

The major difference between such early inquiries and those of contemporary research lies in the invention and refinement of modern
research instruments and scientific design. Even with these advances, however, we have taken only the first tentative steps toward the development of a mature science and technology of instruction.

Criteria Used to Select Educational Technology Antecedents

The choice of theoretical and methodological antecedents of educational technology for this chapter was guided mainly by two broad criteria. First, only the theories and methods of professional teachers were included, thus automatically eliminating the work of religious figures known as "great teachers" and nonteaching philosophers such as Rousseau and Locke who, nevertheless, influenced the educational practices of others. The second, and most important, criterion was to identify the most distinctive instructional techniques that were key precursors of a modern science and technology of instruction.

The Elder Sophists: Ancestors of Educational Technology

The Elder Sophists, a small group of peripatetic teachers drawn to Athens during the last half of the fifth century B.C., were probably the first instructional technologists.\textsuperscript{2} We know that there were five Elder Sophists: Protagoras of Abdera (ca. 500 B.C.), Gorgias of Leontini (ca. 485-380 B.C.), Prodidus of Cos, Hippias, and Thrasymachus.\textsuperscript{3} The Sophists never formed a school in the institutional sense, but rather operated as freelance teachers in competition with each other, accepting fees for their work.\textsuperscript{4} Since it was not customary to accept payment for teaching in those days, they persuaded the public to purchase their skills by resorting to publicity stunts such as donning purple robes or making proclamations from a throne. Plato referred to the Sophist as a "paid hunter of the young ... a sort of trader in intellectual disciplines of the soul"; yet in his dialogue Protagoras, Plato attested to the Sophists' fame in a scene in which young Hippocrates roves Socrates from sleep to tell him that Protagoras has just arrived in Athens, and that the great Sophist teacher must be persuaded without delay to accept Hippocrates as a student.\textsuperscript{5}

Typically, a Sophist demonstration took one of three forms: a carefully prepared lecture, an exemplified lecture on a subject suggested by a member of the audience, or a free debate with another Sophist or some other person on a subject chosen by the audience. Once he had obtained students, the Sophist taught by a modified tutorial system.\textsuperscript{6} For the first time, the relationship was not between a tutor and a single disciple, but between a teacher and a group of pupils. This was the first recorded instance of mass instruction.

Sophist Theory

The Elder Sophists belonged to the pre-Socratic-Promethean liberal tradition in Greek thought. The basic tenets were:

1. Man evolves through technology and social organization to a state of civilization where he can guide his affairs effectively.

2. This evolutionary process is continuous. Morality and law evolve and are accepted because they have survival value, and derive their sanction from social consensus, not from a priori absolute principles or from divine authority.

History is a slow but forward progress in the management of human affairs, neither cyclical nor regressive.

Society should be democratic and egalitarian.

The theory of knowledge is progressive, pragmatic, empirical, and behavioristic.\textsuperscript{6}

Not every Sophist expounded all these views, but all of them built on this common liberal tradition, which was condemned by Plato in his dialogues.

The Sophist believed all men were capable of intelligent, socially responsible self-rule, but that they could not achieve their potential without education. Plato, on the other hand, believed all men were destined for either a low or high social position, for subservience or leadership. In contrast to Plato's belief that virtue could not be taught and only aristocrats might be depended upon for right action, the Sophists believed in the value of teaching virtue and of defending a just cause. Plato also differed with the Sophists on the value of techne (technology). The Sophists honored all technology, which included both statecraft and handicraft, whereas Plato believed technology was unworthy of gentlemen and had no place in their education. The beginnings of the rift between culture and religion in ancient Greek education can be located in the age of the Sophists.

Instructional Method

The Sophists undertook to teach the art of politics and develop political arete — that is, the excellence of the individual human being in relation to an ideal that could be realized in a democratic community. This arete, for them, was primarily intellectual power and oratorical ability. To develop these skills was clearly the systematic expression of the principle of shaping the intellect, because it begins by instruction in the form of language, the form of oratory, and the form of thought. This educational technique is one of the greatest discoveries which the mind of man has ever made: it was not until it explored these three of its activities that the mind apprehended the hidden law of its own structure.\textsuperscript{7}

Although the instructional methods of individual Sophists varied, all used the expository lecture and "Sophistic dialogue," or group discussion method (probably invented by Protagoras) of solving problems.\textsuperscript{8} The lecture and group discussion techniques were combined by Protagoras into a third method applicable specifically in political activities, but which can also be considered an instructional technique. This technique is defined by Havelock as "the antithetical formulation of public positions and the setting of party lines which took place in any parliament or assembly where power was at stake and public policy was made."\textsuperscript{9}

The Sophists probably invented and developed the technique of analysis in teaching of rhetoric. By analyzing exemplary models of writing and speaking, they formulated rules for effective writing and speaking. Rhetoric was the chief subject of Sophistic instruction for two reasons: (1) In ancient Greece the oral tradition reigned supreme, and (2) the Sophists found rhetoric the most effective technique for transmitting practical knowledge.

In teaching rhetoric, they combined theory and application. First, the Sophist taught his students the rules (theory) of the spoken and written word. Then he prepared a model speech for them to copy, analyze, discuss, and present in actual spoken practice. The model discourses were often on a poetic, moral, or political subject, although sometimes a fantastic subject, such as a eulogy of mice or peacocks, was used to demonstrate pure virtuosity. The final objective was not precise imitation of the model, but the development of virtuosity
and the skill to use alternative formulas and accurately judge the relative merits of each according to the differing demands of each situation (application).

However, Sophist instruction was not confined to formal aspects of rhetoric. Their goal was a "polyhypotist," a man who possessed universal competence and knowledge in everything. Consequently, Sophist instruction was a combination of form and content. The technique of applied analysis was used to formulate whole bodies of cognitive rules in various fields: geography, natural history, logic, history, painting, drawing, music, religion, sculpture, and athletics. They also evolved a branch of rhetoric devoted to ideas. Their analytical approach enabled them to develop a rather sophisticated technology of instruction that combined rhetoric with eristic (the art of disputation).

Because Sophist procedures were inherently systematic, the student always knew what was expected of him, how he might achieve his goals, and how well he was progressing. And although Sophist methods have often been considered formal and rigid, they possessed a certain amount of flexibility in that the student could choose from a variety of formulas or modes of action for application to practical situations.

Influence of the Sophists

The Sophists had enormous influence on subsequent instruction and courses of study. Their use of rhetoric, dialectic, and grammar dominated the design of the "quadrivium" and the "trivium" (the seven liberal arts, as they came to be called), which made up the curriculum of European education for a thousand years to come. Before Plato overthrew the educational success of the Sophists and became the chief influence in the Western world, the Sophists offered a bold solution to a difficult problem that has still not been satisfactorily resolved. It is the current problem explored by Snow in The Two Cultures and the Scientific Revolution: One culture is presumed to be inhabited by people of science and another, separate, culture by people of letters. Yet, as Snow shows, science and technology do not necessarily deny art, any more than art or any of the humanities denies science. The Sophist solution was to combine the two cultures in a single concept, technique, or technology; this is the Sophist legacy.

The Socratic Method

Socrates (470-399 B.C.) left no writings; all we know of his teaching was gleaned from the works of his students, Plato and Xenophon. In contrast to the relativism of the Sophists, Socrates sought to understand the nature of virtue as a guide to moral conduct. Perhaps his most important educational contribution was the so-called Socratic method of instruction (inquiry). The inquiry was carried on through the give-and-take of conversation, which Socrates guided by a series of leading questions. In the Socratic method, the questioner used only those facts already known to the pupil. If the pupil had to collect data in order to reach a new conclusion, the teacher had strayed from the original Socratic technique.

A dramatic example of the Socratic method is described in Plato's Meno. Socrates, at random, selected a boy off the street and by clever questioning led him to demonstrate a geometrical theorem despite the fact that the boy had no previous mathematical training. This story has led some current leaders in the programmed instruction movement to mistakenly claim Socrates as their educational forefather. The Socratic method was dedicated, however, on the principle that knowledge is inborn and can be brought out by means of skillful questioning. Since the reinforcement schedule of the programmed text or machine is usually based on an entirely different principle (stimulus-response association), it is incorrect to claim Socrates as the forerunner of programmed instruction.

Abelard: Precursor of Scholastic Method

Scholasticism, an intellectual movement that flourished in Europe during the twelfth and thirteenth centuries, was a vitally productive and effective method of instruction. Its name was derived from the medieval term doctor scholasticus, which referred to authorized teachers in monastic or cathedral schools, for these teachers, best exemplified by Pierre Abelard, developed the distinctive methods of philosophical speculation that are associated with scholasticism—ultimately transforming some of these schools into universities, especially in the north of Europe.

Abelard Shapes the Pattern of Scholastic Instructional Method

The basic characteristics of the scholastic method were established by Abelard when he taught at the Notre Dame cathedral school (which became the University of Paris in 1180). By training his theology students in Aristotelian logical analysis, Abelard helped to transform theology from the mere citing of authorities into the interpretation of Scripture. His method was best represented by his famous book Sic et Non (Yes and No), wherein he presented the pros and cons of theological and philosophical propositions, leaving the formulation of conclusions to his students. Abelard allowed any subject or thought to be reasonably examined for the purpose of understanding, verification, or qualification. This method shocked many of his colleagues, who felt that Abelard gave his students the freedom to arrive at heretical conclusions.

Elements of Abelard's Method

In Sic et Non Abelard formulated 158 questions about the Trinity, Redemption, and the Sacraments. He placed the views of the authorities in one column and the opposite views in another column. His instructional procedure in reaching reconciliation was as follows:

1. The statements had to be read and studied in context to determine whether they were contradictory. Before the contexts could be fully considered, some historical research was usually required of either the teacher or other scholars.

2. Textual distortions were to be discovered and corrected. The necessary textual and criticism skills were a knowledge of etymology, grammatical form, and linguistics.

3. The next step was to judge the real meaning of each statement. Authorities could be consulted at this stage.

4. A final check was made to ensure that there was no later change by the authority of the cited passages on record.

5. Finally, an inquiry was made to discover the circumstances that led to the writing of the statements.

If contradictions still remained, the student could reach one of two conclusions: (a) this was a mystery to be believed, or (b) a theory was needed that could encompass both views, each of which was but a partial aspect of the truth.
Influence of Abelard on Lombard and Aquinas

Abelard's method directly influenced Peter Lombard (1100-1160) and St. Thomas Aquinas (1225-1274), his successors at Paris. Lombard, a former student of Abelard, modeled his famous textbook *The Sentences on Sic et Non*; but for every question he posed, he was careful to supply the correct, orthodox answer. As a result, Lombard's method was more generally accepted because of its less controversial approach.

The final technique of instruction that was widely employed by many generations of scholars was the scholastic method as developed by St. Thomas Aquinas. According to Aquinas, the proper instructional approach was to teach the student how to acquire knowledge using syllogisms. In his *Summa Theologiae*, Aquinas, like Abelard, introduced material in the form of questions, then proceeded, through a series of syllogisms, to propose the solutions. A thesis was formulated, the proof was given, objections were raised and refuted; the whole proposition was treated in a minutely logical procedure.

Influence of the Scholastic Method

Without question, Abelard deserves an important place among the forerunners of modern educational technology. His greatest achievement was the development and popularization of the scholastic method. It may be argued that Abelard's scholastic method degenerated into a cumbersome formalism in which Aristotelian logic became hopelessly ossified. But this instructional method played an important role in the rise of European universities and helped lay the groundwork for the later system of scientific inquiry and experimentation. Confronted with a mass of traditional and irrational doctrines, the medieval teacher used the scholastic method to examine ideas in a systematic and rational manner.

A Method of Instruction According to Comenius

Johann Amos Comenius (1592-1670) was born to modest, Protestant (Moravian Brethren) parents in Moravia (now a part of Czechoslovakia) and attended the Protestant universities of Herborn and Heidelberg in Germany. As a Moravian pastor and teacher, Comenius spent a long, itinerant life in Poland, Hungary, Sweden, England, and Holland—due primarily to the disruptions of the Thirty Years' War (1618-1648) between the Catholics and the Protestants.

His period of greatest educational productivity began in 1627 at the Polish town of Lesno where, as a teacher of Latin and rector of the Moravian Gymnasium, he began to write a series of remarkable textbooks. Later he directed curriculum reforms in Holland and Sweden and organized a model school in Hungary.

Educational Theory

The Great Didactic, Comenius's most important theoretical treatise, dealt with every phase of instruction. One of its recurrent themes was his idea of "panSophia," or a system of universal knowledge in which a methodical procedure could be applied to all problems of humankind. Further, he recommended the establishment of a college of pansophy, or scientific research.

According to Comenius, Christian philosophy should not prevent examination of the human mind by methodical and empirical observation. Thus the theory underlying the instructional system of Comenius said that the goal of education was to be derived deductively using Christian philosophy; the instructional process had to be analyzed and improved inductively, according to science.

Comenius's educational aims were knowledge, morality, and piety. He regarded education as a means of preparing men to live as human beings rather than as a means of fitting them into a predetermined occupation or station. Moreover, he wanted to end the custom of providing education according to social status rather than ability. To achieve these broad
aims, Comenius proposed a system open to all that led from the kindergarten through the university—an idea some three centuries ahead of its time.

Principles of Instructional Method

Among the great mass of instructional principles advocated by Comenius were the following:

1. Instructional method should follow the order of nature. Content should be studied according to the developmental stage of each learner.

2. Instruction should begin at infancy and be designed for the age, interest, and capacity of each learner.

3. Everything that is taught should have a practical application to life and possess some value for the learner.

4. Subject matter should be organized according to its difficulty. Instruction should proceed by the inductive process from the simple to the complex.

5. A graduated series of textbooks and illustrative materials should be correlated with instruction.

6. Sequence is important. For example, it is irrational to teach a foreign language before the native language has been learned.

7. General principles should be explained and examples given before rules are learned. Nothing should be memorized until it is understood.

8. Reading and writing should be taught together; subjects should be correlated whenever possible.

9. Learning is to be approached through the senses. Actual objects and things should be studied and associated with words.

10. Content should first be presented orally by the teacher and pictorially illustrated whenever possible.

All parts of an object (or subject matter) must be learned with reference to their order, position, and connection with one another; only one thing should be taught at any one time. (Comenius suggested outlining all the texts specified for use on the walls of the classroom so the learner could see the entire content to be studied.)

12. Corporal punishment should not be administered when a student fails to learn.

13. Schools must be cheerful, equipped with real and illustrative materials, and staffed with sympathetic teachers. (Something of the monitory plan was latent in Comenius's system. He believed that it was possible for one teacher to instruct several hundred children at one time. After the general presentation by the teacher, the large group was to be divided into sections of ten for further drilling and reciting to small-group student leaders.)

It is evident from such a system of instruction that Comenius anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes. He anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes. He anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes. He anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes. He anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes. He anticipated, to a degree, the modern trend toward the making of pedagogy into an exact science and the study of the foundations of educational processes.

The Orbis Pictus Method of Comenius

Perhaps the best known of all instructional tools was the Orbis Pictus, thoroughly planned, systematically organized, and illustrated book or picture book ever written. Organized in a series of alphabetical lessons (A = a to z), it was a guide for the study of the natural world, with each lesson containing a picture related to each letter of the alphabet. The book was later expanded and refined, and it became the standard text for teaching the English language in many schools.

Influence of Comenius on Instructional Theory

For nearly two centuries, Comenius's ideas on instructional theory provided the basis for educational practice. His work laid the groundwork for the development of modern educational systems and influenced the development of the modern classroom. His emphasis on the importance of practical application and the use of visual aids in teaching continues to be a cornerstone of educational theory and practice today.
It is evident from these instructional principles that Comenius was the first true forerunner of modern educational technology. By applying Bacon's inductive method to education, he anticipated, to a remarkable extent, the modern concept of educational technology as an applied science in support of the practical arts. It is unfortunate that during his lifetime he was never in a position to test his own pioneering principles for any extended period of time.

The *Orbus Pictus*: Application of the Method of Comenius

Perhaps the best example of an application of Comenius's method of instruction was his own *Orbus pictus* (The World in Pictures), published in Nuremburg in 1658. This illustrated, thoroughly planned, "visual aid" textbook was written specifically for children who were studying Latin and sciences. Although it has often been referred to (erroneously) as the first illustrated book of its kind, it has been without question the most popular illustrated textbook ever written for children. The book was still being purchased in the United States as late as 1810.

Organized in a series of topics (e.g., God, world, air, trees, man, flowers, vegetables, metals, birds), the *Orbus pictus* was illustrated by 150 pictures, each serving as a topic for one lesson (see figure 2.2, page 32). Thus the teaching of Latin and the sciences was accomplished by associating objective reality, or its pictorial representations, with abstract cognate word symbols.

Influence of Comenius

For nearly two centuries, Comenius was generally unknown and had little direct effect on instructional theory or practice, except through his language methods texts. The *Orbus pictus* went through an almost unlimited number of editions in many languages and became the sole link to his work. When his other works were finally rediscovered in the middle of the nineteenth century, it became clear that he had been the greatest educator of his century. Many of his ideas have since been incorporated into contemporary instructional method.
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Status of Instructional Method in American Schools: Before 1800

Before continuing with our survey of the forerunners of educational technology, we will briefly examine instructional method in American schools prior to the nineteenth century.

Before 1800, instruction at both the elementary and secondary levels was predominantly individual. The principal method of the village schoolmaster consisted of calling one or several pupils to his desk to hear individual, memorized recitations. Developing understanding through inductive group discussions was unknown. When teaching writing, the teacher's
primary concern was with whistling goose-quill pens and “setting copies” for pupils. Much instruction was superficial and impractical, and the school term was short (one to six months). Children sometimes attended school for years without progressing beyond a smattering of reading and writing skills. The teachers were generally incompetent and so relied on fear to motivate learners and keep order in the classroom.21

The buildings and equipment of early American schools, not to mention their instructional materials, were primitive. The typical one-room schoolhouse prior to 1800 was a log building, with one end usually occupied by a fireplace and the room’s only window at the opposite end. Sticks were inserted between the logs that formed the walls and used to hold boards that served as desks. Backless benches made of split logs ran the entire length of the board desks.

The beginning of the nineteenth century brought little improvement in these conditions. Public and free schools were generally lacking outside the New England area, and even there conditions and facilities were wretched. Illiteracy prevailed among children of the poor, and conditions intensified with the development of industry, the breakdown of the apprenticeship system, and the rapid growth of American cities. “Free school societies” (such as the Public School Society of New York) were organized in some of the larger cities to try to cope with the problems of ignorance, poverty, and crime. These semipublic, philanthropic organizations later came to regard the so-called Lancasterian system as ideal, since it offered mass education at low cost. And as the public became increasingly aware of the desperate need for mass education, legislatures saw in monitorial schools a possible solution to the school-financing problem, which had to be solved before adequate public schools could be established. The introduction of the Lancastrian system, in fact, provided the basis for the eventual support of free public schools in the United States.

Lancastrian Monitorial Instruction

The wide success of a monitorial system of instruction in the first half of the nineteenth century was chiefly due to Joseph Lancaster (1778-1838) of England, whose unique manuals included details of classroom organization and economic management, as well as subject matter organized according to a graded plan for group instruction.22 To aid in the implementation of his method, Lancaster studied the construction of special classrooms that would make the most effective use of instructional media and student grouping. He also explored the techniques of motivation. Although it appears questionable that Lancaster’s method was rooted in any systematic theory of learning, he was probably influenced by Locke’s theory of learning, which prevailed at the time.23

Economy of the Lancastrian System

Much of the popularity of the system was due to its low cost. For example, during the period when the Lancastrian plan was operating in New York City (1806-1853), the annual cost of instruction per child ranged from $1.37 to a maximum of $5.83. The system was also adopted in Pennsylvania, where legislators were unwilling to appropriate money for free education, except for the children of paupers. A particular aspect of Lancastrian economy may be noted in the ratio of pupils to teachers. In Philadelphia in 1819, there were 10 public Lancasterian schools with 10 teachers and 2,845 pupils, or 1 teacher per 284 pupils.

School buildings were constructed to accommodate hundreds of children in a series of large, undivided rooms, with careful attention paid to lighting, ventilation, seating, and acoustics. One 50-by-100-foot room could accommodate as many as 500 pupils, with a space of 10 square feet allotted to each. Slates, sand tables, wall charts, and blackboards saved paper, ink, and pens, and made fewer books necessary. By following the principle of mass
instruction at low cost, the Lancasterian schools provided the only kind of instruction that could be hoped for in what were to become free schools during the latter part of the nineteenth century.

The Lancasterian Monitorial Method of Instruction

The Lancasterian plan provided a detailed, systematic method in the following six areas: instruction (memorization and drill) and a body of content, monitor training, control, grouping, testing, and administration. Under an efficient scheme of classroom management, one teacher taught a group of fifty head pupils, or monitors, who, in turn, each drilled ten other pupils. Thus, one teacher was able to take charge of five hundred or more students at one time.24

In the teaching of arithmetic, for example, Lancaster had the following plan. The basis of progress was founded on a thorough knowledge of the multiplication tables. As each new rule was introduced, the examples were at first short and easy, then increased in length and difficulty as the ability of the learner increased. Each class worked a group of sample problems over and over until they could solve the problems with facility. When teaching a new rule, the monitor first dictated an example, then worked it out while the pupils copied the process on their slates. Then the slates were cleaned and examples were written on the blackboard; each pupil, in turn, solved a sample problem.25

The results of the Lancasterian method, when contrasted with the one-room school method of individual recitation, were revolutionary. In fact, Salmon relates an incident in which an anxious parent protested to his pastor against the practices of the monitorial school, because he was convinced that the rapid progress of his son in arithmetic resulted from an evil magic being employed by the school.26

Fig. 2.3. A monitorial school, 1839 (Courtesy of Pestalozzi Foundation of New York.)

Pupils were grouped in reading or writing, and the entire school, corresponding quotient, each pupil too. indicated the absentee.

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Pupils were grouped according to ability, which meant a pupil might recite with one group in reading or spelling and with another group in some other subject. Economy of time was also achieved in the Lancasterian school routine. For example, to avoid calling the roll of the entire school in order to discover who was absent, each pupil was given a number, and corresponding numbers were printed in a row on the wall. The class was marked into position, each pupil took his place beneath his number, and the vacant numbers immediately indicated the absentees.

Use of Instructional Materials

Ingenuity was refreshingly displayed in the use of instructional media. For example, a thin layer of sand was spread on each desk for writing practice. The learner wrote with a pointed stick and made erasures by passing a long straight stick across the sand. This procedure was designed to save ink and paper. The text of a speller or some other book was sometimes printed in large letters and hung on the schoolroom wall, in order that one volume could serve an entire class. Through the use of slates, hundreds of learners wrote and spelled the same word at the same time, and when reciting, groups of ten gathered around the monitors.

Assessment of the Lancasterian System

As we have seen, the Lancasterian schools were not only economical but also effective, particularly when compared to the prevailing, primitive instructional conditions of the times. Influenced by Lancaster's methods, American schools began to adopt centralized management practices, improve instructional media, develop more systematic approaches to instruction, and recognize the need for trained teachers. The system was praised by such men as Governor DeWitt Clinton of New York; Governor Oliver Wolcott of Connecticut; William Russell, editor of the first American Journal of Education; and John Griscom, noted scientist and educator. Governor Clinton stated in 1809:

When I perceive that many boys in our school have been taught to read and write in two months, who did not before know the alphabet, and that even one has accomplished it in three weeks—when I view all the bearings and tendencies of this system—when I contemplate the habits of order which it forms, the spirit of emulation which it excites, the rapid improvement which it produces, the purity of morals which it inculcates—when I behold the extraordinary union of celerity in instruction and economy of expense—and when I perceive one great assembly of a thousand children, under the eye of a single teacher marching with unexampled rapidity and with perfect discipline to the goal of knowledge, I confess that I recognize in Lancaster the benefactor of the human race. I consider his system as creating a new era in education, as a blessing sent down from heaven to redeem the poor and distressed of this world from the power and dominion of ignorance.27

Likewise, a prominent educator of the time, William Russell strongly favored the system and even edited a Manual of Mutual Instruction (1826), which contained directions for organizing instruction according to the Lancasterian plan and encouraged its adoption in the colleges.

The monitory method solved a great educational emergency in the United States, but it was clearly mechanical and lacked a systematic psychology of learning. Furthermore, it encouraged the development of narrow, supposedly practical rules of thumb, which were to
be used as instructional method for teacher education in the newly established normal schools. Under the monitodial influence, method became a set of standardized techniques for handling large numbers of children at one time. This practice-centered approach lacked theoretical unity and was utterly separated from a recognizable theory of learning. Lancasterian schools do, however, deserve to be called forerunners of modern instructional technology, because they introduced order and system into instructional method in American schools. Indeed, their impact on subsequent educational practices, although negative in many respects, would be difficult to overemphasize. For example, in 1891, Gordy pointed out two misconceptions of the monitodial method that had not yet disappeared from teacher training: (1) that teaching is imparting knowledge; and (2) that all that is necessary to teach is simply to possess the knowledge to be taught. Even today one can discover such views in much of the rationale voiced by critics of teacher education.

The practice and influence of the Lancasterian system began to wane by the middle of the nineteenth century as increased financial resources enabled the people to support free public education. Moreover, the inherent defects of the Lancasterian method became more apparent as the psychological systems of Pestalozzi and, later, Froebel and Herbart were more widely implemented.

Pestalozzi and His “Psychologizing” of Instructional Method

Johann Heinrich Pestalozzi (1746-1827) developed a comprehensive system of instruction based on the educational theories expounded by Jean Jacques Rousseau (1712-1778) in his *Emile.* Born in Zurich, Switzerland, Pestalozzi attended the university there to prepare himself first for the pulpit and later for law. Then, discouraged by legal conservatism and profoundly influenced by Rousseau’s ideas, he decided to undertake what was to become a historic series of educational experiments. These began (1774-1780) with waifs he gathered at his home (Neuhof), near the village of Birrfield, and continued in his experimental schools at Stanz (1798), Burgdorf (1799-1804), and Yverdon (1805-1825), where he did his most significant work.

Educational Theory

Pestalozzi said, “I wish to psychologize instruction,” by which he meant that he wished to organize instruction in accordance with what he believed were the laws of natural human development. He felt that the moral, intellectual, and physical powers of each learner would develop, according to natural laws, in successively widening circles of experience. To Pestalozzi, this development of the learner was the supreme objective; he believed it could be accomplished by constant emphasis on sensory impression. “The most essential point from which I start is this: Sense impression of Nature is the only foundation of human instruction, because it is the only true foundation of human knowledge.”

Pestalozzi believed it vital for instruction to follow the stages of natural human development: It must begin with the simplest elements, advancing gradually in a series of steps connected with the learner’s psychological development. Thus, Pestalozzi recognized that learners have individual differences, and saw the necessity for instructional methods that functioned with the learner as a whole. Although sensory instruction became Pestalozzi’s chief method, he accepted the theory of separate faculties. As we have seen, exercising the faculties was often considered more important than acquiring knowledge. Ironically, however, Pestalozzi’s followers began to concentrate on the formal discipline of the senses, similar to the formal training of the faculties undertaken by the classicists.

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Fig. 2.4. Johann H. Pestalozzi.

Instructional Method

The reform of instruction had been anticipated by Comenius, who predicated his
method on nature and the senses and insisted on moving from concrete to abstract concepts.
But with the exception of Comenius's instructional methods, Francke's Realschule, and
Basedow's Philanthropinum, little had been done to implement these insights in the
classroom until Pestalozzi began his educational experiments. Briefly, Pestalozzi's method
focused on providing content to ideas through firsthand experience and giving significance
to individual expression by means of ideas. He simplified the complicated process of cogni-
tion by giving learners threefold instruction: (1) in the elements of number (arithmetic); (2) in
the elements of form (drawing, leading to writing); and (3) in names and the ideas they con-
note (language). According to Pestalozzi, this method led to Anschauung, or the develop-
ment of insight. Insight is achieved when instruction follows the order of the mind's natural
growth, gradually proceeding from the simple to the complex. (See figure 2.5, page 38.)
In the study of mathematics, Pestalozzi's pupils were taught to develop their understanding through practical exercises and visual aids. This approach was designed to make learning more engaging and to help students grasp abstract concepts through concrete experiences.

Influence of Fichte

Although Pestalozzi's teaching method, as described, was designed to foster learning through practical applications, it was not without its limitations. Observers noted that Pestalozzi's pupils struggled to apply these skills in real-world situations.

Pestalozzianism

Pestalozzianism, which was popular in the early 19th century, emphasized the importance of practical education and the development of a well-rounded individual. Pestalozzi's teachings were seen as a significant influence on the educational system of the time.

In summary, Pestalozzi's concept of the ABC of Anschauung was a pioneering approach to teaching mathematics. His emphasis on the importance of visual aids and practical exercises was a significant contribution to the development of educational methods.
Pestalozzi and His “Psychologizing” of Instructional Method

In the study of words (language), the fundamental units were the elementary sounds. From articulating sounds, the learner progressed to reading syllables, words, and sentences. Pestalozzi’s pupils would examine the number, form, position, and color of the designs, holes, and rents in the wallpaper of the school, and then express their observations in increasingly complex sentences.

Like the Lancasterian system, Pestalozzian instruction replaced the old recitation approach. Under Pestalozzi’s method, the teacher taught the whole class as a group, framing questions according to the understanding reflected in students’ answers to previous questions. This method challenged the teacher, since it demanded knowledge of subject matter as well as competence in questioning and group management.

Influence of Pestalozzi

Although Pestalozzi experimented without the aid of modern science or an empirical method, he did anticipate a science of instruction. Through introspection, he sought to understand what he should do and then attempted to use these insights to improve his method. Observers who visited Pestalozzi’s experimental schools reported a program of studies that brought life closer to the learner, replaced drill with observation and learner motivation, respected the individuality of each learner, and supplanted fear of punishment with mutual cooperation.

Since the instruction principles set forth by Comenius had not yet been rediscovered, Pestalozzi’s ideas seemed unique, and found champions in Europe and in the United States. His greatest contribution, however, was not his own instructional methodology, but the stimulus that his ideas provided to others in the search for better teaching methods.

Pestalozzi’s major influence in Europe was in Germany. In philosopher Johann Gottlieb Fichte’s (1762-1814) famous Addresses to the German Nation (1807-1808), in which he emphasized the regeneration of Germany following the defeat by Napoleon, he declared: “To the course of instruction which has been invented and brought forward by Heinrich Pestalozzi, and which is now being successfully carried out under his direction, must we look for our regeneration.” German schools became models of Pestalozzianism and were observed by many educators from other countries.

Pestalozzi also exerted an important influence on the German educator Friedrich Wilhelm Froebel, the founder of the kindergarten. Froebel incorporated Pestalozzian object-teaching into his own methodology by means of his now well-known “gifts and occupations.”

Pestalozzianism in the United States

Pestalozzianism first appeared in the United States in 1809, when William MacClure (1763-1840) brought an assistant of Pestalozzi, Joseph N. Neef (1770-1854), to Philadelphia, where MacClure opened the first of a series of schools. Later, Neef opened his own “Pestalozzian” schools in Pennsylvania, Kentucky, and Indiana. Although Neef’s schools did not have a significant influence, they represented the earliest American interpretation of Pestalozzi’s teachings.

Another variation of Pestalozzi’s method also came into vogue quite early in the United States. Philip von Fellenberg (1771-1844), a Swiss nobleman and educator, had developed a school where the objects of instruction were the tools and materials of shop and farm; Fellenberg’s ideas swept the U.S. between the years 1825 and 1835. In New York City in 1831, the Society for Promoting Manual Labor in Literary Institutions was formed for the purpose of collecting and diffusing information about Fellenberg’s approach, but by 1860 the movement had come full circle, and there was little respect in academic quarters for manual labor instruction.
In the meantime, Pestalozzian principles had been widely spread by early educational journals, professional textbooks, and official reports about Pestalozzian schools in Europe, including Albert Pickett's *Academician* (1818-1820), William Ruskell's *American Journal of Education* (1826-1830), and Henry Barnard's *Connecticut Common School Journal* (1838-1842). Others praising Pestalozzi were Calvin Stowe (1802-1886), Victor Cousin (1792-1867), and Horace Mann (1796-1859), Louis Agassiz (1807-1873), and Herman Krus, Jr. (1817-1903).

Warren Colburn (1793-1833) published his *First Lessons in Arithmetic on the Plan of Pestalozzi* (1821); David P. Page (1810-1848), director of New York State Normal School at Albany, condemned mere book learning; Warren Burton (1800-1866), in his charming little book *The District School as It Was* (1833), asserted that the abstract moral sentences of texts presented only faint meaning to the child; Henry Barnard (1811-1900) anticipated that educational efficiency might be increased "ten-fold" by the use of "some simple apparatus so as to employ the eye in the acquisition of knowledge"; and Charles W. Eliot (1834-1926), president of Harvard University from 1869 to 1909, in his later years believed that the absence of sensory training was "the greatest defect in the kind of education which has come down upon us from the middle ages."

After precariously maintaining itself for almost six decades, Pestalozzian object-teaching achieved its first widespread acceptance in the United States through the work of Edward A. Sheldon (1823-1897), superintendent of schools in Oswego, New York. Sheldon was first inspired to adopt new classroom methods after visiting an educational museum in Toronto, Canada, in 1859, where he saw an appealing display of pictures, color charts, models, and other object-teaching materials. He purchased various "objects" to show to his own board of education; upon his return to Oswego, Sheldon obtained approval for their use and immediately began revising the curriculum and classroom procedures of the Oswego schools.

In 1860, at Oswego, the object-lesson plan became the first major attempt by American educators to psychologize instruction. From London, Sheldon brought a teacher familiar with Pestalozzian principles and methods; shortly thereafter he engaged Herman Krus, Jr., son of one of Pestalozzi's helpers at Yverdon. Within a few years, the Oswego system, along with the Oswego State Normal School (1867), became the great proponent of object-teaching and progressive instructional methods in the United States.

The Oswego method soon assumed a formalism of its own, however, and sometimes became as verbal and unrealistic as the classical object was it trying to reform. Many teachers shifted from the traditional concept that everything could be learned by reading to the new extreme that everything should be taught exclusively by the object method. Even Krus observed that the lessons at Oswego sometimes had no connection with each other and failed to form a more general plan. Furthermore, in the object lessons, the objects chosen were not always used effectively.

As Oswego declined, a new variation of American Pestalozzianism was being introduced in 1875 by Francis W. Parker (1837-1902), superintendent of schools at Quincy, Massachusetts. Although the so-called Quincy methods were similar to the Oswego method in the use of concrete materials, they were actually a new form of object-teaching that employed a wider variety of materials from everyday life and the sciences. To learn about erosion, for example, the children formed hills in a sandbox and poured water on them. In an introduction to botany, they planted seeds in a box filled with sterile soil. Local geography assumed more importance than the study of foreign lands, and the solving of common, everyday problems was of more consequence than learning abstract rules and principles.

Quincy parents soon began to criticize Parker for changing their schools into "natural history museums" and "mud-pie factories." To settle the issue, the Massachusetts State Board of Education gave the Quincy children an examination in traditional subject matter and found them superior to children educated by traditional methods. Ultimately, the Quincy methods exerted a wide influence on instructional method throughout the country.

Object-teaching made a brief reappearance in the nature study movement of the late 1800s and early 1900s. L. H. Bailey of Cornell University said the movement was an effort to put the child in contact with his own environment, and insisted that "education should always begin with objects and phenomena" instead of books and museums. He also insisted that nature study was itself a new instructional method rather than a subject area.

There had always been a few teachers who took their pupils on excursions or brought natural objects and specimens into the classroom for the children to study. In the United States, the father of nature study as a movement was probably Louis Agassiz, the great naturalist and Harvard professor. As early as 1847, when lecturing at teachers' institutes, he would appear with a jar of live grasshoppers and explain their structure and habits as each teacher personally examined one of the specimens. He helped his wife, also a teacher, prepare *A First Lesson in Natural History* (1859), and gave daily lectures illustrated with specimens, drawings, and models to her pupils. Agassiz and his students were also instrumental in the creation of many natural history museums, among them the American Museum of Natural History in New York City, for which one of his students, Albert Smith Bickmore, created the design.

H. H. Straight (1846-1886), a disciple of both Agassiz and Nathaniel Shaler (1841-1906), another early leader in the nature study movement, was regarded by some as the real founder of the movement. Proponents of the nature study movement denounced textbooks, dispersed with lectures, and ridiculed questions on assigned readings. They were convinced that the most effective method of learning about nature was to find a specimen and study it until it was understood.

Object-teaching achieved its greatest popularity in the 1860s. Some of its method and philosophy were incorporated in the kindergarten movement of the 1870s and in the learning-by-doing movement, which reached its height in the 1880s. By the end of the nineteenth century, object-teaching had begun to decline and increasingly gave way to Herbartian principles. There was no doubt, however, that Oswego had made a lasting contribution to the development of educational technology. Under the Oswego program, wherein experts demonstrated methods and explained the underlying philosophical rationale, there occurred the first synthesis of theory and practice in both action and word. Before examining the next step in the evolution of a technology of instruction, we turn first to an examination of Froebel.

**A Method of Instruction According to Froebel**

Friedrich Wilhelm Froebel (1782-1852) was born in Oberweissbach, Germany, and, after a baphez education, spent several years growing for a career until Herr Grüner, headmaster of a Pestalozzian model school in Frankfurt, persuaded him to become a teacher there. Froebel later lived and worked with Pestalozzi at Yverdon, where he developed a keen interest in young children that culminated in his greatest educational achievement—the kindergarten.

**Educational Theory**

Detailed discussion of the complicated metaphysical framework of Froebel's educational theory, as laid out in his *The Education of Man* (1826), is not within the scope of this chapter. A few words with regard to some of his key ideas are necessary, however, in order to understand his method.

The dominant idea underlying Froebel's whole view of education was the organic unity of all things in God. The forming crystal, the growing tree, the developing child all reflect God's plan of creation. The purpose of the educator was to control the growth of a child...
Perhaps most important to Froebel's instructional method was his notion of opposites. He believed a plant or animal or child grew by the twofold process of impressing the form of its own life on some external material while developing its inner nature in doing so; or, as Froebel put it, by making the inner outer and the outer inner. Growth was the process of overcoming differences by finding some connection between things that at first appeared opposed.

Instructional Method

The most notable application of Froebel's theoretical principles was his kindergarten system of early education, which was designed to appeal to the child as play. The system, although not rigid, was methodical. It consisted of three aspects: (1) games and songs, (2) construction, and (3) gifts and occupations. The games and songs, perhaps the finest expression of the kindergarten spirit, were chiefly for acquainting children with the inner life of animals and humanity. Froebel was the first educator to grasp the value of socialization as a basic teaching method. The "morning circle" in his kindergarten, where the teacher and the children stood in a ring and joined hands for song and play, is an excellent example of this method. A visitor to almost any kindergarten anywhere may still observe a dozen children singing in a circle while they pantomime planting, watering, weeding, plucking, or smelling flowers.47

Construction was undertaken in such pursuits as drawing, paper cutting, pasteboard work, modeling, etc. — all familiar activities in a contemporary kindergarten. To implement his instructional method, Froebel devised a series of materials that he called gifts and occupations. The occupations were activities, while the gifts provided ideas for such activities. Gifts were of two types: geometric shapes, and the basic materials for modeling, drawing, sewing, and coloring. The first gift was a ball, the most universal plaything and symbolic of the unity of the universe. The second gift consisted of a ball, a cube, and a cylinder, which symbolized the thesis, antithesis, and synthesis. The third gift was formed by dividing a cube into various shapes. These building blocks were specifically designed to illustrate certain relationships and teach form, number, and measurement. They also led children to compare, examine, arrange, and analyze. Today's modern school has adapted Froebel's concept of gifts by providing materials and games, miniature industrial processes, and mechanical models from the child's real world.

Froebel used objects (gifts) in a uniquely different way from Pestalozzi. While Pestalozzi used a great variety of materials and expected the learner to exercise his sensory powers to become acquainted with each object, Froebel, on the other hand, used fewer formal objects and placed more importance on the symbolic knowledge suggested by the quality of the object than on the immediate knowledge yielded by a sensory experience (observation) of it.

Influence of Froebel

Although a reactionary Prussian government closed all kindergartens in 1861,48 a year before Froebel's death, his influence spread rapidly throughout Europe and the United States, reaching its height in the United States about 1880. The U.S. kindergarten movement was led by Mrs. Carl Schurz (a former student of Froebel), who established the first American Kindergarten (German-speaking) at Watertown, Wisconsin, in 1855. By the end of the nineteenth century, there were about 1,400 English-speaking, public kindergartens in the United States, enrolling more than 95,000 pupils.49
The manual-training movement (not to be confused with the manual labor movement mentioned previously in connection with Pestalozzian influence) also owes much to Froebelian ideas of motor expression, or learning by doing. This method was brought to the attention of American educators during the Centennial Exposition in Philadelphia in 1876, where it was shown as it was then being practiced in postkindergarten schools in Finland and Russia.  

Although superficial defects of Froebel's method such as his mysticism and the crudity of his materials31 may seem obvious, his basic doctrines have proven to be psychologically and socially sound. Through his emphasis on motor expression and the social aspects of instruction, along with his advocacy of a school without set tasks, Froebel made a distinctive contribution to instructional method. His experiments not only led to the establishment of kindergartens, but also his principles of instruction were applied in later years.

The Herbartian Method of Instruction

It is appropriate to conclude this chapter with an examination of Johann Friedrich Herbart (1776-1841), in whom the various trends that had developed since the time of Comenius came to fruition. Both Comenius and Pestalozzi, as we have seen, believed sense perception was necessary in developing clear conceptualization. Herbart expanded their work to show how the teacher could assimilate new concepts with old ones. Herbart's view that moral development was the primary aim of education reflected the influence of Froebel. Perhaps not since the time of the Elder Sophists had instruction become so highly systematized, nor had such a sophisticated formula been devised for the teaching of virtue.

The brilliant son of a distinguished, middle-class family of Oldenburg, Germany, Herbart entered the University of Jena, at Bremen, to prepare for a law career. However, he left before graduation to spend two years (1797-1799) as private tutor to the sons of the governor of Interlaken, Switzerland. During this period he visited Pestalozzi's school at Burgdorf, and was impressed with what he saw. Later, after completing his doctoral studies, Herbart focused on education. From 1802 to 1809, he lectured on education and philosophy at the University of Göttingen, Germany, where he published his Science of Education (1806). For the next twenty-four years, he held the chair of philosophy (formerly occupied by Immanuel Kant) at the University of Königsberg, Germany. Here he founded an educational seminar and a practice school for teacher education and experimentation in method teaching. In 1833, he returned to Göttingen where, in 1835, he published his famous Outlines of Educational Doctrine.

Educational Theory

In contrast to all of his predecessors, Herbart rooted his method in a systematic psychology of learning. His was the first modern psychology of learning to harmonize with the tabula rasa (blank tablet) theory formulated by Locke. Not only did Herbart negate the idea of inborn faculties, which had been prevalent since classical times, but he denied that the mind itself existed at birth. Minds, according to Herbart, were simple battlegrounds and storeshouses of ideas, and ideas had an active quality of their own. Ideas, he thought, could lead a life of their own in a mind, which was completely passive. On this basis, Herbart developed a systematic psychology of learning and instruction.  

To Herbart, all learning was apperception, or a process of relating new ideas to old ones and assimilating them into a total, apperceptive mass. Within this apperceptive process, Herbart identified three levels of learning: the first level, predominantly sensory activity; the second level, wherein previously formed ideas were reproduced; and the third, or highest, level, in which conceptual thinking or understanding occurred.

Herbart's theory suggested that the primary task of instruction was the formation of this apperceptive mass through the proper presentation of the right sequence of ideas. Psychologically, learners were formed by the world of ideas as it was presented to them from without. Thus the problem of instruction was selecting the correct ideas and materials to develop a large, apperceptive mass within learners. Herbart was particularly convinced that the history and great literature of the world, when properly selected and arranged, would develop the interests and understanding of learners at each successive period of growth.

Instructional Method

Herbart formulated a four-step, systematic method based on his concept of the mind and theory of apperception:

1. **Clearness.** The first stage concentrated on the learner's absorption of new ideas. Objects of study were broken up into elements so that the learner might focus on each fact or detail in isolation.

2. **Association.** When the learner had gained sufficient knowledge of the object, it was then associated with related objects already known. This could be done by free conversation or by sensory experiences, if these experiences would help in the foundation of generalization and abstraction.

3. **System.** When the facts were seen in their proper relationship, they could then be viewed as an integrated whole. At this stage, a clear distinction was made between the essential and the irrelevant, thereby completing the process of apperception.

4. **Method.** In this stage, the system was tested by checking the relationship of individual facts within it. For example, once an arithmetical rule had been established (system), the learner tested his knowledge of the rule with new problems (method). Each new experience in this process then became part of the unity of the mind.

In essence, the four steps of Herbart transferred Pestalozzi's method of sensory impressions to the intellectual level of learning. While Pestalozzi identified the need to begin with sensory impressions, he had neither the time nor the scholarship to construct a psychology of learning beyond what already existed. Herbart, on the other hand, was able to develop a system of learning that, while purely speculative and mechanical, provided a logical theoretical framework for educational practice.

Influence of Herbart

Herbart's ideas had surprisingly little impact on European educational practice until about a quarter of a century after his death. In Germany, Tuisken Ziller (1817-1882) popularized Herbartian principles by applying his methods to elementary school instruction,34 by organizing a pedagogical seminar at the University of Leipzig, and by founding the Association for the Scientific Study of Education. Wilhelm Rein (1847-1929), astudent of Ziller who became head of the pedagogical seminar and of the practice schools at the University of Jena, further spread the influence of Herbart by making Jena a great center of German Herbartianism. 

Aside from Germany, the United States has been influenced by Herbartianism more than any other country. Before 1880, little mention had been made of Herbart in American educational literature. The American movement was fostered largely by a few enthusiastic
American teachers, who studied with Rein at Jena and brought back with them the new science of instructional method. These included Charles de Garmo, who published The Essentials of Method in 1889, and Charles A. McMurtry, who published his General Method in 1892 and also published books with Frank M. McMurtry, his brother, on the special methods of teaching various subjects that were stressed by the Herbartians.

Simultaneously, Herbartians began to penetrate the entire structure of American public education. In 1892, the National Herbart Society was organized at the Saratoga Springs meeting of the National Education Association, for the purpose of translating the works of Herbart and various German Herbartians. Most of the normal schools—particularly in the Midwest—were soon advocating Herbartian principles and, through the teachers they sent to every section of the country, greatly influenced the practices of the schools. For some twenty or thirty years after 1895, Herbartianism wrote most of the educational textbooks and dominated several educational journals as well as the professional discussions and debates. Nevertheless, it was clearly evident as early as 1901 that Herbartianism was waning in the United States.

In his book of 1901, Talks to Teachers on Psychology, William James (1842-1910) made a distinction between the art and the science of education and proceeded to refute the Herbartians' key concept of apperception by revealing its empty verbalism and mystical origins. James was joined in his attacks by philosophers John Dewey, William Dilthey, and Josiah Royce, all of whom pointed out the anachronisms of Herbartian rational science. More important, perhaps, than criticisms of the abstruse features of Herbart's theoretical system were criticisms of the instructional practices that system established. Herbartianism essentially committed teachers to a program of indoctrination whereby they determined precisely what their pupils would be taught. Each lesson plan included not only the questions, but all the answers as well, which the learners arrived at through a largely mechanical process that was completely dominated by the teacher. Thus, learning was seen as a process similar to the filling of a storage container.

Despite its limitations, no other system of instruction, except that of Pestalozzi, has ever had so great an influence on American instructional method as well as on teachers' thinking. Herbart made important contributions to educational technology by emphasizing a psychological and scientific, if not experimental, approach to instruction and learning.

Recapitulation and Analysis

This survey is intended to provide only a set of concepts, selected from historical instructional theory and method, that may be considered precursors to modern educational technology. It is not a history of instructional method in any definitive sense. Probably the first professional teachers, the Elder Sophists, appear to have been the ancestors of modern educational technology. Their systematic analyses of subject matter and organization of teaching materials laid the groundwork for a technology of instruction. More important, when teaching was not considered a profession, the Sophists viewed it as techne in the old Greek sense, or technology, in which the theoretical is combined with the practical.

With Abelard and the scholastic method, some of the techniques of the Elder Sophists were combined with the rules of logic and the content of philosophical, theological, and other writings to create a distinctive method of instruction suited to the period. The primary emphasis was on developing an attitude toward knowledge.

For Comenius, nature offered the key to biological, cognitive, and moral development whereby the learner was led inductively to generalized knowledge by working with natural objects and studying practical things. On the basis of these convictions, Comenius devised a system of instruction that anticipated many of the modern principles of learning.

In the learning theory that was the foundation for the methods of the early forerunners, faculty psychology was implicit or openly advocated. Faculty psychology assumes that, with adequate cultivation, the human mind can know the objective reality of the world. Man, being a rational animal, is free (within limits) to act as he chooses in the light of what he understands. Instead of being a creature of instinct, he enjoys a complex and delicate faculty of "knowing" whose basic aspect is reason. In an educational context, it is assumed that knowledge is a fixed body of true principles that are handed down in the form of great books or basic subject content. Thus, specific subject matter lends itself to the exercise or training of the faculty of reason.28

Abelard, and later medieval Scholastics, also accepted faculty psychology as a theory of learning. The emphasis on the role of intellect in learning, at the expense of the senses, was generally stressed even more in the medieval world. Knowledge derived from sensory impressions was considered highly. For some twenty or thirty years after 1895, Herbartianism wrote most of the educational textbooks and dominated several educational journals as well as the professional discussions and debates. Nevertheless, it was clearly evident as early as 1901 that Herbartianism was waning in the United States. In his book of 1901, Talks to Teachers on Psychology, William James (1842-1910) made a distinction between the art and the science of education and proceeded to refute the Herbartians' key concept of apperception by revealing its empty verbalism and mystical origins. James was joined in his attacks by philosophers John Dewey, William Dilthey, and Josiah Royce, all of whom pointed out the anachronisms of Herbartian rational science. More important, perhaps, than criticisms of the abstruse features of Herbart's theoretical system were criticisms of the instructional practices that system established. Herbartianism essentially committed teachers to a program of indoctrination whereby they determined precisely what their pupils would be taught. Each lesson plan included not only the questions, but all the answers as well, which the learners arrived at through a largely mechanical process that was completely dominated by the teacher. Thus, learning was seen as a process similar to the filling of a storage container.

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Notes


2. Between 450 and 359 B.C., the Greek title sophist or sophates was used to describe any man of science or learning. But by the time of the Peloponnesian War (431-404 B.C.), the name began to acquire an equivocal ring because the conservative followers of Athens suspected the Sophists as teaching the young to lead the youth from the traditional Homeric virtues and the old religion. Plato's later denigration of the Sophists accentuated the prejudices against them. We must, however, go beyond Plato's prejudices to assess the educational role of the Elder Sophists. In this effort, we are indebted to the technical scholarship of Eric A. Havelock and his The Crossing of Intellectual Men, as well as his The Liberal Temper and Greek Politics, in which he endeavors to put Sophist thought and practice into proper historical perspective.
Although the widespread prejudice against the Sophists was partly due to their acceptance of fees, Protagoras was quite unashamed of his profession. His fees, indeed, seem to have been high. He demanded 10,000 drachmas for a two- or three-year course of instruction at a time when 1 drachma was a skilled worker’s daily wage. By 350 B.C., however, the price of such a course had fallen to about 1,000 drachmas. In spite of the liberal, democratic ideals the Sophists espoused, it is clear that only aristocrats could afford their services.


5The period of instruction generally seems to have lasted for three or four years.

6Havelock, The Liberal Temper, 30-80.


8In contrast to the so-called Socratic method, the Sophistic dialogue provided both flexibility and creativity in its free conversational exchange of ideas. Students were not expected merely to answer yes or no to questions or, in effect, to separate one syllogism from another. The theory of Sophistic dialogue viewed the student as an active, inquiring individual who could lead the discussion down new, divergent paths.

9Havelock, The Liberal Temper, 216.

10The favorite subjects of the Sophists, grammar and rhetoric, occupy two-thirds of the “trivium,” in which Plato is not even represented.

11In contrast to the democratic viewpoint of the Sophists, Plato’s philosophy suggested an antidemocratic, totalitarian government in which an aristocratic and military elite of “superricus” ruled a lower-class majority who were considered to be inferior and motivated by gross appetites. This philosophy supported authoritarian tendencies and control throughout the history of the Western world. In the teaching of the Church, Platonic doctrines were wedded with the will of God as revealed in Scripture, which led to the identification of Platonism with Christianity.


13Pierre Abélard (1079-1142) was born of noble stock in Brittany and died in the Priory of St. Marcel, near Chalon, France.


15Abélard may have found a model for his method in the work of such men as Ivo of Chartres, who in the tenth century had undertaken to reconcile contradictory statements.

16The cloister University of Prague was then controlled by the Utraquists, a Hussite sect opposed to the Moravians.

17Among them was the Ioannes Liguerrum renovatris (The rate of languages unlocked), published in 1631, in which Comenius selected 8,000 of the commonest words and used them in 1,000 graded sentences.

18Comenius’ idea for his system of instruction were first formulated at Leshno, Poland, where he wrote his Great Didactic. His later texts were elaborations of this basic work, The Great Didactic, written in Czech, was first published in German in 1633 and in Latin in 1657.

19The Moravians, who had suffered severely at the hands of the Catholics during the Thirty Years’ War, were secretly sympathetic to the Protestant Swedes during their invasion of Poland. After peace was declared, Comenius openly published a letter of congratulation to the Swedish king, Charles Gustavus.

In retaliation, the Pole attacked and plundered Leshno, the town where Comenius was living. He barely escaped with his life and lost his entire family and his collection of panopticon materials on which he had worked most of his life. Since he was then in his sixty-fifth year, he lacked the enthusiasm and strength to pursue the dream further.

20Peter Canisius, one hundred years before, had issued a child’s catechism with marginal pictures and woodcuts illustrating the lives of Christ and the saints, as well as church ceremonies.

21The teachers included ministers, college students, indentured servants, mechanics, physicians, and even ex-convicts and tramps. In many areas, the summer sessions catered to young children who were not needed in the field for work. Women and girls as young as sixteen were often employed to teach these sessions, since the problems of discipline were not so severe. In the winter term, men generally taught the older children.

22A. Scott, Andrew Bell (1753-1832), simultaneously and independently developed the monistorial method. In the matter of details, Lancaster elaborated more than Bell; he also toured both Europe and the United States. The method, however, was not original with either Bell or Lancaster. It had been used by the Hindus; it had formed part of the Jesuit method; and it had been recommended to Comenius in his Great Didactic. Bell was primarily concerned with religious instruction while Lancaster was generally interested in secular systems. In time, laymen and educators began referring to the monistorial system as the Lancasterian method.

23In the seventeenth century, John Locke (1632-1704) challenged the whole notion of innate faculties or ideas, as well as the concept of learning as the development of such innate faculties. His tabula rasa (blank tablet) theory held that the mind is empty at birth and that any ideas a person holds must have come to him originally through his senses. Locke’s theory opened the way for psychologists to emphasize environment over heredity. Locke believed teachers should develop a systematic instructional method for training the senses rather than the faculties.

24Schools that used the monitor method soon experienced difficulties because of competition for clerical and other kinds of literate workers in the cities. Pupils mature enough to become monitors seldom could be induced to remain after their parents discovered that they could earn more money in other occupations. About 1827, women replaced boy monitors, but at a salary of $25 for the first year. These untrained women, however, could not provide even the low-level, standardized instruction that the trained boy monitors had assumed. To improve this situation, some cities, such as New York, established Saturday classes for new women teachers. These “normal schools,” which developed after 1840, became the main teacher training ground. However, these training schools were so influenced by the Lancasterian method that the adults who would replace the boy monitors were given essentially the same authoritarian perspective. This was a simple process of insisting on obedience within a hierarchial chain of command, which made rote learning the only practical type of instruction.


28Those who support the idea of using master teachers, assisted by monitors, to instruct large groups using such a medium as television might well study the Lancasterian scheme.


30See H. G. Rickover, Education and Freedom. New York: Dutton, 1959; Arthur E. Bestor, Educational Wastelands. Urbana: University of Illinois Press, 1953; and James D. Koerner, The Case for Basic Education. Boston: Little, Brown, 1959. We generally agree with these critics that teachers often have been poorly educated, but this does not imply that strengthening teachers’ backgrounds in the liberal arts and science will necessarily increase their effectiveness in the classroom. It is surprising
that, in the current teacher education controversy, the nature of instruction has not been analyzed nor has the relevance of various proposals been examined with respect to the realities of the process of instructing groups of learners.

Rousseau's central theme in Emile was that education should be in accordance with the natural interests of the child. He divided the learner's development into definite stages and prescribed a distinct educational program for each successive period. His approach stemmed from the viewpoint that man is naturally good and is at the same time active in relation to his environment. Since man is naturally good, the teacher should let the learner develop in a natural environment, free from corruption. Pestalozzi used the same principle, under the name of "organic development," as a basis for his own educational theory and practice.


3Ibid.

4August Herman Francke (1663-1727) founded the first Realschule at Halle, Germany, where he and his fellow teachers employed "real things" to facilitate instruction. Johann Bernhard Basedow (1723-1790) established his Philanthropinum at Dessau, Germany, where he attempted to put Rousseau's theories into practice.

5Johann Gottlieb Fichte, Die Reden an die Deutsche. Fourteen in all; the endorsement of Pestalozzi's principles occurs in the tenth.

6Colburn's book ranks with the New England Primer and Webster's Speller in historical importance because it was the first to emphasize sensory objects in teaching mental arithmetic.


8Warren Burton, The District School as It Was. Boston: Phillips, Sampson, 1850, 52. (First published in 1853.)


15In post-Civil War years, the spread of Oswego graduates throughout normal schools all over the United States developed the first unified theoretical viewpoint in teacher training.

16Ecoobel first spent two weeks with Pestalozzi at Yverdon in 1805, and later taught there from 1807 to 1809. Thereafter he pursued a university career, first at Göttingen and then at Berlin. He founded his first school at Kelhau in 1817 and established the first kindergarten at Blankenburg in 1837.

17Ecoobel published Mother Play and Nursery Songs in 1843. This work consisted of an organized series of songs, games, and pictures intended to direct the educational role of the mother. Each song consisted of three parts: (1) a motto for the guidance of the mother; (2) a verse with the accompanying music, to sing to the child; and (3) a picture illustrating the verse.

18Prussian kindergartens were suspected of reflecting socialist and liberal viewpoints dangerous to the existing government. The effects of their closing were felt in Prussia for a decade. Elsewhere, this education movement, in which women took a major part, received impetus from Baroness von Marahrens-Bulow in Germany and spread to England, France, Italy, and the Netherlands. Henry Barnard, an American educator, witnessed a kindergarten demonstration at the Great Exhibition in London in 1854 and his description inspired Elizabeth Peabody to start a kindergarten in Boston in 1860.


20Jos Cynaeus (1810-1888) introduced the manual-training concept into Finnish schools in 1886. John D. Runkle, president of the Massachusetts Institute of Technology, after seeing a display of the Imperial Technical School of Moscow, recommended the establishment of manual-training workshops in the United States. His idea was further developed by Calvin M. Woodward and others. The manual-training vogue continued until about 1910.

21In Mother Play and Nursery Songs, for example, the pictorial illustrations are rough and poorly drawn, the music is crude, and the verses are lacking in rhythm, poetic spirit, and diction. The arrangement of verses is awkward and seems at times to lack consistency.

22Tutoring proved to be a valuable practical experience as well as an important influence on Herbert's educational views. His patron required a bimonthly written report of Herbert's methods and his students' progress; five of these letters are still extant and reveal the germ of an educational system. At this early date, Herbert already recognized individual differences in learners and attempted to adapt his instruction to their particular needs. He afterward maintained that careful study of the development of a few children was the best preparation for a teaching career.

23See note 23 for information on Locke's tabula rasa theory.

24Herbert's psychology was the last great system of metaphysical psychology. Although he maintained that his system was based on "metaphysics, empiricism and mathematics," he conducted no empirical studies. His entire system was based on introspection. He felt that it was appropriate for a science like physics to be experimental but equally appropriate that psychology be introspective and metaphysical.

25Herbert's four steps were later expanded to five by American Herbertians. Clearness became (1) preparation and (2) presentation; association became (3) comparison and abstraction; system became (4) generalization; and method became (5) application.

26Ziller elaborated the Herbartian principles of correlation and concentration, which unified all subjects around one or two central studies such as literature or history. Ziller also formulated the cultural epochs theory, which held that materials for a course of study should be selected to parallel the development of the individual and the race.

27The National Herbart Society was the predecessor of the National Society for the Scientific Study of Education, which was organized in 1895. However, the NSSS never seemed comfortable with the word scientific; in 1910, the official title became the National Society for the Study of Education.

28Plato and his student-successor, Aristotle, formulated and refined the theory of faculty psychology. Plato's entire educational structure was based on faculty psychology, directed toward producing leaders by means of a rigid choice of subject matter. He believed that training the faculties through mathematics and philosophy was the best preparation for the conduct of public affairs. Having trained his mental faculties, a philosopher-king was considered ready to solve all problems. Aristotle agreed with Plato and further contended that once a man had trained his faculties by mastering specific subject matter he would be able to transfer his power to the mastery of other subjects. Aristotle described at least five different faculties, the greatest, and the one unique to man, being that of reason.
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Beginnings of a Science and Technology of Instruction: 1900–1950

No particular event or date marks the beginning of a modern science and technology of instruction. Yet it is clear that at the beginning of the twentieth century there occurred a series of related events that together might be interpreted as the beginning of a science of instruction.

William James (1842-1910), for example, in his book, *Talks to Teachers on Psychology*, made one of the first distinctions between the art and the science of teaching, calling for a scientific approach to instruction. Similarly, also in 1901, John Dewey (1859-1952) interpreted the method of empirical science in educational terms, viewing the classroom as an experimental laboratory. In 1902, Edward Thorndike (1874-1949) offered the first course in educational measurements at Columbia University and became the first to apply the methods of quantitative research to instructional problems. G. Stanley Hall (1846-1924) published his *Adolescence* (1904), a landmark in the scientific study of the child. The French psychologist Alfred Binet (1857-1911) and Theodore Simon, his collaborator, published *A Method of Measuring the Intelligence of Young Children* (1905). Moreover, a true science of behavior, and especially of learning theory, began to emerge, no longer based primarily on metaphysical or philosophical speculation. This new science and learning theory would eventually be applied to a technology of instruction.

This chapter focuses on a few educators whose theories and methods either produced or fostered a modern science and technology of instruction. Two who dominated much of the thought and practice of American education during the first half of this century were Edward L. Thorndike and John Dewey. Both Thorndike and Dewey rose to eminence during roughly the same period and, for a time, both argued against those who still clung to the unscientific modes of thinking. Dewey, a philosopher, developed a comprehensive theoretical system that encompassed everything from the nature of man and learning to ethical and logical theory. Thorndike, an educational psychologist, fashioned the first scientific learning theory and established empirical investigation as the basis for a science of instruction.

By the early twenties, it was apparent that Thorndike's and Dewey's theories of instruction were incompatible. Dewey, a pragmatist and founder of the experimentalist school, built a system
that had little basis in empirical data and whose hypotheses still have not been subjected to experimental investigation, despite his warnings to inquire, test, and criticize. On the other hand, Thorndike was the exemplar of what might be achieved through empirical theorizing and investigation. His theories, however, were rejected by many educational leaders, who were attracted by Dewey's more democratic, though untested, approaches to instruction and learning.

Thorndike and the Science of Instruction

American educational psychologist Edward L. Thorndike made monumental contributions to a science and technology of instruction. The most remarkable aspect of Thorndike's work is that he dealt with every major psychological concept of his time. He either demonstrated an approach's inadequacies experimentally or incorporated it into his own system. It is well known, for example, how he refuted the mental discipline theory as a psychology of learning, as well as the recapitulation theory of psychological development. Thorndike was not an ivory-tower theorist. He shuttled back and forth from his laboratory at Columbia University to countless public-school classrooms, tackling the relevant instructional problems of his day.

Thorndike's psychological career began with laboratory studies of learning in various animal species, while he was a student of William James at Harvard and of James McKeen Cattell (1860-1944) at Columbia. His doctoral dissertation, Animal Intelligence (1898), remains a landmark in the history of psychology. Thorndike joined the faculty of Teachers College at Columbia University in 1899, where, at the suggestion of Cattell, he shifted his emphasis from animal learning to what became his lifetime concern with a science of human learning and a technology of instruction.

Thorndike's Theory of Connectionism

Thorndike's studies of animals led to the first scientific theory of learning, his theory of connectionism. Whereas previous theories had emphasized practice or repetition, Thorndike gave equal consideration to the effects of reward or punishment, success or failure, and satisfaction or annoyance on the learner. Building on the idea of the reflex arc, which said that the brain and neural tissues were connected with the total behavior of the organism, he eliminated the idea that the mind was a separate entity, placing it in the total response of the learner to his environment. Moreover, Thorndike discarded the earlier views that man is either sinful or good and that he is completely modifiable. Human nature, Thorndike maintained, was simply a mass of "original tendencies" that could be exploited for either good or evil, depending on what learning took place.

Thorndike's laws of learning provided the basic principles that led to his particular technology of instruction. We describe here only his three primary laws:

1. The law of exercise or repetition. The more often a stimulus-induced response is repeated, the longer it will be retained.

2. The law of effect. The law of effect states the pleasure-pain principle: A response is strengthened if followed by pleasure and weakened if followed by displeasure.

3. The law of readiness. Thorndike assumed that, because of the structure of the nervous system, certain conduction units, in a given situation, are more predisposed to conduct than others.

Thorndike based these laws on the stimulus-response hypothesis: that a neural bond would be established between the stimulus and the response when a particular stimulus produced a satisfying response within a given environment. Learning took place when these bonds formed into patterns of behavior.

Thorndike's Technology of Instruction

According to the connectionist concept, the instructional task of the teacher is guided by two broad rules: (1) to put together what should go together, and (2) to reward the expression of desirable connections and create discomfort for the expression of undesirable connections. In his classic three-volume work, Educational Psychology, Thorndike formulated the basic principles underlying his technology of instruction: (1) self-activity, (2) interest
Theories of Instruction According to Dewey and Kilpatrick

John Dewey's importance in educational technology stems primarily from his vast influence on American education and, particularly, from his analysis of thinking in reflective, problem-solving terms. Dewey studied with G. Stanley Hall at Johns Hopkins University, where he received his doctorate. He then taught at the universities of Michigan, Minnesota, and Chicago, before joining the Columbia University Faculty in 1904. More than anyone, Dewey was responsible for the application of pragmatism to education, the notion that education was life. However, Dewey's ideas were frequently misinterpreted, and taken to excess by many of his followers in the Progressive Education movement.

Dewey's Psychology of Learning

A comprehensive analysis of John Dewey's psychology of learning has yet to be accomplished; only a few of the most significant ideas underlying his view of instruction are presented here.

In contrast to Thorndike, Dewey believed that stimulus and response were not to be sharply distinguished, but rather should be seen as organically related. In a short paper that is now regarded as a psychological classic, he attacked the widely held reflex arc concept, contending that learning involved interaction, or two-way action between the learner and his environment. In his view, the environment supplied cues and problems, and the human nervous system functioned to interpret the cues so problems could be evaluated and satisfactory solutions found. Moreover, Dewey explained that the experiences of learners within their environments became the materials out of which they made meanings and upon which they base goals and actions.

Dewey's Experimental Laboratory School

In 1896, while at the University of Chicago, Dewey decided to establish a Laboratory School for the purpose of testing his educational theories and their sociological implications. Beginning with 16 pupils and 2 teachers, it grew by 1902 to 140 children, 23 teachers, and 10 assistants. Dewey served as director; his wife was principal; Ella Flagg Young, who became Chicago's first woman superintendent of schools, was supervisor of instruction. The Laboratory School closed in 1903, and the next year Dewey left Chicago to teach philosophy at Columbia University.

During its seven years the Laboratory School became the most interesting experimental endeavor in American education. An observer found none of the conventional arrangements, routines, or activities. Desks and benches were not arranged in rows; the traditional teacher's desk with bell and ruler was missing; drills and recitations were never heard. Subject matter was not clearly separated. Some children might be busily engaged with books; others, with pen and paper; and some might be painting or using hammers. The teacher could usually be found mingling with the children, offering guidance as the pupils proceeded in their activities.

From the time Dewey established this experimental school he was hailed as the guiding light of the Progressive Education movement. But, as Dewey himself observed, the school was overweighted on the individualistic side so that he might obtain data. More important, Dewey sought to substitute a new curriculum that was better planned, better designed, and more effectively organized than the conventional curriculum, which he pointedly criticized. Although his instructional approaches at the school were clearly effective, he did not consider his innovations as final, but only as the first step in developing a science of instruction.
He was, however, destined for disappointment; a quarter of a century later he declared progressive education a failure because it had too hastily destroyed the traditional instructional pattern without replacing it with something better. 16

The Reflective Method of Instruction

Dewey's lasting contribution to a technology of instruction was probably his conception of instruction in terms of scientific method (defined in its broadest sense). To him, all worthwhile thinking was reflection, or the "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends." The essence of this reflective method was contained in his little book How We Think (1910), which described reflection as a psychological process made up of the following steps:

1. The learner sensed and recognized a problem. Preferably, he became aware of some goal and felt blocked by an intervening obstacle, so that he felt a need to restore continuity.

2. After having sensed a problem or felt a discrepancy in known data, he would formulate hypotheses for the purpose of providing tentative answers or generalizations that might offer possible solutions.

3. Once the problematic situation had been surveyed, deductive observations had been checked against present knowledge, or experiments had been designed to test hypotheses, steps could be taken to restore the continuity of the learner's activity. His goal could be more adequately visualized.

4. The learner would test hypotheses and attempt to verify the consequences of the logical implications.

5. Finally, the learner would draw conclusions. He might accept, modify, or reject his hypotheses or decide that the available evidence did not provide a basis for action, for making an unqualified statement, or for taking a firm position.

Dewey did not mean to imply that reflection was a rigid, mechanical process. All the steps were closely interrelated and a learner did not necessarily go through them consecutively. A learner might move back and forth, from problem to hypotheses to evidence to conclusions, in varying order. Thus, Dewey's instructional approach resembled that of a scientific investigation in which hypotheses could be formulated and tested.

Many so-called followers of Dewey never understood the full implications of his theory of instruction, either because they found his writing difficult to understand or because they tended to ignore his insistence that the reflective approach be the center of the instructional process. Dewey believed the primary goal of instruction was the improvement of intelligence, and he attacked much of the formalism inherent in both the mental discipline theory and the connectionism of Thorndike. Dewey gave teachers a philosophical, theoretical-deductive psychology of learning that made empirical inquiry unnecessary for most educators who accepted his ideas. And although he urged inquiry and experimental investigation, his philosophy tended to block educational research. Thus, until Dewey's hypothesis is tested against predictions made from it, it cannot meet the basic criteria of a scientific technology of instruction. 17 Nevertheless, his theory continues to hold important implications for current instructional design.

Kilpatrick: The Popularizer of Dewey

The man who probably had most to do with popularizing Dewey's educational ideas was William Heard Kilpatrick (1871-1965). After graduating from Mercer University in Macon, Georgia, Kilpatrick taught for a time in the public schools before returning to Mercer, first as a teacher of mathematics, later as vice-president, and then as acting president. In 1906 he resigned, and the following year became a graduate student and Dewey disciple at Columbia University. After completing his doctoral dissertation in 1912, he joined Teachers College as a full-time faculty member, an association that lasted throughout his professional life.

Kilpatrick was simplifying and clarifying Dewey's complex thinking and writing, as well as adding his own interpretations. He became known as "the million-dollar professor," because his estimated 35,000 students (mostly classroom teachers and school administrators) had paid a total of more than a million dollars in fees to Columbia University. Kilpatrick was, in fact, a compelling teacher who was extraordinarily successful in acquiring his own
disciples. Although acclaimed as the great interpreter of Dewey, it seems clear that Kilpatrick ended by transforming Dewey’s ideas into something quite different than Dewey had originally intended.

Kilpatrick’s Project Method

Some of the theoretical differences between Dewey and Kilpatrick come clearly into focus when Kilpatrick’s project method is examined. In his effort to present a purposeful approach to instruction, Kilpatrick developed the project method in the spring of 1918. It was also his purpose to reconcile Thorndike’s connectionism with Dewey’s theory of instruction. By emphasizing purposeful activity that was in harmony with the learner’s goals, he sought to take full account of Thorndike’s law of effect; by locating this activity in a social environment, he believed he could introduce an ethical outcome, since moral character was, for him, anchored in the welfare of the group. Kilpatrick reorganized the curriculum as a succession of projects suitable to the interests of each stage of learners. He summarized the role of the teacher as follows: The teacher helps (1) initiate the activity; (2) plan how to carry the activity forward; (3) execute the plan; (4) evaluate progress; (5) think up new leads; (6) formulate the new leads by writing them down for later reference; (7) keep the pupils critical of their thinking en route to the solution; (8) look back over the whole process to pick up and recapitulate important kinds of learning, as well as to draw lessons for the future.

Within this particular technology of instruction, Dewey’s problem-solving method became only one special type of project. Other types of projects such as building a boat, presenting a play, or developing a skill might be less scientific, or not scientific at all. The other steps of conventional instructional method—presentation, eliciting the trial response, correcting the trial response, and eliciting the test response—were also part of the Kilpatrick approach, in which each assumed a distinctive form. Rather than presenting an instructional task, the teacher assisted the learner in defining it. The object was not to learn something from a book but to meet a need or resolve a problem. Trial responses and their corrections were automatically resolved during the planning and execution process. The test response constituted the results of the activity and the degree to which that activity had achieved a desired goal.

Comparative Analysis of Dewey and Kilpatrick

On the surface, the Dewey problem-solving method and the Kilpatrick project method seemed to have been cast from the same theoretical mold. There were, however, basic differences. Dewey considered problem solving central to the instructional process and was deeply concerned with the interests and purposes of the learner. He also proposed a new body of content, beginning with the learner’s experiences and culminating with structured subject matter. Kilpatrick, on the other hand, attacked subject matter that was fixed in advance and emphasized a child-centered approach that Dewey himself had rejected, first in his *The Child and the Curriculum* (1902) and later in his *Experience and Education* (1938). Moreover, Kilpatrick’s influential *Foundations of Method* (1926) unequivocally stated a Thorndikean, connectionist psychology, which Dewey had consistently opposed. For example, one of the slogans popularized by Kilpatrick and other progressives, “Children learn by doing,” distinctly implies a connectionist psychology of learning. Finally, Kilpatrick seemed to assume the validity of Rousseau’s permissivism, which was incompatible with Dewey’s views.

The Montessori Method

An important pioneer in nourishing a science of instruction was the remarkable Italian educator Maria Montessori (1870-1952), the first woman to receive a medical degree from the University of Rome. Her dominating interest in the development and welfare of children soon diverted her from medicine to education, and she was placed in charge of a state school for defectives, a position she held from 1899 to 1901. During this period, Montessori began to develop techniques for teaching mentally deficient children, based on the methods and materials of Edouard Seguin (1812-1880).

In 1907, Montessori resigned to reenter the University of Rome for courses in experimental psychology and anthropology, hoping to obtain a scientific foundation on which to build the science of instruction she wished to develop for normal children. By 1907, she was ready to apply her theories to the instruction of culturally deprived children in the first of the *Case dei Bambini*, or Children’s Houses, which she established in a low-cost housing development in a Roman slum. Montessori trained a resident teacher for each school, selected the instructional materials, and devised techniques derived partly from Seguin, partly from Froebel, and partly from her own experience with teaching mental defectives. She continued this work with extraordinary success until 1911.
When Montessori published her "Scientific Pedagogy as Applied to Child Education in the Children’s Houses" in 1909, people came from all over the world to observe her schools. She devoted herself to two principal activities: acquainting teachers and educational leaders outside of Italy with her methods, and working out applications of those methods to older children. Many prominent Americans became intensely interested in her work, including such diverse personalities as Alexander Graham Bell, psychologist Dorothy Canfield Fisher (better known for her novels), Arnold Gesell, Howard C. Warren, and Lightner Witmer. S. S. McClure, publisher of the muckraking "McClure's Magazine," helped communicate Montessori’s methods to the public, generating an interest that exploded into a social movement.

By 1917, however, American interest had already subsided. This was partly due to a false tension that developed between educational progressivism and Montessori. For example, the basic criticism of Montessori, as offered by William Heard Kilpatrick, centered on her failure to provide for "self-directing adaptation to a novel environment." Also, as Joseph Hunt pointed out in his introduction to "The Montessori Method," she collided with several of the more firmly held psychological beliefs relative to "fixed intelligence" and the "unimportance of early experience."

A second explosion of American interest occurred during the mid-1930s, partly because many of her instructional practices seemed justified in the light of new contributions to learning theory. One of the decisive catalysts in the revival of the Montessori movement was the work of the American Montessori Society, founded in 1956 by Nancy McCormick Rambusch in Greenwich, Connecticut. A third revival of American interest occurred in the early 1990s.

Basic Concepts of the Montessori Method

Montessori’s genius lay in her ability to anticipate what a learner was attempting to do in his informational interaction with his environment, and then to develop a plan that provided relevant experiences. Her technology of instruction possessed three characteristics: adaptation to the individuality of each learner; provision for freedom, which the teacher did not dominate the learner nor did the learner become overly dependent on the teacher; and emphasis on sensory discrimination, perhaps the most distinguishing feature of the system. Two of the basic principles of the Montessori method—respect for the learner’s individuality and encouragement of his freedom—determined not only the psychological climate and physical arrangement of the classroom, but also the relation of teacher and learner, the instructional media, and the nature of instructional procedures. For example, she used small, light chairs and tables that the children could rearrange as they chose. Each learner selected from a central room those materials he wished to use, took them to a place that suited him, and proceeded to work in his own way. There was no group instruction, although the children sometimes played group games or did their work together on their own initiative. A teacher was always present to observe and guide. If a learner failed to complete an exercise, he received no penalty; his failure indicated that he was not yet ready for the work, and the teacher would suggest some other exercise. Whenever possible, the instructional materials used by the children were self-corrective, so that learners could discover their own mistakes and become progressively more independent.

To reinforce the idea that freedom implies independence, small children in the Montessori schools were taught how to dress themselves, keep themselves clean, dress the room, care for school equipment, and help serve lunch. The youngest began with exercises in buttoning, hooking, and lacing pieces of cloth together. Later they learned to walk quietly, to move their chairs without noise, and to be able to handle increasingly delicate objects. At first, the younger children were helped by the older children, but they were encouraged to decline aid as soon as possible.

Montessori emphasized the senses, individually and in association with one another, working particularly with visual, muscular, tactile, and auditory sensations. Through sight, sound, and touch, the children learned to distinguish shapes, sizes, weights, textures, colors, and pitch. They were also trained to observe and care for plants, birds, and animals. Thus the Montessori technology of instruction was a blend of three somewhat divergent elements: the two fundamental tenets of learner individuality and freedom, and the specific technique of sensory training.

Contributions of Montessori

Montessori’s stated theories often diverged sharply from their implementation. In general, her theories were derivative, whereas her practices stemmed from her own clinical observation and special insights. As a consequence, her instructional procedures often either contradicted her theoretical principles, or at least had no apparent relation to them. Thus Montessori often did the right things for the wrong theoretical reasons. However, she considered her system completely scientific. And despite the fact that she never employed techniques of measurement, statistical design, or analysis, many of her concepts suggest that she built a sounder system of instruction than her critics realized. For example, Montessori’s emphasis on sensory learning, based as it was on her careful observation of mentally retarded children, was closer to reality than the theories of critics who held such learning in contempt. Recent evidence appears to indicate that the role of the eyes and the ears, and perhaps the tactile organs, may be much more important in the organism’s development than was thought possible.

Another example from recent data seems to provide an important psychological basis for Montessori’s notion that children have a spontaneous interest in learning and that motivation is inherent within a human’s interaction with the environment. In accordance
with this idea, Montessori attempted to grade didactic materials and match them to standards the learner had already developed in the course of his past experience. What is more, by having children aged from three to seven years together, she provided the younger children with a graded series of models to imitate and the older children with an opportunity to learn by teaching. Thus Montessori succeeded in breaking the lockstep process and provided an opportunity for the learner to make his own selection of materials and models.32

Of particular relevance to current educational problems of curricular deprivation was Montessori's contention that the young learner is characterized by self-creating energies that can be sustained and enhanced by the imaginative and controlled use of environmental materials. Her "prepared environment," so successful with the Italian slum children among materials. Her "prepared environment," so successful with the Italian slum children, was a shift from an individual to a more systematic group instruction approach. With the evolution of the graded school, a graded instructional materials, and even graded teachers in the middle of the nineteenth century came the advent of a lockstep educational machine that has changed little since those days.

However, beginning in the 1880s, there arose what has been an almost continuous interest in individualizing instruction. One of the first attempts to break the lockstep of graded instruction came with the general introduction of the laboratory method about 1885. Each instructional approach with the general introduction of the laboratory method about 1885. Each instructional approach had its limitations, as its limitations, as technology and educational theories evolved. However, over 100,000 text materials were written, published, and distributed throughout the United States and foreign countries. The instructional materials were well-received and even graded instructional materials rested entirely with the state power to publish and distribute them. The result of this was a lockstep educational process. As a result, the fruitful work begun by Burk was curtailed. It remained a model for the next two of his associates, Carlton W. Washburne and Helen Parkhurst, to develop two of the most outstanding and distinctive plans of individual instruction.

Individualized Instruction According to Burk, Washburne, Parkhurst, and Morrison

Prior to 1800, instruction in American schools was predominantly individual. The introduction of blackboards, slates, and steel pens brought about innovations in methods of instruction. The monitorial method, as used in the Lancasterian schools, was a shift from an individual to a more systematic method of instruction. With the evolution of the graded school, a graded instructional materials, and even graded teachers in the middle of the nineteenth century came the advent of a lockstep educational machine that has changed little since those days.

Burk's System of Individualized Instruction

Frederic Burk (1862-1924) developed one of the first systems of individual instruction, at the San Francisco State Normal School in 1912. He and his staff wrote courses of study to permit learners to advance at their own rate with a minimum of teacher direction. Self-instruction textbooks in arithmetic, geography, grammar, history, language, and phonics were written, published, and distributed throughout the United States and foreign countries. The instructional materials were well-received and even graded instructional materials rested entirely with the state power to publish and distribute them. The result of this was a lockstep educational process. As a result, the fruitful work begun by Burk was curtailed. It remained a model for the next two of his associates, Carlton W. Washburne and Helen Parkhurst, to develop two of the most outstanding and distinctive plans of individual instruction.

Washburne's Winnetka Plan

The Winnetka Plan was developed by Carleton W. Washburne (1890-1968) when he was appointed superintendent of the Winnetka, Illinois, public schools in 1919. The plan provided self-instructional and self-corrective practice materials (workbooks), a simple record-keeping system in which each pupil's progress was noted, and prepared materials appropriate to each pupil's particular project and assignment. Thus, the twofold task of the faculty was to analyze course content into specific objectives and develop a plan of instruction that would enable learners to master each objective at their own rate.

The Winnetka Plan not only allowed learners to proceed at different rates, but also recognized that learners proceed at different rates in different subjects. Each learner was given diagnostic tests to determine what goals and tasks he should undertake. When the learner thought he had accomplished his goals, he took a self-test to see whether he was ready to be tested by the teacher, and also to see whether he was prepared to undertake new goals and tasks.

Parkhurst's Dalton Plan

The Dalton Plan, first developed by Helen Parkhurst (1887-1973) in 1919 in an ungraded school for crippled children, was adopted by the Dalton, Massachusetts, high school in 1920. Its principal features were: differentiation of assignments for different ability levels, self-instructional practice materials, and assistance with individual study difficulties. Under this plan, the teacher made a contract with each student concerning assignments. The student was free to budget his time in order to complete every phase of the contract. Group activities in both the Winnetka and the Dalton plans were not neglected, but emphasis was on individualized instruction. The Winnetka Plan emphasized group activities more than did the Dalton Plan, devoting approximately half of each morning and afternoon to such activities as plays, music, student government, and open forums. In both plans, classrooms became laboratories or conference rooms, and teachers became consultants or guides.

The Morrison Plan

Another instructional proposal, highly influential from about 1925-1935, was that of Henry Clinton Morrison (1871-1945), former director of the University of Chicago High School. His system provided a sequence of units and guides for lesson assignments. The classroom was viewed as a laboratory where units and assignments were differentiated for learners of varying ability. Morrison's (1931) formula for mastery was, "Pretest, teach, test the result, adapt procedure, teach and test again to the point of actual learning." For science-type units or those designed to develop understanding, Morrison devised a five-step procedure reminiscent of Herbert's four-step plan: exploration, presentation, assimilation, organization, recreation. Exploration was a test to determine how much each learner already knew or how much understanding he possessed. Presentation usually involved lecture, which provided an overview or summary of the unit as a whole and explained the principle to be learned. Assimilation represented the achievement of unit understanding. Once the learner had passed a mastery test, he reached the organization phase, which Morrison referred to as the time when the learner provided a written outline discussing the logical arguments that supported the basic understanding or principle embodied in the unit. Recreation was essentially the reverse of the first step, presentation: now the learner orally presented a summary version of the principle learned in the unit.
Morrison's plan called for individualized instruction, but unlike Washburne's Winnetka Plan, class members began and ended each unit together. Moreover, learners tended to remain together through all the steps with the exception of step three, assimilation, when each was on his own. To inform each learner what was expected of him, a guide sheet (worksheet) was provided. The teacher maintained close supervision as the learners worked, reading their notebooks, conversing with them, or conducting group discussions.

**Analysis of Individualized Instructional Plans**

The significance of these individualized instructional plans lay in their attempts to provide for individual differences in learning and, at the same time, to teach for specific objectives. A study of the current programmed instruction approach reveals that early individualized instruction plans anticipated much of what has been called today's major breakthrough in education.

At this point, it seems relevant to note that the phrase *science of education* was expanded by Washburne and others (such as Bobbit and Charters) to mean not only basing a technology of instruction on scientific principles, but also employing statistical analysis of the activities people most frequently perform or the kinds of information or words most frequently used, as a basis for selecting curriculum content.

These individualized instructional plans made an outstanding contribution to educational technology by breaking the lockstep method of lesson progress and substituting mastery learning for partial learning. They opposed the concept of a normal distribution curve and the notion that only a small percentage of learners should complete the period of study with a thorough mastery of the subject. Individualized instruction enabled learners to progress at their own rate but required that they reach an approved level of achievement as a requisite for advancement.

Another contribution of these particular methods to a technology of instruction was their emphasis on careful organization of assignments. Organizing materials on an individual basis often led to a deeper appreciation of the nature of learning and the realization that much could be eliminated from courses formerly considered essential. Moreover, the teachers in these programs found that they had to analyze their own instructional materials more carefully than when they had employed traditional procedures. Thus individualized instruction led to a technology for organizing the curriculum as well as to a technology of instruction.

**Lewin's Field Theory and a Science of Instruction**

The series of experimental studies directed by Kurt Lewin (1890-1947) at the University of Berlin in the late 1920s were models of theoretical creativity combined with brilliant experimentation. Although Lewin was associated with an active center of Gestalt psychology at Berlin, his theories had little formal relationship to those of the orthodox Gestalts.

Lewin's early work on motivational problems led to an interest in personality organization and also in a wide variety of problems in social psychology. This culminated in his development of the group dynamics movement and action research (i.e., research directed at producing social changes). Lewin also concerned himself with the problem of constructing scientific principles of learning as the basis for a science of instruction. In all these diverse areas, he took the same fundamental approach: He emphasized the psychological over the simple, environmental factors.

A native of Germany, Lewin received his doctorate at the University of Berlin, where he later became a professor of psychology and philosophy. He came to the United States in 1932 and taught at the universities of Stanford, Cornell, and Iowa. In 1944, he was named director of the Research Center for Group Dynamics at the Massachusetts Institute of Technology, where he remained until his untimely death in 1947.

**Lewin’s Theoretical Approach**

It is not necessary to review the substance of Lewin's field psychology, since excellent expositions are readily available. A primary concern is, rather, to point to Lewin's general theoretical orientation so that the reader may have a clearer understanding of the constructs that supported his theory of learning.

Although Lewin began his scientific career as an associationist, he soon became convinced that the associationist concept of learning had to be radically revised. Moreover, he also diverged from the views of the major Gestalt psychologists, saying: "Psychology cannot try to explain everything with a single construct, such as association, instinct, or Gestalt. A variety of constructs has to be used. These should be interrelated, however, in a logically precise manner."

To Lewin, scientific method included not only the processes of observing and classifying data, but also those of formulating and testing hypotheses. He stressed the importance of theory by stating that "a science without theory is blind because it lacks that element which alone is able to organize facts and give direction to research." He was also convinced that, in order to understand and predict learner behavior, he had to focus on careful, full descriptions of particular, learner-environment instructional situations.

To portray his conceptualization of psychological processes, Lewin chose topological geometry as the best mathematical model, because he felt it adequately represented concepts that were broad enough to be applicable to all kinds of behavior and, at the same time, specific enough to apply to a specific person in a concrete situation. Since topology lacked directive concepts, Lewin invented a new hodological (from the Greek hodros, translated as path) space geometry, which he used to represent certain dynamic factors in psychological relationships.

![Fig. 3.5. Life space of an individual according to Lewin.](image-url)
order to define the range of possible perceptions and actions. He accomplished this by explaining the functional parts of a life space in terms of regions and boundaries, and indicated that, when an individual structures or makes sense of his life space, he divides it into regions. For example, if the region "eating" is located in a person's life space, the person is either eating or thinking about eating.

Lewin used the vector concept to represent direction and strength as two of the three properties of a force. The third property was its point of application. Thus Lewin saw vectors symbolizing the tendencies of the life space to change or to resist change. For example, the actions of another person, or from the impersonal aspects of an instructor, from the actions of another person, or from the impersonal aspects of an instructor-learning, from the actions of another person, or from the impersonal aspects of an instruction situation. Lewin's guiding formula, based on a summary of his work, could be written

\[ B = f(P, E) \]

Behavior depends on the interaction of the Person and the Environment within a psychological field, or life space.

Lewin's Cognitive-field Theory of Learning

Lewin's cognitive-field theory is called merely "field theory." However, "cognitive field-theory" is more truly descriptive, since the theory describes how a learner comes to know (from the Latin verb cognoscere, which means to know) or gains insights into himself and his environment and how, using his insights or cognitions, he acts in relation to his environment. Learning, to Lewin, was perceived as problem solving—seeking perceptions to restructure the cognitive field, acting to overcome barriers, and incorporating understandings (or insights and ways of behaving) into a newly reorganized life space. Within this process, he distinguished four kinds of change, namely: change in cognitive structure (knowledge); change in motivation (learning to like or dislike); change into group belongingness or ideology; and gain in voluntary control and dexterity of muscle action.

Implications for a Technology of Instruction

Within a field approach to educational technology, the teacher's unique function is to implement the development of useful insights, helping students respond more intelligently and more effectively in differing situations. To accomplish this, a technology of instruction built around the field concept must provide for analysis of the instructional situation as a whole. According to Lewin:

A teacher will never succeed in giving proper guidance to a child if he does not learn to understand the psychological world in which the individual child lives. To describe a situation "objectively" in psychology actually means to describe the situation as a totality of those facts, and of only those facts, which make up the field of the individual. To substitute for that world of the individual the world of the teacher, of the physicist, or of anybody else is to be, not objective, but wrong.\(^4\)

The Lewin field theory of learning can be used as a starting point for the technical analysis of instruction design. One approach is to ask what characteristics could be used in a scientific technology of instruction to symbolically, as well as functionally, represent the following three interrelated aspects of the instructional situation: (1) the

A Technology of Instruction According to Skinner

In essence, B. F. Skinner's (1904-1990) psychology, operant conditioning or behaviorism, was a modern extension of the earlier stimulus-response psychologies—Thorndike's connectionism and Watson's behaviorism. Thorndike dealt with both physical and mental elements but was always mechanistic. Watson, too, was mechanistic, but he limited his study to the behavior of biological organisms. Skinner, as did both Thorndike and Watson, assumed that man is neutral and passive and that all behavior can be described in mechanistic terms.

A professor at Harvard University starting in 1947, Skinner was influenced by the research of Pavlov and Watson while attending Harvard as a graduate student in biology. Following several years of postdoctoral fellowships, he taught at the University of Minnesota and at Indiana University before returning to Harvard to join the faculty. Skinner displayed great breadth of interest and ingenuity in his work.\(^5\) He concerned himself with an analysis of verbal learning, "missile-guiding pigeons," teaching machines, and the control of behavior by scheduled reinforcement.

Skinner's goal was a science of behavior in which the basic order of nature can be discovered, including human nature, for the purpose of achieving predictability and control of human behavior. To Skinner, a science of instruction had to be based on operant reinforcement in which sets of learner acts are reinforced, or strengthened, to increase the probability of recollection. In this process, it was essential that teachers use properly timed and spaced schedules of reinforcement.
Skinner's System of Operant Conditioning

Skinner's thesis has been that, since an organism tends to repeat actions that are reinforced, it can be led to do much what the experimenter or the teacher wishes. For example, Skinner taught rats to use a marble to obtain food from a vending machine, pigeons to play a modified game of tennis, and dogs to press a lever to obtain a banana. He concentrated his study on lower animals because their behavior is simpler, their environments are more easily controlled, and techniques for observation can be less complicated.49

On the basis of his many animal experiments, Skinner developed his psychological theory of operant conditioning. However, he considered his methodological approach to the problem of operant conditioning, the important stimulus is the one immediately following any emitted response that leads to reinforcement is thereby strengthened. According to this viewpoint, it is not the specific response that is strengthened but rather the general tendency to make the response. The law of operant conditioning states that if the occurrence of an operant is followed by presentation of a reinforcing stimulus, the strength probability is increased.

In instructional terms, this concept implies that the key to successful instruction is to analyze the effects of reinforcement and then design techniques and set up specific, reinforcing sequences in which a response is followed by a reinforcing stimulus. Operant conditioning occurs, for example, when a child is taught reading by being reinforced with "right" or "wrong" according to his response to appropriate visual stimuli. Implicit in operant conditioning is the conviction that "when all relevant variables have been arranged, an organism will or will not respond. If it does not, it cannot. If it can, it will."49

A Technology of Instruction Based on Operant Conditioning

Skinner was convinced that operant conditioning, which is very useful when applied to animals, held great possibilities for more complex instruction. He felt that achieving efficient control over human learning requires instrumental aid and, therefore, that steps should be taken to rectify the shortcomings of traditional instructional practice by developing a scientific technology of instruction.

For example, Skinner criticized conventional instruction as being dominated by aversion stimulation and as lacking a planned program of serial reinforcement. Thus, according to Skinner, a learner is usually trying to escape or to keep away from pain; there is an excessive lapse between behavior and reinforcement; or desirable behavior may not be reinforced at all. Skinner contended that a test given near the end of a week is too far removed from the behaviors the learners emitted (sent out) while studying the subject matter earlier that week. Instead, reinforcement should immediately follow the behavior.

According to Skinner, in order to develop a technology of instruction based on operant conditioning, certain specific questions need to be answered: (1) What behavior is to be established? (2) What reinforcers are available? (3) What responses are available? (4) How can reinforcements be most efficiently scheduled? The teacher is the builder and architect of behaviors; he must establish specific learner objectives and define them in terms of desired behaviors. Skinner contended, however, that a teacher is not an effective reinforcing mechanism and that mechanical and electrical devices must be used for efficient control of learning.

To schedule reinforcements efficiently, Skinner made them contingent on the desired behavior. Skinner said:

The whole process of becoming competent in any field must be divided into a very large number of very small steps, and reinforcement must be contingent upon the accomplishment of each step... By making each successive step as small as possible, the frequency of reinforcement can be raised to a maximum, while the possible aversive consequences of being wrong are reduced to a minimum.49

This is the purpose of programmed instruction, according to the Skinnerian concept. In Skinner's view, teaching machines encourage learners to take an "active" role in the instructional process because they must develop the answers before they can be reinforced. In building a case for teaching machines, Skinner stated, "The effect upon each student is surprisingly like that of a private tutor."

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Influence of Skinner

Skinner's influence guided the mainstream of developments in programmed instruction during the late fifties and early sixties. Historically, the term program as applied to a sequence of instruction presented by a teaching machine derived from his 1954 and 1958 papers. In some respects, Skinner represents a renewal of Watsonian behaviorism. Like Watson, he too attracted many young experimenters eager to make behavior study an exact science. Such Skinnerians resent the orthodox restrictions of the American Psychological Association's journals (particularly the unwritten regulations concerning sample size and statistical tests), and so established their own, the Journal of the Experimental Analysis of Behavior.

Piagetian Approach to Instructional Design

Jean Piaget (1896-1980), born in Neuchatel, Switzerland, began his work in the field of biology, but eventually became the foremost developmental psychologist of the twentieth century. From 1920 until his death in 1980, Piaget (at the University of Geneva) and his associates at the Institute J. J. Rousseau in Geneva, Switzerland studied many aspects of children's intellectual development, including perception, imagery, play, language, memory, reasoning, problem solving, and awareness of as well as conceptions of causality, quantity, space, time, distance, movement, speed, number, geometry, and morality. What most intrigued Piaget was epistemology, the branch of philosophy that focuses on the nature of knowledge. But most important, from the point of view of educational technology, was his formulation of models of cognition, which provided guidelines for a fresh, fruitful approach to the problems of instructional design.

Fig. 3.7. Photograph of Jean Piaget (Courtesy of the Foundation Archives Jean Piaget, Université de Genève.)

This discussion of Piaget's theory will first introduce some of his basic concepts, then review his models of cognitive development, and finally suggest some implications of his theory and research for educational technology. Rather than comprehensively elucidate Piaget's theory, the discussion will explain its basic elements for a general purpose understanding of his contributions.

<table>
<thead>
<tr>
<th>Tests of Various Types of Conservation</th>
<th>Sheet</th>
<th>Them.</th>
<th>Ask the child</th>
<th>Preoperational</th>
<th>Unknown quantity answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSERVATION OF LIQUIDS</td>
<td>Two equal glasses of liquid</td>
<td>Pour one into a taller, thinner glass</td>
<td>Which glass contains more?</td>
<td>The taller one</td>
<td></td>
</tr>
<tr>
<td>CONSERVATION OF NUMBER</td>
<td>Two equal lines of checkers</td>
<td>Lengthen the spaces between one line</td>
<td>Which line has more checkers?</td>
<td>The longer one</td>
<td></td>
</tr>
<tr>
<td>CONSERVATION OF MATTER</td>
<td>Two equal balls of clay</td>
<td>Squeeze one ball into a long, thin shape</td>
<td>Which piece has more clay?</td>
<td>The long one</td>
<td></td>
</tr>
<tr>
<td>CONSERVATION OF LENGTH</td>
<td>Two sticks of equal length</td>
<td>Move one stick</td>
<td>Which stick is longer?</td>
<td>The one that is farther to the right</td>
<td></td>
</tr>
<tr>
<td>CONSERVATION OF VOLUME</td>
<td>Two glasses of water with equal balls of clay inside</td>
<td>Change the shape of one ball</td>
<td>Which piece of clay will displace more water?</td>
<td>The long one</td>
<td></td>
</tr>
<tr>
<td>CONSERVATION OF AREA</td>
<td>Two identical pieces of cardboard on which are placed the same number of equally sized blocks</td>
<td>Rearrange blocks on one piece of cardboard</td>
<td>Which has more cardboard covered up?</td>
<td>The one with the blocks not touching</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3.8. Piaget's conservation tests (From Kathleen Stassen Berger, The Developing Person through the Lifetime. New York: Worth Publishers, 1983, 224. Used with permission of the publisher.)

Basic Concepts

According to Piaget, cognition developed not through maturation or learning alone, but through the continuous interaction between learner and environment. As the learner continues to cope with his environment, his cognitive processes become more and more complex.

One of the basic notions underlying Piaget's theory was the scheme, a complex concept involving both overt motor-behavior patterns and internalized thought processes. It includes simple, predictable responses at the reflex level and also a complex cognitive structure involving broad understandings. Piaget asserted that every scheme has certain unitary properties and that all actions involved in it are parts of a single scheme.
To Piaget, the scheme represents the structure that adapts and adaptation is the cognitive striving of the learner to achieve equilibrium or stability between himself and his environment. Equilibrium depends on two interrelated processes: assimilation and accommodation. Assimilation is the process of change through which the learner becomes able to cope with situations that are initially too difficult for him. Accommodation is the process whereby the learner adjusts to new environmental conditions and incorporates new elements into his scheme. For example, an infant may be unable to pick up small objects, although he may be able to pick up slightly larger ones. In order to adapt to the demands of his environment, the infant's grasping scheme must accommodate to the demands of the small objects. Once the ability to pick up these small objects has been acquired, the grasping scheme can assimilate such behavior. Thus, the processes of accommodation and assimilation are always mutually interactive.

Piaget's basic question was: Under what laws does cognition develop and change? He answered this question by formulating chronologically successive models, or phases, that represent cognitive development as inherent, unalterable, and ordered in time. Each model reflects a range of behavioral patterns that occur in a definite sequence within approximate age spans. Whether or not the learner would realize his potential or whether the learner's rate of progression varies were separate questions.

What was important, according to Piaget, was the order of these phases. While Piaget set down approximate ages for each phase, he did not contend that these were absolutely fixed. He simply held that the order would not vary from one learner to another. Each phase of development carries possibilities for new ways of processing and representing information. If, during each, each of these abilities is sufficiently stimulated as it emerges, it will not develop fully and will therefore not adequately prepare the learner for the demands of the next phase.60

Piaget's theory encompassed the development of cognition from the infant's first suckling, looking, and grasping to the adolescent's ability to manipulate logical propositions in a symbolic fashion. The learning of these skills is simultaneous across all dimensions of his thinking. As the child grows, he moves from a concrete subjective view of the world to one that is increasingly objective. On another dimension, the learner moves from the concrete world of things present to a world of things possible.

Cognitive Models

Piaget represented cognitive development with four chronologically successive models: (1) sensory-motor, (2) preoperational, (3) concrete operations, and (4) formal operations. In his attempts to characterize these models, Piaget made sophisticated use of logic and mathematics. An extended discussion of these models, however, is not justified for our purposes. The general attributes of the four models of cognition will be looked at in their developmental order.

Phase 1 of cognitive development, the sensory-motor, lasts from birth until approximately eighteen months to two years. The child perceives and acts, but does not have internal representations of the world. However, he develops the beginnings of internalized schemata, if not actual concepts of space, time, matter, and causality. Related to causality is the concept of probability; Piaget pointed out that the infant comes to recognize the likelihood that the footsteps he hears approaching are those of his mother. With respect to the concepts of space and matter, the large concept that develops during this phase is that of permanence. The infant first believes that an object no longer exists when it disappears from sight. But at some time during the first eighteen months, the infant comes to realize that this object can continue to exist even if he does not see it; thus the infant develops a notion of permanence.

The next development phase involves continuity in space-time. Piaget repeatedly hid a toy at point A while the child observed. The child learned to look at A and found the object there. Piaget then moved the object to point B and, with the child watching, hid it there. The child began his search, not at point B, but at A. If the object was moved to point C, the infant again began at A, went to B, and then to C. This cannot be explained by sensory experience alone. On the basis of earlier experience, the child had stored information about where to find the object; he needed additional interactions to learn differently.

Piaget held that the fundamental categories of cognition are developed in the sensory-motor phase of his development. The concept of causality begins then as well as the development of prehension (grasping) and what Piaget calls primary, secondary, and tertiary circular reflexes. Behavior begins to manifest the directionality that suggests purpose. Finally, the sensory-motor phase ends with the first signs of imagery, or the beginnings of the symbolic processes. In Piaget's view, the clearest signs that a child has begun to represent absent objects to himself are a particular kind of imitation and a particular kind of representational play. Piaget believed imagery makes language possible, and therefore asserted that language begins to become important to the infant at about eighteen months.

Phase 2 in cognitive development is the preoperational, which extends roughly until six or seven years of age. The child's thinking during this period is distinguished by what it lacks, namely, logical operations and, particularly, reversibility. The child cannot reverse a thought process and therefore knows the world only as he sees it; he knows alternatives. Further, he sees his physical and social worlds only as he has previously experienced them. This leads to his assumption that everyone thinks as he does and understands him without any particular effort on his part to communicate.

In one of Piaget's tests, 'Cows in the Field,' the child is presented with two pieces of green cardboard that represent fields of grass. A cow is placed in each field, and the child is asked if each cow will have the same amount to eat. Then a barn (a small model) is placed on each field, to which the six-year-old may say, "The barn takes up some room and each side has a barn so the grass is the same." Barns are added one at a time to each field; but in one field the barns are lined up in a horizontal row with their sides touching, whereas in the other field the barns are scattered. The child continues to assert equality while the barns are equal in number, but only up to a certain point. Beyond that point (which may be as many as ten barns), unoccupied space in the fields begins to look different; one field looks as if there were a great deal more grass. The child in the preoperational phase falters; he is judging in terms of perceptions, and so he now says that one cow has more to eat than the other. Or he may say that one cow can eat all around the edges of the barns, while the other cow cannot. Because he cannot perform certain mental operations on the data before him, he is misled by his perceptions.

Piaget saw in play and imitation during this phase the emergence of symbolic schemes, or internal schemes that make symbolic behavior possible. There are two types of symbolic schemes, the verbal and the nonverbal. Verbal schemes become objective, fitted to cultural norms, and, through language, serve as a medium of social communication. Nonverbal schemes remain idiosyncratic, subjective, and appear in fantasies, dreams, and play.

From two years until eleven or twelve, the child is working out a conception of the world. Piaget found that a child during this period does not distinguish adults as doing concerning mental, physical, and social reality. For a time he believes everything that moves is alive. Moral law and physical law are not clearly distinguished. The child's theory is that everything was originally made or created, the creators being his parents, early men, or gods. The child's parents are the source of everything and are simultaneously omnipotent, omnipresent, and omnipresent. In the child's eyes, as Freud argued in The Future of an Illusion (1927), they are God.

The preoperational child's perceptions, play, and language clearly reveal his egocentricity. He is not aware of other points of view nor does he recognize that he has a point of view. The child is unable to explain something clearly to another person because he assumes that the listener already understands everything.
When the child is old enough to begin school, his language is largely the verbalization of his mental processes. Much as he once employed motor apparatus to act out his thinking, he now uses speech. However, he can think of only one idea at a time, and his perceptions and interpretations remain largely egocentric and at variance with the thinking of adults. He also lacks the ability to combine related objects into classes and thus establish a hierarchy of classification. He may say that a rose is, indeed, a flower, and then identify certain other flowers by name. However, if one asks, "If all the roses in the world were to die, would there be any flowers?" one is likely to get a negative answer. For the child, a rose is a rose, but at the same time comprises the complete class of flowers. He is not capable of understanding the ascending nature of a hierarchy — he cannot combine subclasses into a superclass of one of the subclasses and still have something left.

A child in this phase also uses appropriate language without fully understanding its meaning. For example, the child in the early years of this phase may know his right arm from his left, but he has no notion of the concept of right and left. Further, the child can think only in terms of an ongoing event. All experiences are judged by their final results. A toy car that arrives first in a race is the "fastest," regardless of whether it only traveled half as far as the other cars did. His reasoning proceeds directly from premise to conclusion. It is typical for a child in this phase to see the world in terms of opposing absolutes — something is either the best or the worst.

In phase 2, language serves a threefold purpose: first, it is an important tool of intuitive thought to reflect on an event and project it into the future; second, it serves as a vehicle of egocentric communication; and third, it is a means of understanding and adapting to the external environment.

Phase 3 begins, at about six or seven years of age, with the emergence of logical operations, which Piaget calls "groupment." For example, the child becomes able to mentally reverse a process and see an event from different perspectives. Piaget's tests for demonstrating whether or not a child has achieved this level are well known. One of them involves a ball of clay that is rolled into a ball, flattened, or broken into small pieces. As the clay's appearance changes, the child is asked whether he thinks the amount of clay has changed.

The child may use an identity operation to arrive at a logical conclusion. Thus, one test involves establishing an identity between two amounts of liquid and then testing to see whether the child retains that identity relationship when he sees one vessel of liquid poured into another vessel of different shape.

The child also learns to combine subclasses into a superclass and to separate superclasses into their components. Thus he knows that if all the roses in the world died, there would be no roses left, but there would still be other flowers. Although the child has long been aware of objects belonging together, it is only in this phase that he begins to be able to hold a large category constant while he manipulates subcategories. For example, he recognizes that a general class such as animals can be subdivided into land animals and sea animals.

Finally, there is the operation of associativity. In arithmetic, this means that \(3 + (4 + 2)\) achieves the same result as \((3 + 4) + 2\). In other words, the child learns that the same goal can be reached by different paths, and is able to manipulate data in various ways to test his hypotheses. However, he is not yet able to think abstractly about a problem, but can only work out the relationships of concrete variables.

At approximately eleven or twelve years of age, in phase 4, Piaget again found changes occurring in the child's cognitive processes. Between the ages of eleven and fifteen, thought becomes increasingly tied to the concrete; the adolescent becomes more and more capable of abstract reasoning and cognition begins to rely more on symbolism and the use of propositions. He can also logically combine such propositions. For example, he can compare by conjunction — "Both A and B make a difference" — or by disjunction — "It's got to be this or that." He understands implication — "If this, then that happens" — and incomparability — "When this happens, then that doesn't." Thus, his thinking becomes fixed on possibilities rather than on specific objects or events.

The ability to reason supplies the youth with new methods of understanding his physical world and his social relationships. One of these new tools is logical deduction, which allows him to bring together apparently contradictory and unrelated wholes into logical relationships. This becomes a new means of generalization and differentiation that opens up new possibilities in dealing effectively with abstractions.

Around fourteen or fifteen, the youth usually achieves maturity in cognitive thought. Then he can depend solely on symbolism for operational thought; he thinks by using symbols to formulate hypotheses and structure a wide variety of combinations of events as they might occur. Simultaneously, he attempts to prove empirically which possibilities could materialize. Meanwhile, language continues to develop more fully, encouraging cognitive thought and behavior.

Near the end of the formal operations phase, Piaget saw the adolescent achieving equilibrium through his ability to tie together propositional operations into structured patterns of relationships and systems that eventually form a single unit. Piaget concluded that the "structured 'whole'," considered as the form of equilibrium of the subject's operational behavior, is therefore fundamental psychological importance. At this juncture, Piaget's analysis of cognitive development ended. Although he did not specifically say so, Piaget implied that the individual has reached cognitive maturity at the end of this phase.

### Some Implications for Instructional Design

This section examines the broad significance of Piaget's theory of cognitive development for instruction and attempts to extract some guiding principles for instructional design from Piaget's research and other Piaget-relevant studies.

The primary implication of Piaget's theory and research is that they provide a scientific basis for a technology of instruction. Thus, a Piagetian instructional design makes it possible for a teacher-communicator to predict the cognitive mode and range of a learner's understanding, which also serves as a frame of reference for synchronizing instruction with individual development.

The real significance of Piaget's system is that it suggests a new approach to the old problem of readiness, or developmental capacity, through instructional design, a problem that has faced the educational profession at least since Comenius. Until Piaget developed his theory, two views of cognitive development dominated instructional design and the selection of content.

Probably the oldest view is based on the notion of the progressive emergence of inherent abilities; the learner cannot learn something until he has reached the appropriate stage of maturity for its achievement. According to this view, learning depends entirely on the maturation of the learner; it is believed that maturation takes place within the organism and is governed by its own laws and conditions, quite apart from the environment. In its extreme this view holds that cognitive development occurs independently of instruction and that teaching children reading, writing, and counting before they are eight years old is, at best, a waste of time, and might actually be harmful.

A second traditional view rules out stages of development and considers any cognitive change the direct result of a change in the quantity of synaptic connections. The clearest statement of this position was given by Thorndike; it is also found in associative or behavioral psychology that is based on the theory of the conditioned responses a learner acquires. Thus, according to this view, cognitive change occurs when the right stimuli are provided at the proper time.
In contrast to these two traditional views, Piaget's theory suggested that cognitive development is a product of organism-environment interaction. He considered neither maturation nor learning, by itself, to be sufficient for cognitive change. Both are necessary factors in the cognitive growth of the learner, but cognitive growth and change consists in the interaction of these two factors. Moreover, this interaction process implies that the learner's cognitive development depends upon his opportunities to have and think about new experiences. Also, what a learner incorporates into his cognitive processes or what stimulates him to reorganize or reclassify information is, in part, dependent on the cognitions he already possesses. Concrete or abstract cognitions do not emerge automatically, but rather are the product of a series of encounters with things and ideas.

In summary, the Piagetian view considers the following factors vital to cognitive development: first, certain stages of maturation; second, the results of experience with the environment; third, the results of explicit and implicit instruction of the learner within the society; and fourth, the process of equilibration, a kind of catalytic motion generated whenever the learner's cognitive system begins to contain self-contradictions or doubt.

Piaget's views of cognitive development clearly differed considerably from the two established traditional views. The basic implication of Piaget's theory is the possibility of developing a technology of instruction that can be based on an individual rate of cognitive development.

**Match between Information and Cognitive Structure**

The first implication concerns the match between information and cognitive structure, an implication that Piaget himself suggested but never quite formulated. This poorly understood factor appears to be of prime importance for instructional design and educational practice. It has been pointed out that cognitive conflict, or discrepancy between the learner's cognitive structure and his environmental encounters, may or may not promote cognitive growth. We know, for example, that it is useless to expect a four-year-old learner (in Piaget's preconceptual phase) to see that an increase in length is compensated for by a decrease in thickness or that a particular bead can be counted as both a brown and a wooden bead.

Discrepancies that are too large may cause emotional disturbance whereas lesser discrepancies may be a positive challenge. Unfortunately, although a true understanding of this relationship is essential to an effective science and technology of instruction, it is still largely a process of trial and error.

**Concrete Operations Precede Symbolic**

The second implication of Piaget's system is that the young learner must initially be led, with concrete materials, to perform cognitive operations that he will later handle through symbols alone. As actions are repeated and varied, they become interrelated and internalized as conceptual patterns are formed. Piaget's investigations showed that from the time the learner begins elementary school until he reaches the more advanced stages of learning, he moves toward the process of abstracting the forms of cognitive operations from the instructional content he encounters. Teachers long before Piaget, of course, understood the importance of using concrete materials, especially in the instruction of young children. However, many have continued to emphasize the concrete rather than the symbolic long after the learner entered the phase of formal operations, when he could begin to deal verbally with concepts and no longer required concrete materials. In fact, there is research that seems to indicate that presenting a learner with a wealth of stimuli that approximate reality is not necessarily the most effective
to facilitate cognitive change. What is more, excesses of realism may actually interfere with the transmission of information.

Thus, the teachers instructing the learner in the early stages of the concrete operational phase (the early elementary school years) might begin by having the child directly manipulate concrete materials, move to pictorial representation later in this phase (approximately nine to eleven years of age), and finally shift to cognitive anticipation and retrospection of earlier operations for the learner in the formal operations phase (approximately eleven to fifteen years of age). In the formal operations phase, the learner is able to manipulate symbols in various ways to accomplish what he could previously accomplish only with things. He is capable of thinking abstractly and of systematically using the kinds of formal methods characteristic of scientists, mathematicians, and philosophers. The learner's failure to think systematically and to perform symbolic operations may be due to the teacher's failure to get him to reflect on his actions, something he must do in order to generalize symbolic operations beyond their instructional context. It appears that considerable improvement in the educational program could be realized, at both the elementary and secondary levels, if instruction in logical operations could be appropriately geared to the developmental phase of each learner.

**A Frame of Reference for Instructional Design**

The third implication of Piaget's system is the need to liberate the learner from his egocentrism through group interaction with his peers, and also the importance of the process of equilibration in cognitive development. The development of organized belief systems, or groupings as Piaget described it, becomes a necessity as part of a whole, coherent system which sustains the individual's ego. However, as the learner in a group situation confronts other learners with different belief systems, doubt and conflict may arise. The challenge of a belief may throw his whole system into disarray and imbalance. Equilibrium is re-established either by explaining away the evidence and saving the belief or by modifying or discarding the belief itself. Thus, the cognitions of the learner are organized into a coherent, harmonious system that functions as a whole.

Piaget's theory of equilibration suggests a frame of reference for a group-oriented instructional design. Current instructional approaches in this direction are reflected in what has come to be known as the discovery method, which has been characterized by such words as conflict, surprise, doubt, contradiction, dissonance, and incongruity. The object is to encourage a learner to independently find information required to solve a vexing problem, rather than relying largely on the teacher for information and help. The first stage of this problem-solving process is what Dewey termed the felt difficulty.

The present state of our knowledge calls for caution in judging the ultimate value of the discovery method and, above all, for intensive research on the psychological processes involved. Nevertheless, the notion that a learner can profitably search for his own answers is supported by Piaget's research and fits with recent experimental and theoretical work on problems of motivation. In fact, experimental analysis of motivation is just beginning; when research has progressed further, we may find that the essential base for a science and technology of instruction rests not on independent discovery, but on such factors as curiosity and conflict. Moreover, the current version of discovery learning does not incorporate conflicts that occur in the symbolic domain; not all the significant problems the learner faces have to do with concrete situations. For example, the learner should be helped to examine, reflectively, issues in various areas of American culture. Reflective problem-solving instruction might be drawn from conflicting propositions in such areas as minority group relations, social classes, religion, morality, and national beliefs.
Assessing Cognitive Development

The fourth implication of Piaget's system is that it may make possible a psychometrics that can be anchored to cognitive-field theory. Such tests may be a better predictor of cognitive functioning than those now available. For example, conventional test scores often fluctuate radically and show poor predictive validity because of the considerable variability of the quality of the learner's interaction with his environment, which the tests do not assess.

Piaget's method of assessing cognitive development involved clinical observations of children, devising practical tasks, and asking precise questions about events taking place or about their own actions. Piaget wrote:

This study of the child's actions brought me to the conception of logic based on operations—an operation being considered as internalized action which becomes reversible, that is to say, can be carried out in both directions, and links up with others. In the sphere of intelligence, operations always constitute whole structures rather like the Gestalt in the sphere of perception; the structures being, however, larger, more mobile and essentially reversible and capable of coordination.4

In contrast to Piaget's method, American psychologists usually present a problem to the learner that he could not have learned outside the laboratory. The learner may be required to memorize a list of objects to acquire some type of conditioned response. Some procedures may even be adapted from methods used with animals. The serious danger in this strategy is that these methods are not representative of the cognitive operations a child can perform. Thus, the acquisition of such cognitive operations as language, number, and quantity may involve cognitive processes that have no relation to classical problems of the psychological laboratory, such as discrimination learning, serial learning, and conditioning.

There is little question that Piaget's unique contributions to the study of cognition hold great potential for the development of new testing instruments. Although the psychometrization of Piaget's cognitive tasks is itself just beginning, it promises a new approach in the years ahead.

Need for Revised Teacher Education Programs

The fifth implication of Piaget's system relates to the need for new teacher insights. As Piaget suggested, cognitive change occurs within a relatively narrow range of moderate uncertainty. Or, in other words, the learner can learn only in the range of the knowable unknown. This implies that the teacher must be aware of and sensitive to each learner's competence, and possess some understanding of each learner's ability to accept and use uncertainty. Barring unforeseen advances in educational technology, only the teacher can move fast enough to modify uncertainty effectively, to vary the learning conditions of the classroom in order to assure useful uncertainty for most learners, and to support the development of reflective problem solving in each learner.

Obviously, before this situation can be realized, the teacher will have to be the product of a radically different kind of teacher education than that offered currently, and will have to work in a totally different school from the one we know today.

Conclusion: The Absence of a Synthesis in Theories of Instruction

From the foregoing survey of selected instructional theories and methods, it should be clear that almost every significant system of instruction, from the time of Comenius to Piaget, has left a residue of theory and technique in current educational technology. It is also clear that a scientific technology of instruction has developed at a painfully slow rate and, simultaneously, that there is a general lack of agreement upon concepts of educational technology. Nor have these concepts been synthesized into theories of instruction that could be tested empirically. What is needed are theories of instruction that prescribe what the teacher should do to improve learning, theories of learning that describe what the learner does, and theories of communication that explain the interaction between teacher and learner.

Notes

1 Sometimes called the father of educational measurements, Thorndike cannot be credited with initiating the movement in the United States. This happened in 1895, when J. M. Rice, editor of The Forum, undertook a ten-month study to show teacher effectiveness in teaching spelling. He tested nearly 31,000 children with this aim: "I endeavor to prove that the first step toward placing elementary schools on a scientific basis must necessarily lie in determining what results may reasonably be expected at the end of a given period of instruction." (J. M. Rice, "The Fulfillment of the Spelling Grind," The Forum.)

2 A year visit to Europe where he studied pedagogy and psychology at the universities of Jena and Leipzig. Upon his return to the United States, he began to devote his efforts to educational reform, through the publication and by undertaking research studies of instructional practices. Professional educators paid scant attention to his work, and little reference to him is found in the educational literature of the period. Yet most of the reforms for which he worked have been implemented in modern educational practices.


4 Both James and Castell significantly influenced Thorndike. Thorndike commented in an autobiographical piece that he had "no memory of having heard or seen the word psychology" until his junior year at Wesleyan University (1891-94). During his first year at Harvard, Thorndike dropped literature in favor of psychology as his doctoral subject, as a result of a psychology course with James. Although James was not an experimentalist, he started to conduct informal psychological experiments about 1875 and contributed to the growth and development of psychology through his ability to synthesize psychological principles. His definitive work in psychology was the famous, two-volume Principles of Psychology (1890).

5 Castell probably influenced Thorndike to an even greater extent through his pioneering work in promoting mental tests and his interest in individuals' differences. As a result of work with Wilhelm Wundt (founder of the first psychological laboratory) at the University of Leipzig, Castell founded a psychological laboratory at Columbia in 1899.

6 Thorndike, Educational Psychology. Vol. 1, Original Nature of Man, chapter 17, 270-312.
Thornik developed the most complete system of psychology as yet developed along associationist lines. Since associationism has its roots in philosophy, its history extends back to Aristotle. Associationism as a doctrine was developed by British empiricists during the seventeenth and eighteenth centuries. For John Locke (1632-1704), ideas were the units of a mind, and associations consisted of combinations of ideas. David Hartley (1703-1757) developed Locke's concepts still further and established associationism as a systematic doctrine. Such men as James Mill (1773-1836), John Stuart Mill (1806-1873), and Herbert Spencer (1820-1903) also postulated associationist positions. The experimental work of Hermann Ebbinghaus (1850-1909), Ivan Pavlov (1849-1936), and Vladimir M. Bekhterev (1857-1927) during the nineteenth century replaced the association of ideas with association of stimuli and responses. This shift was related to the transition of psychology into an empirical and natural science in its own right.


John B. Watson (1878-1958) published *Behavior* (1914) and championed a new school of psychology that came to be known as behaviorism. Watson claimed that environment (stimuli or conditioning) forms the organism and, therefore, that any child could be reared to become anything from a thief to a professional. The behavioristic theory of learning, a logical extreme of Thorndike's connectionism, assumed that learning was simply a result of what happened to the learner.

B. F. Skinner's system of instruction is discussed later in this chapter.

Hall received, in 1878, the first American doctorate in psychology under William James at Harvard. He then went to Germany, where he did two years of postdoctorate work under Wilhelm Wundt at Leipzig. In 1883, he founded the first psychological laboratory in the United States, at Johns Hopkins. Hall developed a number of new areas in psychology, proceeding from child psychology—where he popularized the questionnaire as a research tool—through adolescent psychology to the psychology of old age. He was also one of the leaders in developing the field of educational psychology.

For Dewey's criticism of reflex arc psychology, see "The Reflex Arc Concept in Psychology," *Psychological Review* 3, 4 (July 1896), 357-70.

Dewey anticipated this Gestalt-field viewpoint twenty years before it was first formulated.

The published records of the Dewey Laboratory School are voluminous. See especially the nine monographs published monthly through 1900 as *The Elementary School Record* and successive issues of *The Elementary School Teacher* for 1901 and 1902. The entire June 1903 issue of *The Elementary School Teacher* was devoted to the Laboratory School. Also, for firsthand accounts of the school, see Katherine Camp Mayhef and Anna Camp Edwards, *The Dewey School*. New York: Appleton-Century, 1936.

This is not a criticism of Dewey's theoretical model in itself, but only of the failure to test it and to use the empirical method to revise it.

Franklin Ernest Heald (1870-1943), specialist in agricultural education (1914-1918) in the U.S. Department of Agriculture, first used the term project in connection with vocational agricultural education.


Maria Montessori was born at Chiaravalle, in the province of Ancona. Her father, Alessandro Montessori, was descended from a noble family of Bologna; her mother was a niece of Antonio Stoppani, noted philosopher-scientist-priest.

Educational technology owes much to the French educator Seguin for his ingenious work with idiots. Seguin is one of the forgotten men of education, although he had a great influence on the training and teaching of children of low ability. Even today, one finds evidence of his work in kindergartens and first- as did Alfred Binet, his were the first modern tests for the measurement of intelligence. The student of the year 2 of the Binet Scale.

Montessori worked with children as young as two and one-half years at a time when American educators were discussing the relevance of her ideas for four- and five-year-olds in American public school kindergartens.

Montessori established her first training course for teachers in Rome in 1913. This training program was attended by seventy American teachers. She ultimately set up similar programs or served as a consultant in realizing her goals of applying her methods to older children.

Arnold Gesell was director of the Yale University Clinic of Child Psychology and pioneering investigator in the scientific study of child behavior. Howard C. Warren was president of the American Psychological Association (1912). Lightner Witmer founded the first psychological clinic at the University of Pennsylvania (1914).

S. S. McClure offered to build an institution for Montessori in the United States in 1913, but she rejected his offer.


Largely through the influence of the American Montessori Society, Montessori schools have been organized throughout the United States. The current Montessori movement revives its historical danger of becoming a cult, which could restrict innovation and experimental research much as did the cult that developed around Dewey despite his own intentions.

One of Montessori's exercises consisted of a series of wooden blocks with ten holes of different diameters and ten wooden cylinders that exactly fitted the holes. Since a child could put a cylinder into a hole too small or too large for it without having a cylinder left at the end of the exercise, the materials automatically informed him of his errors. This can probably be considered the first "teaching machine." Maria Montessori, *The Montessori Method* (translated by A. E. George). Philadelphia: J. B. Lippincott, 1912.


A member of Burk's faculty, Mary Ward, deserves the credit for initiating the Burk program. After trying an informal experiment using self-instructional materials with a small group of students, she explained to Burk what she had done and the successful results. Burk was impressed with her approach and proposed that every teacher-supervisor begin to prepare self-instructional bulletins for his classes. At first, these bulletins were used with existing textbooks, but in time they became complete in themselves.

For a comprehensive report on the Winnetka Plan, see Carleton W. Washburne and Sidney P. Marland, "Winnetka: The History and Significance of an Educational Experiment," Englewood Cliffs, N.J.: Prentice-Hall, 1963. The Winnetka Plan has continued as established by Washburne; meanwhile, other schools in various sections of the United States have introduced a compromise between the Winnetka Plan and traditional practice.


*The Dalton Plan has generally been discontinued: too many pupils accepted the freedom but neglected their responsibility. However, the New York City Dalton School still uses the plan.

*Although the term unit was employed prior to Morrison, it was Morrison who apparently inaugurated its widespread use. Today the term is so standard in educational terminology that it is not often realized how recent is its origin. Whatever it is, its use today does not usually follow the Morrison pattern, but more frequently refers to long-term assignments of two to three weeks or more, in contrast to daily lesson assignments.*


*Preston W. Search (1853-1932) organized an individualized instructional program as early as 1877 at West Liberty, Ohio. When he became superintendent of the Pueblo, Colorado, public schools in 1888, Search introduced his then fully developed plan, which practically dispensed with home study and recitations. Instead, the school day became a working period or a kind of laboratory where pupils mastered their assignments as rapidly as their differing abilities permitted. Although there were inadequate instruments or hardware for recording or checking pupil progress, the results were startling. Some pupils completed their work in half the normal time. However, this method was discontinued after Search left to become superintendent of schools in Los Angeles, where he was unsuccessful in establishing his plan.* See P. W. Search, *An Ideal School,* New York: Appleton & Company, 1901.

*Franklin Bobbitt (1876-1952), professor of education at the University of Chicago, proposed an "activity analysis" of the broad range of human experience into major fields, in order to arrive at an effective curriculum and sound instructional objectives. See Franklin Bobbitt, *How to Make a Curriculum,* Boston: Houghton Mifflin, 1924. W. W. Charters (1875-1956), another pioneer in activity or job analysis, contended that educational aims were far too general to be effectively translated into teaching directives. By careful analysis he broke the broad aims down into their constituent parts. This approach met opposition from educational philosophers, especially Boyd H. Bode (1873-1953), who claimed that science was not equipped to determine educational aims.

*Max Wertheimer (1880-1943), Kurt Koffka (1886-1941), and Wolfgang Kohler (1887-1971), who had been together as research students at the University of Berlin, founded the Gestalt school of psychology about 1912, while working together at the Psychological Institute in Frankfurt-am-Main. They began by criticizing the analytical methods of connectionism and associationism, contending that learning does not arise from a specific response to a specific stimulus, but rather as the individual sees the overall pattern (or Gestalt) in a situation and changes his behavior accordingly. Thus the learner responds as a whole organism and not automatically, or mechanically, through specific reflexes.*


"Topology is a nonmetrical geometry that encompasses concepts such as inside, outside, and boundary but has no dealings with length, breadth, or thickness. No distances are defined; rather, topology is by no means to be confused with a topological plane as a perfectly elastic sheet of rubber that may be Arnold Bradford, *Intuitive Concepts in Elementary Topology.* Englewood Cliffs, N.J.: Prentice-Hall, 1962, 24.


For example, of the present emphasis within motivational theory have direct connections with associates; another is cognitive dissonance, associated with Festinger; the third is cognitive balance, a

"His accomplishments include a novel on a utopian theme, *Walden Two* (1948), and the invention of an automated baby-making device, which has been commercially marketed.

"For his animal studies, Skinner invented the Skinner box, a simple form of puzzle box that contained a rat, a lever, and a device for delivering a pellet of food each time the rat pressed the lever. Recording devices were set outside the box to record the rat's responses during the experimenter's absence.


"Ibid., 152-53.

"Ibid., 153.


"A complete discussion of behaviorist and educational technology can be found in chapter 10 of this book.


The pioneering studies of the 1920s were reported in such books as The Child's Construction of the World (1926), The Child's Conception of Physical Causality (1927), and Judgement and Reasoning in Reality in the Child (1930) andPiaget was referred to in the previous studies of the 1930s, influencing especially the books The Construction of the Child (1937) and The Origin of Intelligence in Children (1936). The studies of the 1940s: number, measurement, geometry, velocity, the law of flowing bodies, chance, logical groupings, and

"See Sarah F. Campbell, ed., *Piaget Sampler.* New York: John Wiley & Sons, 1976. This is a good introduction to Jean Piaget through his own works.


The inclusion of the concept of a phase or stage in Piaget's theory has produced considerable criticism. Many critics do not understand that Piaget used stage in a statistical sense, to denote the
probability that a certain percentage of children at a particular age will be functioning intellectually in a certain way. To other critics, stage implies a discontinuity in development rather than a continuous process, and they reject the notion of discontinuity. However, many critics fail to recognize that Piaget did not view the process as discontinuous, in fact, in analyzing protocols of test responses he made provision for a transition from one stage to another.

62 The reader with some knowledge of symbolic logic will understand more fully the Piaget model of adolescent thinking, for Piaget used the language and symbols of logic. See B. Inhelder and Jean Piaget, The Growth of Logical Thinking from Childhood to Adolescence. New York: Basic Books, 1958.
63 This viewpoint is usually associated with such men as Jean-Jacques Rousseau, G. Stanley Hall, and Arnold Gesell.
64 It should be clear that Piaget's view of the interaction process did not differ essentially from views traditionally held by cognitive-field psychologists (e.g., Kurt Lewin). Nevertheless, it is important to note that Piaget's monumental investigations provided increased scientific support for this view and generated some important principles for instructional design.

Select Bibliography

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