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CRITERIA FOR SELECTION OF THE RESEARCH PROBLEM

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These suggestions are offered to candidates for graduate degrees, to field workers interested in problem solving, and to other students of research. Most of the illustrations are drawn from the areas of education, psychology, and the social sciences.

Factors to be considered in selection of a thesis or research problem are both external and personal. External criteria have to do with such matters as novelty and importance for the field, availability of data and method, and institutional or administrative cooperation. Personal criteria involve such considerations as interest, training, cost, and time. A more detailed list of criteria for selection of the problem follows:

1. Novelty and avoidance of unnecessary duplication
2. Importance for the field represented
3. Interest and intellectual curiosity
4. Training and personal qualifications
5. Availability of data and method
6. Special equipment and working conditions
7. Sponsorship and administrative cooperation
8. Costs and returns
9. Hazards and penalties
10. Time factor

Novelty and Avoidance of Unnecessary Duplication.—Students of research have recognized as a source of problems the repetition of experiments or the extension of investigations; however, this means deliberate, planned repetition rather than accidental or blind duplication through ignorance of the area and literature represented.

An almost unexplainable example of duplication is found in the thesis projects of two professors in different state universities of Ohio, both of whom were working on the certification of teachers in Ohio, one at a graduate school in the same state and the other at a university on the eastern seaboard. In 1935 the dissertation of one candidate was published at the eastern school, to the great surprise and chagrin of the other investigator, who then took up another problem. The latter candidate could have found the thesis of the successful doctorate investigator listed as under way in the January, 1933, number of the *Journal of Educational Research,* well before he began work. This instance of duplication is all the more surprising in view of the fact that both men were in the same state, were engaged in similar occupational pursuits, and no doubt were using many of the same records of the state department of education and of other agencies or institutions interested in certification.

Even great scientists and able scholars have been negligent and sometimes contemptuous of the literature and earlier investigations in their fields of specialization. Pasteur blundered in representing himself as the first to discover that microscopic animals could live without breathing, since Leeuwenhoek two centuries earlier and Spallanzani a hundred years before Pasteur had found the same thing. Pasteur also rediscovered the fact that microbes cause meat to spoil, without giving proper credit to Schwann, who was the first to make that observation.[1]

The problem of novelty or newness is not merely one of duplication of earlier investigations. It involves the recency of the data interpreted, especially in the case of survey studies made during a period of great economic, educational, or social change. The city superintendent of schools and doctorate candidate who early in 1940 made an industrial survey of his community, a youth and employment survey of the high school graduates, and a canvass of parents and high school pupils concerning attitudes toward the curriculum found the data inadequate as a basis for curriculum reorganization late in 1941. In the intervening period great industrial changes as a result of the national defense program had taken place, with marked effects on employment, attitudes, and the school program.

The question of duplication arises when two graduate students propose a joint thesis, a type of cooperative effort seldom permitted, although many wives of candidates have well earned a share in the graduate degrees awarded their husbands. It is true that there are many commissions, surveys, and research agencies with large programs of investigation in which graduate studies are worked out as complementary parts of a research pattern. Also, in certain historical areas, different chronological periods are treated separately in graduate theses; for example, the constitutional and legal basis of education in Ohio, 1800-1850, by one doctorate candidate; 1850-1900 by a second doctorate student; and 1900-1930 in a Master's thesis. The problem of pupil transportation requires a series of studies for regions with different geographic, climatic, population, and road conditions, as in Wyoming, Ohio, and West Virginia.

It frequently happens that two or more scholars, scientists, or inventors may be working simultaneously on the same problem, each

[1] T. A. Boyd, *Research*, pp. 74-75. New York: D. Appleton-Century Co., 1935.

without knowledge of the other, and may announce their findings at almost the same time. In such instances, history has viewed the discovery as a joint contribution; for example, James and Lange, a theory of the emotions; Darwin, Spencer, and Wallace, a theory of evolution; Lancaster and Bell, a system of monitorial instruction; Newton and Leibnitz, the calculus as a general method and a system of notation for it; the Wright brothers and Langley, heavier-than-air flying; Bell and Gray, the telephone; Faraday and Henry, the principles of electromagnetic induction; Mendelyeev and Meyer, similar classifications of the chemical elements; and Mayer, Mohr, Helmholtz, and Golding, the generalization of the conservation of energy.[2]

Importance for the Field Represented.—This criterion for choice of a problem involves such matters as significance for the field involved, timeliness, and practical value in terms of application and implementation of the results. Scientific work in education, psychology, and the social sciences in general has an especially urgent obligation to play a social role in rendering service to society and humanity.[3] It is high time that the social responsibilities of scientists and of research workers be recognized and accepted.

Francis Bacon was aiming at the invention of a method that would solve not only particular scientific problems, but also provide for the adaptation of the results to the social process. The core of Bacon's work was not so much science as the social relations of science. He was critical of Galileo's method of abstracting problems entirely from their general and social context. Scientists, in the main, have followed Galileo for three centuries, accumulating discoveries in areas of research artificially isolated from the general body of knowledge and social affairs.[4]

An illustration of failure to recognize a socially valuable problem

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[2]E. G. Boring, *A History of Experimental Psychology*, pp. 165, 502-3. New York: Century Co., 1929.

T. A. Boyd, *op. cit.*, p. 280.

J. G. Crowther, *The Social Relations of Science*, p. 450. New York: Macmillan Co., 1941.

Charles A. Ellwood, *A History of Social Philosophy*, pp. 437-41. New York: Prentice-Hall, 1938.

Gardner Murphy, *An Historical Introduction to Modern Psychology*, pp. 121, 216-17. New York: Harcourt, Brace and Co., 1932.

[3]Carter V. Good, "Educational Progress During the Year, 1940," *School and Society*, LIII (March 15, 1941), 330-37.

For extended recent discussions of this problem see:

J. D. Bernal, *The Social Function of Science*. New York: Macmillan Co., 1939. Pp. xvi., 482.

J. G. Crowther, *The Social Relations of Science*. New York: Macmillan Co., 1941. Pp. xxxiv., 665.

Florian Znaniecki, *The Social Role of the Man of Knowledge*. New York: Columbia University Press, 1940. Pp. viii., 212.

[4]J. G. Crowther, *op. cit.*, pp. 351-52.

is found in the case of two research students who went to investigate a racial conflict in a certain community. They returned with the statement that everything was harmonious between Orientals and Americans, a race riot having just been settled amicably, hence there was nothing to investigate. They overlooked an excellent opportunity to study an accomodation process, an adjustment between races.[5]

The element of timeliness is illustrated by studies of the tuitional value of motion pictures, an important problem about 1922. If similar studies were undertaken today for the simple purpose of ascertaining whether children secure value received for time spent in viewing an instructional film, the problem would be considered relatively unimportant, since an affirmative answer is already well known.[6]

The research worker is not expected, as a general rule, to implement the results of his studies, however desirable this consummation may be; he is not even compelled to point out the practical applications of his findings, although this step seems essential, especially in the social sciences. It is suggested that the scientist in education cannot leave himself out of his own picture and that research in education is part of the process of education itself.[7] Even in the physical aspects of child development, traits cannot be measured as if they were independent entities growing without some central control on the part of the organism. In reading, research has advanced from study of relatively mechanical factors toward the purpose of the reader and the social uses of the process. Guidance investigations have moved away from the notion of fitting a pattern of aptitudes into a pattern of demands to a consideration of the individual in relation to society. Research in educational finance must concern itself with forces of public opinion and common desire. Survey testing is now of secondary importance as compared with functional use of measurement for segregation or classification, diagnosis, prediction or prognosis, evaluation, and standardization of desirable practices. "When it comes to education there is no avoiding the step from the study of the elements of a problem, objectively considered, to the study of what can be done to acquaint the individual or the group with the situation. Educational research leads into education. How to implement research is a part of research itself."[8]

Even where applications of scientific discoveries are clearly in-

[5]Emory S. Bogardus, *Introduction to Social Research,* p. 5. Los Angeles: Suttonhouse, 1936.

[6]Douglas E. Scates and Charles F. Hoban, Jr., "Critical Questions for the Evaluation of Research," *Journal of Educational Research,* XXXI (December, 1937), 241-54.

[7]H. W. Holmes and Others, *Educational Research,* pp. 181-82. Washington: American Council on Education, 1939.

[8]H. W. Holmes and Others, *op. cit.,* p. 182.

dicated, there are almost countless examples of the thwarting of science in such fields as health, nutrition, medicine, housing, recreation, education, industry, and invention, owing to economic and social factors, tradition, competition, the profit motive, war, and prejudice.[9]

Interest and Intellectual Curiosity.—The history of science is studded with the names of scholars led (and sometimes driven) to their discoveries by consuming intellectual curiosity. One of the personal motives for research most frequently mentioned by scientists themselves is pure curiosity, accompanied by genuine interest and a derived satisfaction or enjoyment. Only an insatiable curiosity and driving interest could have compelled Aristotle to undertake so varied a program of activities, which identify him in the language of today as professor, philosopher, psychologist, logician, moralist, political thinker, biologist, founder of literary criticism, and author of books on all these subjects.[10] Herschel was a musician until the age of forty, but his curiosity and strong interests in astronomy and in the making of telescopes led to the spectacular discovery of the planet Uranus, origination of descriptive astronomy, and a lasting impetus to the construction of large telescopes. Galileo's interests cropped out in his freshman days at the University of Pisa; he soon gave up premedical work in favor of mathematics and natural science. While poor, he evidently was not interested in monetary rewards; a professor of medicine then received the equivalent of about $2,000 a year, and a professor of mathematics only about $65.

The desire to understand fully and to construct a completely coherent system of ideas that will explain phenomena frequently is so strong that scientists go to extremes in concentration, withdrawal from human contacts, and in reluctance to publish anything short of perfect solutions of problems.[11] Cavendish had his meals placed through a hole in the wall of his room, to avoid speaking to anyone and to reduce interruptions to a minimum. He failed to publish his invention of electrical condensers, which was rediscovered by Faraday. Newton asked that his first paper, the solution of a problem in annuities, be published without his name attached, for fear of increasing the number of his acquaintances. Darwin worked on the *Origin of Species* for more than twenty years, and might never have published it without pressure from Lyell.

Striking differences in intellectual curiosity and scientific interests are noted in the work of Huxley, a great propagandist for science,

[9]J. G. Crowther, *op. cit.*, pp. 576-91.
[10]Frederick Slocum, "Intellectual Curiosity," *School and Society*, XLVIII (August 6, 1938), 157-63.
[11]J. G. Crowther, *op. cit.*, pp. 511-16.

and of Darwin, a great research worker.[12] Huxley's diary of the voyage on the *Rattlesnake* is concerned with personal psychological problems and resistance to fits of depression, while Darwin's diary of the voyage on the *Beagle,* in spite of his poor health, is devoted to the collection of facts and the development of scientific ideas.

It follows that the graduate student's choice of area, problem, or method will depend to a large extent on his interests, as well as on such criteria as novelty, importance for the field represented, training, etc.

Training and Personal Qualifications.—It should be recognized that such fields as education, psychology, and sociology are greatly indebted to workers with specialized training in other disciplines, especially during the stages when the foundations are being laid for a new science. To use psychology as an example, contributors to the early development of psychology include: Descartes, philosopher and physiologist; Leibnitz and Locke, philosophers and men of political affairs; Berkeley, philosopher, bishop, and educator; Hume, philosopher, historian, and politician; Hartley, learned physician; James Mill, historian and diplomatist; John Stuart Mill, philosopher, logician, and political economist; Charles Bell, Flourens, Johannes Muller, and E. H. Weber, physiologists; Lotze, metaphysician; Helmholtz, physiologist and physicist; Bain, really a psychologist but formally a logician; Fechner, physicist and philosopher; and finally Wundt, physician and physiologist who in 1875 accepted a chair of philosophy at Leipzig, although his experiments and work make it possible without reservation to call him the senior psychologist in the history of psychology.[13] Many later psychologists have continued to pursue special training in medicine and physiology. Graduate students may well interpret the preceding illustrations as a suggestion to avoid over specialization or narrowness in their programs of training.

The versatility of Leonardo da Vinci should be interpreted in the light of his training as an apprentice in the shop of Verrocchio, a distinguished painter, goldsmith, and craftsman who had some knowledge of sculpture, architecture, and engineering.[14]

Gabriel Tarde's contributions to sociology were derived primarily from his training for the law and his long period of service as a criminal judge in France. He saw how crime was so frequently the result of contagion and association, and decided that most of the phenomena of human society are socially acquired and socially transmitted.[15]

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[12] *Ibid.*, p. 516.
[13] Edwin G. Boring, *op. cit.*, pp. 223-24, 310.
[14] J. G. Crowther, *op. cit.*, p. 253.
[15] Charles A. Ellwood, *op. cit.*, pp. 417-26.

The worker's physical equipment must be considered in relation to the contemplated field and problem. James Rowland Angell, near the end of his college course, considered the pursuit of medicine, but weak eyes compelled him to forego the arduous microscopic work that was and is an essential feature of the medical training program.[16] If medicine was the loser, psychology and university administration gained a competent worker.

Freedom from bias is an essential prerequisite for successful research in the social sciences.[17] There is the interesting case of the young college woman who undertook to write a hero-worshiping paper on the career of a fascist leader and in despair asked the instructor for an extension of time, because the evidence was "all on the wrong side of the question."[18]

The wise graduate student will consider carefully both the subject-matter content and the treatment of research methodology in his program of training—past, present, and future—in selection of the thesis problem. Through organized courses and seminars, supplemented by independent reading, the necessary background concerning content and research methods can be secured. For example, to write the history of a state department of education, the student should know at least the history of the state and nation, history of education in the state and in the United States, school administration, and the historical method. In this particular instance, the graduate investigator in question has had substantial advanced work in all the fields mentioned. The student may well become acquainted with the different investigational procedures, considering the available courses and seminars where certain of these methods are analyzed in detail, before definitely formulating his thesis problem. It has even been suggested that, if life were longer and time less fleeting, those engaged in educational research should know the entire range of research in psychology, biology, and sociology, as well as possess basic training in the humanities, history, philosophy, and science.[19]

It is admitted that classroom instruction is only one source of training. John Stuart Mill never went to school except to his father. What he learned through personal accomplishment and exacting paternal instruction was further impressed on him by later becoming the

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[16]Carl Murchison, Editor, *A History of Psychology in Autobiography*, Volume III, p. 5. Worcester, Mass.: Clark University Press, 1936.

[17]For examples drawn from graduate theses in education see: Carter V. Good, A. S. Barr, and Douglas E. Scates, *The Methodology of Educational Research*, pp. 72-73. New York: D. Appleton Century Co., 1936.

[18]Cecil B. Williams and Allan H. Stevenson, *A Research Manual*, p. 30. New York: Harper and Bros., 1940.

[19]Henry W. Holmes and Others, *op. cit.*, pp. 184-86.

tutor of his younger sisters and brothers.[20] However, it should be remembered that Mill's native equipment was such as to enable him to begin study of Greek at the age of three years.

Availability of Data and Method.—Closely related to the immediately preceding criterion of training and personal equipment is that of availability of satisfactory data and an appropriate method. The data under consideration must meet certain standards of accuracy, objectivity, and verifiability. The contemplated problem should be viewed in the light of the possible research approaches.

Writers on research methods have emphasized the desirability of becoming familiar with the purposes served by the several investigational procedures before making a definite choice of the thesis topic. One of the things that graduate students in education have had to live down is the questionnaire complex, the tendency to turn to the questionnaire as an instrument before careful formulation of the problem and before thoughtful consideration of an appropriate method. The normative-survey type of research is not expected to yield rigorous data concerning causes. The experimental method is not pointed toward a description of prevailing conditions or practices.

Sometimes a theoretically desirable procedure breaks down under actual field conditions; for example, an experimental investigation of motion pictures in the school, involving 11,000 children in more than 300 classes, taught by nearly 200 teachers.[21] It was impossible for the investigators to keep in close contact with all the centers; consequently conditions could not be kept uniform. In one school keen rivalry developed between the control and experimental teachers. In many schools visual aids other than those contemplated in the experiment were used. In other instances teachers were so unfamiliar with the instructional use of motion pictures that exaggerated conditions resulted.

Certain types of problems defy solution, in terms of available data and techniques, because of the vastness and complexity of the problem (for example, the causes of the fall of the Roman Empire) or because of the loss or suppression of evidence. Probably Channing's survey of the entire sweep of American history will be the last attempted by one author. A doctorate candidate gave up a study of the social and educational attitudes of one thousand school board members in a particular state when the interview technique seemed the only feasible approach. In turning to another problem, a survey of secondary school

[20]Edwin G. Boring, *op. cit.*, p. 217.
[21]Ben D. Wood and Frank N. Freeman, *Motion Pictures in the Classroom.* Boston: Houghton Mifflin Co., 1929. Pp. 392.
Douglas E. Scates and Charles F. Hoban, *op. cit.*, p. 244.

organization in one of the Spanish-speaking countries of South or Central America, he still must consider the availability of data and method in terms of the language factor, necessary travel, and his knowledge of comparative education.

In certain instances the approach to a problem opens through a fortunate combination of circumstances, increased insight on the part of the investigator, or a change in occupational status or professional assignment. Darwin's trip on the *Beagle* through the South Seas, 1831-1836, gave him a magnificent opportunity to observe and collect plants and animals.[22] A graduate student who called on a prominent citizen to investigate a local conflict received the reply that everything was quiet; a more experienced worker, who understood the sense of local pride possessed by the community "booster," found that bitter racial conflicts actually were in progress in the locality.[23] An elementary school principal found the way open to study the departmentalized elementary school when his school board sent him on a field trip to observe the reorganization procedures employed in a selected group of cities. Specialists in music education and in trades and industries were enabled to make state wide surveys of the opportunities in their respective fields on appointment to state supervisory positions.

Special Equipment and Working Conditions.—Available treatises dealing with the several research methods include descriptions of the special sources, equipment, and working conditions commonly represented in the several types of investigation—historical, survey, experimental, case, and genetic. Consideration is given earlier in this article to personal qualifications and to training in the use of special techniques and material equipment.

It should be emphasized that the quality of scientific work resides not in the ornateness of the laboratory equipment or the complexity of the measuring and recording instruments, but in the soundness of the thinking and the validity of the evidence for solution of the problem. The major purpose of such equipment is to refine the process of observation through control of conditions or through accuracy or permanence of recording. Desirable as elaborate equipment and adequate financial support may be, there are many instances of problem solving outside the laboratory or study.[24] Helmholtz said that, after he had been working on a problem for some time, happy ideas for a solution came to him at some place other than his working table. Darwin was riding in his carriage when his theory of evolution came to him. Watt was walking on Sunday afternoon when he

[22]Gardner Murphy, *op. cit.,* p. 119.
[23]Emory S. Bogardus, *op cit.,* pp. 4-5.
[24]T. A. Boyd, *op. cit.,* pp. 55-62.

invented the condensing steam engine. Morse conceived the telegraph on a return trip from Europe. The aria of the beautiful quartet in the "Magic Flute" came to Mozart while playing billiards.

Improvised laboratories sometimes have produced remarkable results. The Curies conducted their long search for radium in a shed that had been a dissecting room. Bell experimented on his telephone in a Salem cellar and in a Boston attic. Pasteur discovered pasteurization in an old room that had been a cafè. Goodyear stumbled across vulcanization of rubber in a New England kitchen.

Thorndike candidly mentions an extreme ineptitude and distaste on his part for using machinery and physical instruments. He regrets the absence in his training of a systematic course in the use of standard physiological and psychological apparatus and of extended training in mathematics, modestly suggesting that his work might have been better had he been at home with apparatus for exposing, timing, registering, and the like.[25]

Many men of genius, and others of lesser talents, have a drive and a power of concentration to accomplish their tasks in spite of the handicaps of working conditions.[26] Descartes once left Paris in disgust because his friends insisted upon disturbing him in his quarters. During the very productive period of twenty years before his death he is said to have lived in thirteen places and in twenty-four houses, with his whereabouts unknown except to a few intimates who respected his seclusion and forwarded communications to him. Driven by financial pressure, James Mill composed several volumes of the *History of India* at one end of a table, while his son, John Stuart Mill, went to school to the father at the other end, among other things learning Greek and interrupting his father for the meaning of every new word.

Sponsorship and Administrative Cooperation.—In graduate departments of instruction it is common practice for the thesis to be sponsored by a faculty adviser in whose area of specialization the problem lies. When a committee gives this advice, as is usually the case for the doctorate dissertation, the chairman is the major adviser. In selecting his problem, the candidate will do well to consider the availability of a particular professor for the duration of the graduate program. Leave of absence, a heavy teaching schedule, an already excessive number of advisees, concentration on writing or research, numerous speaking engagements, ill health, or personality difficulties on the part of a particular professor may render him relatively unavailable

[25]Edward L. Thorndike, *History of Psychology in Autobiography*, Volume III, *op. cit.*, pp. 267-68.
[26]Edwin G. Boring, *op. cit.*, pp. 159, 209-10.

for additional assignments to the extent that the graduate student may wish to turn elsewhere for thesis guidance or at least to consider the hazards involved in securing the necessary conferences and advice. It is recognized that the beginning graduate student often lacks the factual background to act judiciously in choosing an adviser; however, students have a way of educating each other to the problems of a particular department or institution and to the characteristics and idiosyncrasies of individual professors.

In many instances the sponsorship of a department, institution, or school system is necessary to collect certain types of data or to use special sources. Permission from the responsible school officers usually must be secured to administer tests to children, to interview employees or to distribute questionnaires among them, to observe pupils and teachers at work, to rate school buildings or equipment, to introduce innovations in materials and methods, or to study problem pupils. Official permission ordinarily is necessary to use the minutes of a board of education or the records of a school unit—state, county, city, or smaller local system. Certainly a graduate student would be unwise to attempt a thesis problem where administrative cooperation is withheld. Occasionally an institution or school system is willing to sponsor officially a thesis that relates closely to the work of the sponsoring organization or promises to solve one of its pressing problems, although unfortunate experiences in public relations have rendered most universities and administrative officers wary about too frequent use of this practice.

Costs and Returns.—Graduate instruction and research are expensive. Fortunately for the student, only a part of the cost is passed on to him. Endowments, taxes, and grants from foundations make possible reduced tuition rates as well as scholarships, fellowships, and assistantships. These same sources of revenue have provided financial assistance for certain types of theses, such as those involving large-scale testing programs, extended tabulations, intricate laboratory equipment, or expensive travel. In advance of final selection of the thesis problem, the candidate must consider carefully his own financial resources, in the light of such facilities and assistance as can be provided by the institution.

Graduate students are not alone in encountering financial difficulties in pursuit of their objectives. Thorndike says that he made it a rule early in his career to spend so little and earn so much as to be free from financial worry.[27] It seems the rule rather than the exception for inventors, scholars, and scientists to meet pecuniary

[27]Edward L. Thorndike, *History of Psychology in Autobiography*, Volume III, *op. cit.*, p. 270.

problems in connection with their investigations, writing, and research.[28] Newton at one time in his life was so poverty-stricken that he had to ask relief from paying the weekly dues of a shilling to the Royal Society. Charles Goodyear, after discovering how to vulcanize rubber, died in debt to the extent of $200,000. John Fitch, discouraged and poverty-stricken after his series of experiments with the steamboat, took his own life. LeBlanc discovered how to make cheap alkali, but died in a French poorhouse. Comte, after losing his position and suffering other reverses, found his income so reduced that he told John Stuart Mill of his difficulties. Mill, with the aid of Grote, the historian, raised about 20,000 francs as a gift for Comte in order that he might continue study and publication of his books, but after five years Comte was again in financial straits. Herbert Spencer was an invalid most of his life, with a very uncertain income. He put more into his early books than he received from them, since he usually employed an amanuensis. Only within the last few years of his life did he receive any substantial revenue from his books, and even in those years the publication of *Descriptive Sociology* took from him a large part of his earnings.[29]

Some scientists have had large personal resources, which they used in the pursuit of research.[30] Roger Bacon was a member of a wealthy family and probably earned substantial fees while lecturing in Paris between 1236 and 1251. He spent ten thousand pounds, in modern money, on the purchase of books, experiments and instruments, journeys to meet scholars, and secretaries. Within a period of eighteen years, Lavoisier received an income of sixty thousand pounds, most of which was spent on research. Charles Darwin was an English gentleman of wealth and leisure, which provided favorable conditions for his work.

The illustrations just cited suggest that the work of the scholar or scientist guarantees no fixed monetary return. Often the chief reward is the satisfaction of an intellectual interest in the solution of a problem. Pasteur declared, "I could never work for money, but I would always work for science," while Agassiz said, "I have no time to make money."[31] It is true that the work of both these scientists was supported by educational institutions. For the graduate student, who usually is interested in tangible returns on completion of his program of advanced study, there is reasonable expectation of one or more of the following developments: advancement on the

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[28] Charles A. Ellwood, *op. cit.*, p. 364.
T. A. Boyd, *op. cit.*, pp. 53-54.
[29] Charles A. Ellwood, *op. cit.*, pp. 339-40.
[30] J. G. Crowther, *op. cit.*, pp. 208, 436.
[31] T. A. Boyd, *op. cit.*, pp. 283-91.

salary schedule, promotion, enhancement of reputation, or cultivation of an area of specialization.

Hazards and Penalties.—The illustrations of the preceding section indicate the pecuniary hazards that frequently attend the pursuit of scientific work. In the selection of certain types of problems, the worker may well consider other special penalties of a personal, social, or professional character, not necessarily with the thought of avoiding or giving up a particular study but of making the choice with eyes open. For example, there are agencies that have sought to place restrictions on animal experimentation in psychology, medicine, and other fields, with the result that the American Psychological Association finds it desirable to maintain a Committee on Precautions in Animal Experimentation, which has available a printed list of rules and precautions for such research. Pressure groups and institutional taboos have handicapped the investigation of problems of social hygiene and sex in sociology, psychology, and education. Opposition frequently is voiced against the reporting of results that run counter to the beliefs or programs of certain economic, social, patriotic, or religious groups.[32]

When Fechner was suffering from what today might be called a "nervous breakdown," he increased his difficulties by undertaking the study of positive after-images from bright stimuli, particularly the sun. This produced violent pain in his eyes and partial blindness, from which he did not recover for several years.[33]

Galileo was highly praised by some, ridiculed by others, and summoned before the Inquisition at the age of seventy-eight to recant his so-called heretical teachings. With health broken, he returned home to continue productive work. Totally blind at eighty, he continued work, dictating to some of his faithful disciples.

Physical handicaps were encountered by the historians, Parkman and Prescott, who for long periods were almost blind. At one time Parkman used a frame with parallel wires to guide his black crayon.

The type of stern and uncompromising education received by precocious John Stuart Mill from his father meant that he had no boyhood friends, no child's play, and little youthful reading. The son's curriculum included Greek at three years of age; Aesop's *Fables*, the

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[32]H. K. Beale, *Are American Teachers Free?* New York: Charles Scribner's Sons, 1936. Pp. xxiv., 855.

William Gellerman, *The American Legion as Educator.* Teachers College Contributions to Education, No. 743. New York: Teachers College, Columbia University, 1938. Pp. 280.

Bessie L. Pierce, *Citizens' Organizations and the Civic Training of Youth.* New York: Charles Scribner's Sons, 1933. Pp. xviii., 428.

Bruce Raup, *Education and Organized Interests in America.* New York: G. P. Putnam's Sons, 1936. Pp. 238.

[33]Gardner Murphy, *op. cit.*, p. 87.

Anabasis, all of Herodotus, some of Plato, and many other standard Greek works before eight; and Latin, geometry, and algebra at eight years. Later, there were several years of mental depression when Mill, brought up in austere personal life to scorn all emotion, began to doubt the value of his political and social activities.[34]

To be the butt of ridicule is frequently the price paid by pioneers. People laughed at Fulton's steamboat, Stephenson's locomotive, the Wright brothers' flying machine, the horseless carriage, the achievement tests of James M. Rice, and at the I. Q.

These are some of the penalties of pioneering, although in the interest of accurate perspective for the modern student of the social sciences it should be said that he will not ordinarily encounter such difficulties. Many agencies and institutions have contributed toward smoothing the path of the research worker of today.

Time Factor.—Graduate students quite properly are interested in the length of time necessary to complete the program for an advanced degree. They are eager to begin or to continue their professional careers and usually have limited financial resources. As a general rule, the minimum amount of graduate work for the Master's degree is one year, and for the Doctor's degree, three years. The time required for completion of the thesis depends on the variables of the student, problem, department, adviser, and institution. Most students have their course work finished before the thesis is completed. Few good Doctors' dissertations are accepted with less than the equivalent of a full year of work, while a Master's thesis of similar quality may require half that time. By their very nature, historical, experimental case, and longitudinal genetic studies frequently require more time than the several types of normative-survey work. Many students have found it profitable both intellectually and professionally to do at least part of their graduate work in full-time residence during the academic school year rather than to depend entirely on the part-time courses of the regular year or the summer-session program.

Lest the beginning graduate student and others become too impatient with the time requirements for careful training and research, a few examples may be cited from the lives and works of famous scholars and scientists.[35] Copernicus worked nearly forty years on his problem and eventually published his only book, on the heliocentric theory of the motions of the planets. Galileo's *Dialogues Concerning Two New Sciences* was published in 1638 when he was

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[34] Edwin G. Boring, *op. cit.*, pp. 217-18.

[35] Edwin G. Boring, *op. cit.*, pp. 169-70, 179, 186-88, 495.
J. G. Crowther, *op. cit.*, pp. 308, 513.
T. A. Boyd, *op. cit.*, pp. 177-81.

seventy-four years of age, after collecting and developing the material for fifty years. John Locke did not attain fame as a philosopher until the publication of his *Essay* in 1690 (begun in 1671), when he had reached fifty-seven. On the other hand, George Berkeley, Locke's immediate successor in British philosophy, published his two important contributions in successive years, 1709 and 1710, when he was about twenty-five. Berkeley's philosophical successor, David Hume, also matured early, publishing his most important work at twenty-eight; later in life, court fame and society distracted him from greater philosophical accomplishment. Darwin spent more than twenty years in preparation of the *Origin of Species*. William James worked twelve hard years on his *Principles of Psychology*, published in 1890. Pasteur used five years to find his remedy for hydrophobia. Faraday needed ten years to "change magnetism into electricity." Fifteen years of research and five million dollars went into the discovery of synthetic indigo.

When Charles F. Kettering was doing research for the National Cash Register Company, he estimated that a certain project would require a year for completion. When asked to double his force and reduce the time to six months, his reply was: "Do you think that by putting two hens on the nest a setting of eggs could be hatched out in less time than three weeks?"[36]

[36]T. A. Boyd, *op. cit.*, p. 177.