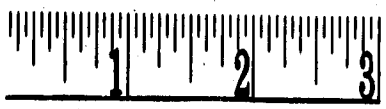
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1949

THOMAS HENRY HUXLEY AND HIS RELATION TO THE RECOGNITION OF SCIENCE IN ENGLISH EDUCATION

by
James A. Boyer

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Education in the
University of Michigan
1949

Committee in charge:

Professor Louis I. Bredvold, Chairman
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PREFACE

In this work the writer has attempted to show that Huxley, the spokesman for science in English education, was probably just as important as Huxley, the scientist. His eminence in the field of natural science has tended to obscure the great service he rendered to the cause of science instruction for the pupil and the layman. This service has been duly recognized and evaluated in this study.

To the members of my committee, Professor Louis I. Bredvold, Chairman, Professor H. C. Koch, Associate Professor Karl Litzenberg, Assistant Professor Fred G. Walcott, Dr. H. C. Barrows, Jr., and to Professor Clarence D. Thorpe, former Committee Chairman now on Sabbatical leave, I wish to express my sincere gratitude for the friendly guidance and cooperation they have given me during the preparation of this dissertation. Their unfailing interest and constructive criticism have made the study a pleasure from beginning to end.

J. A. B.

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CHAPTER I

INTRODUCTION

1. Huxley's Role in Education

Thomas Henry Huxley (1825-1895), though known primarily as an eminent scientist, was also an outstanding educator of his day. Because his first interest was science, it is easily understandable that the main motivating force behind his endeavors for education was the desire to bring science into the classroom and the home, and to show the relationship of scientific knowledge to everyday life.

Huxley's educational services were such as to aid education in general and science in particular. He was a member of the London School Board[1] and of the Science and Art Department; Secretary, and later, President of the Royal Society; and a member of the City and Guilds Institute Council, to which body he submitted a report (1877) that was to become the basis for the Institute's program of technical education. He was elected a Governor of Eton College (1879) and made Honorary Dean of the Royal College of Science (1885). Further, he held office as President of the Marine Biological Association, Inspector of Fisheries, and Trustee of the British Museum; he was a member of the Privy Council,

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[1]Huxley was a member of both the Curriculum Committee and the Books and Apparatus Committee of the London School Board.

the International Education Association Society, the British Association for the Advancement of Science, the National Association of Science Teachers, and the Literary Society. These positions and the accompanying duties resulting from their connection with education and science, enabled Huxley to work more effectively on the side of the forces that were fighting for more and better science training.

Huxley began his career as a teacher when he became Professor of Natural History (1854) at the Royal School of Mines. Later, he taught at St. Thomas' Hospital, at the College of Surgeons, the Royal Institution, the University of London, the Normal School of Science, and the Kensington Museum.

Supplementing his pedagogical duties, Huxley served as an examiner for the Science and Art Department, the Royal College of Surgeons, the University of London, and the Royal Institution.

In addition, Huxley gave yeoman service as a lecturer. He addressed people from many levels of society, ranging from the members of the Royal Society down to the various working men's groups. And he delivered a series of lectures to audiences in America. While in Nashville visiting his sister (7 September, 1876) Huxley spoke on "The Geology of Tennessee" to a large and appreciative audience; five days later, at the formal opening of Johns Hopkins University, he delivered the address, "On University Education," to an

estimated two thousand people; and the following week, in New York, he gave three lectures on evolution, lectures that were simple discourses on a complex subject. During his brief stay in America Huxley more than proved himself worthy of the high esteem in which he was held by Americans long before his coming.[1]

Linked with Huxley's excellent work as a lecturer was his effectiveness as a writer. His clear, forceful essays, revealing letters, and simplified textbooks show how greatly Huxley was interested in this matter of science education. In fact he contributed a fortnightly article to the Saturday Review (1858), helped to establish the Natural History Review (1861-65), and wrote regularly for Nature, a science magazine that made its debut in 1869.

Indeed, Huxley's great accomplishments in the field of science brought him the honor of being chosen for membership in seventy-five societies, national and international. Some of them were the Royal Society, the Linnean, the Geological, the Zoological, the Anthropological, the Medical, the Literary, and the Pharmaceutical; the Royal College of Surgeons, the British Association for the Advancement of Science, and the Royal Institution. Huxley also belonged to the Liverpool Literary and Philosophic Society, the Royal Irish Academy, the Royal College of Surgeons (Ireland), and the

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[1]Leonard Huxley, ed., Life and Letters of Thomas Henry Huxley, 2 vols. (New York, 1901), I, 499-502.

Literary and Antiquarian Society of Perth. Outside of the British Isles Huxley held membership in the International Congress of Anthropology and Prehistoric Archaeology, and in the International Geological Congress. Further, he belonged to the American Academy of Arts and Sciences, the Anthropological Society of Brussels, the Royal Society of Copenhagen, the Imperial Society of Natural Science of Cherbourg, the Imperial Literary and Scientific Academy of Germany, and the Royal Academy of Sciences of Amsterdam.

Huxley was the recipient of honorary degrees from eight different universities, British and Continental. He received the D.C.L. from Oxford (1885), the L.L.D. from Cambridge (1879), from Edinburgh (1866), and from Dublin (1878); the Ph. D. and M.A. from Breslau (1861), and the M.D. from Wurzburg (1882), Bologna (1888), and Erlangen (1893).

Moreover, Huxley served on many Royal Commissions. The most important of these were the Royal Commission on the Royal College of Science for Ireland (1866), the Royal Commission on Science and Art Instruction in Ireland (1868), the Royal Commission on the Administration and Operation of the Contageous Diseases Acts (1870-1), the Royal Commission on Scientific Instruction and the Advancement of Science (1870-5), the Royal Commission on the Practices of Subjecting Live Animals to Experiments for Scientific Purposes (1876), the Royal Commission to Inquire into the Universities

of Scotland (1876-8), and the Royal Commission on the Medical Acts (1881-2).[1]

2. Lack of Attention to Huxley's Role as an Educator

Unfortunately, despite Huxley's great work as a promoter of science education, his biographers for the most part have neglected to accord him proper recognition for his role in this field.

In none of the biographies and critical studies of Thomas Henry Huxley do we find an extended, systematic discussion of his interest in science in education and life. For example, in Houston Peterson's Huxley, Prophet of Science (London, 1932), there is only one chapter, "The Great Teacher" (184-220) which pays any attention to Huxley's interest in science in education. It does not emphasize this interest, however, but deals more with Huxley's relations to general education. There is mention of his work as an instructor of science teachers and of his insistence upon the laboratory method of teaching, and there is a brief section on his manner as a teacher. There are also brief accounts of his attendance at a seance, of his study of psychology, of his disputes concerning theology, and of his lecture tour of the United States. And this last account alone touches upon Huxley's interest in science in education, and at that only briefly.

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[1] Ibid., II, 499-503.

The study of J. R. Ainsworth-Davis, Thomas H. Huxley, English Men of Science (London, 1907), likewise pays some attention to Huxley's work in behalf of science in education. But no one chapter in this book treats this problem exclusively. The emphasis is decidedly upon Huxley the acquisitive-minded and exploring scientist, rather than upon Huxley the disseminator of scientific knowledge and principles.

Thomas Henry Huxley, by Edwin Clodd (Edinburgh, 1905), has very little concerning Huxley's interest in scientific training. The five chapters, "I. The Man," "II. The Discoverer," "III. The Interpreter," "IV. The Controversialist," and "V. The Constructor," are concerned with Huxley's personal life, his research, his explanation of profound theories (mutation, evolution, and so forth) and of scientific discoveries of the day, his religious disputes, and his general social contributions. Out of two hundred and twenty-two pages, only seven refer to Huxley and education, and this reference is sketchy. Moreover, his interest in science in English education is not distinguished from his general interest in education.

P. Chalmers Mitchell, in Thomas Henry Huxley, A Sketch of His Life and Work, Leaders of Science (New York, 1900), devotes one chapter out of seventeen to science as a branch of education. In this chapter the author mentions Huxley's textbooks, his teaching of biology, his interest in medical education, and his insistence upon educational reform. In

another chapter technical education is referred to briefly, along with religion, theology, science and art instruction, and other topics on general education. The treatment of Huxley's interest in science in education is not thorough; the author admits this indirectly when he says that "A mere enumeration of the modes in which he [Huxley] assisted in arousing attention to science among all classes would fill many pages."[1]

Two other biographical works, Clarence Ayres' Huxley (New York, 1932) and Gerald Rowley Leighton's Huxley (New York, 1912), mention only briefly Huxley's work as a spokesman for scientific training.

A little volume with a rather misleading title--Huxley and Education--by Henry Fairfield Osborn (New York, 1910), is merely an address delivered at the beginning of the college year at Columbia University, September 28, 1910. It is brief, sketchy, and occasional in nature, containing a general treatment of Huxley, with very little dealing directly with the problem of his services to science in education.

Finally, The Teachings of Thomas Henry Huxley (New York, 1909), by I. W. Voorhees, which is a presentation of Huxley's ideas on moral duty, and Huxley (London, 1934) by Ernest McBride, which is a study of Huxley as scientist and agnostic, complete the list of biographies. Neither pays particular attention to Huxley's place in English education.

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[1]P. Chalmers Mitchell, Thomas Henry Huxley, A Sketch of His Life and Work (New York, 1900), p. 169.

Most of the secondary works mentioned above are entirely biographical. In common with other studies dealing with Huxley's life and achievements, they present him primarily as a man of science with international fame. He is shown in his early struggle for recognition as a scientist; he is held up as a champion of the theory of evolution; his theological disputes are dwelt upon. But his interest in securing recognition for science in English education receives scant attention.

The shorter biographical writings on Huxley give us a somewhat better account of him as he worked to promote science education, though they, too, cover it only in broad outline, not in detail. Michael Foster, in writing about his former teacher, asserts that Huxley had felt it his duty to expound by mouth and pen the teachings of science in general, and of biological science in particular, to students and the masses; for he believed that science was for the many as well as the few, to be known and understood as a guide for living. It was this conviction, says Foster, which caused Huxley to devote considerable time and care to popular lectures and addresses, inculcating the broad uses and value of scientific knowledge; and his immediate success was great, his influence far-reaching:

> . . . [Huxley] taught to the multitude the power and value of scientific thought . . .; it listened gladly to high themes of science touched by him with an artist's hand; and if, at the close of the century, science stands high in public estimation, that is in

> no small measure due to Huxley's public utterances, and the close accord which his life showed to his words . . . . There is not a biologist of the latter half of this century who has not been helped on his way, directly or indirectly, by some research or by some word of Huxley's.[1]

Another disciple of Huxley, F. O. Bower, states that Huxley's influence was felt as a result of his activities as an administrator, zoologist, and member of many Royal Commissions; and as an essayist and writer of textbooks that greatly affected the schools when science and the classics were competing for priority. Bower thinks that Huxley's contribution to modern methods of teaching biology has been generally overlooked. And he is convinced that, although some earlier men had done sporadic laboratory work, it is largely to Huxley that we owe the initiation of that systematic laboratory training which has now become general. Such training was the second step in Huxley's three-step sequence of instruction, being preceded by the lecture and followed by the examination. The importance of the laboratory was based upon the fact that information received in lectures could thus be verified and better retained by the students.[2]

H. G. Wells, eminent scientist and writer, who also had the privilege of studying under Huxley, points out that even as early as the eighteen-fifties, this advocate of science

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[1]Michael Foster, "Royal Society Obituary Notice to Thomas Henry Huxley," Proceedings of the Royal Society of London, LIX (1895-96), lvi.

[2]F. O. Bower, "Teaching of Biological Science," Nature, CXV (May, 1925), 712-13.

was "hammering away" at the importance of biology in education. Wells adds that in the sixties and seventies, Huxley, largely because of his influence with the Department of Science and Art, succeeded in getting this state-supported body to approve physiography for the curriculum. Though somewhat guarded in his claims for Huxley, Wells clearly implies that the former's influence was a force that helped to emphasize the growing need for a general education of the population, and for a new type of education which took account of scientific discovery, especially in its relation to industry.[1]

There is also a writer in Lancet who calls attention to the fact that Huxley had pointed out the dependence of business and industry upon science, and had thereby assured the future of technical education. This writer proceeds to emphasize Huxley's part in promoting technical science for the purpose of enabling England's commerce and industry to compete with that of other nations:

> The future predominance of the commercial power of England was, he [Huxley] maintained, essentially dependent upon whether her merchants had the wisdom to appreciate the gifts given to them by science, whilst the industries could only be properly developed by scientific methods and by a thoroughly scientific organization.[2]

And believing this, Huxley repeatedly advocated that the Government, wealthy individuals, and rich companies give

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[1]H. G. Wells, Experiment in Autobiography (New York, 1934), pp. 166-8.

[2]"Obituary Notice to Huxley," The Lancet, II (July, 1895), 64.

financial assistance to scientific education, pointing out that it was their duty to render such aid.[1]

Paul Elmer More asserts that Huxley worked diligently for the incorporation of science in the curriculum and avers that although the latter's literary bent would not allow him to criticize the classics severely, he gave his chief attention to the cause of science in education:

> In education, though Huxley's interests were too broad and in some respects too literary to permit a harsh condemnation of the humanities, yet all his energy was devoted to introducing science into the curriculum of the universities and schools. No doubt his action was justifiable to a certain extent and redounded to the genuine profit of pure science . . . . He was convinced that the sciences in themselves are sufficient for a liberal education, and on occasion he was ready to commend a foundation which made "no provision for 'mere literary instruction and education,'" meaning by this "the ordinary classical course of our schools and universities." Biology, he thought included really the whole philosophy of life; and education he limited to "instruction of the intellect in the laws of nature."[2]

More praise is bestowed upon Huxley by Cazamian, who makes the following observation:

> By making knowledge human, and by setting an example of a life full of generous activity, based upon principles which traditional prejudice had deemed pernicious, he has done more than any other to win for the scientific spirit its full and unqualified acceptance among men.[3]

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[1] Ibid.

[2] Paul Elmer More, The Drift of Romanticism, Shelburne Essays, Eighth Series (New York, 1913), p. 241.

[3] Emile Legouis and Louis Cazamian, A History of English Literature, 2 vols., Vol. II, Modern Times, Louis Cazamian, (London, 1927), 344.

Perhaps the best overall evaluation of Huxley as a spokesman for science in education is given by his grandson, Julian Huxley, who states that the whole range of our educational system shows the influence of Huxley's work in the field:

> In purely scientific education his [Huxley's] insistence upon practical work led to the establishment of the first true laboratory of biology in 1871, and his methods, combined with an immense personal influence on his pupils, left a lasting impress on biological teaching. His interest in education, however, was far from being confined to his own special subject. His work on the London School Board, as a Governor of Eton, as a member of several Royal Commissions, and in many essays and addresses, helped to give natural science its due place in general education, while at the same time he fought against any narrowness or pedantry on the part of science as emphatically and vigorously as against the narrowness and pedantry of traditional studies. The whole range of our educational system, from the elementary school to the university, bears the mark of Huxley's work in the field.[1]

Julian Huxley also points out that the educational interests of Thomas Huxley were not confined to the academic or the formal. Instead, his skill as a writer led him to undertake scientific journalism and popular lecturing. His lectures to working men were outstanding examples of what such lectures should be. The one that is perhaps the best known of these, "On a Piece of Chalk," remains as a literary classic,

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[1] T. H. Huxley's Diary of the Voyage of the H.M.S. Rattlesnake, edited by Julian Huxley (Garden City, 1936), pp. 4-5.

a model of lucid, vigorous English, and figured prominently in Huxley's efforts in the field of adult education.[1]

In spite of such occasional general mention of Huxley's work as an educator, much remains to be said about his interest and accomplishments in this field, especially in his role as champion of scientific training in education. This study proposes to reveal in a more detailed manner, the little-known Huxley, the spokesman for science education for the student and the layman.

3. Status of Science in Education in 1850's

In the middle of the nineteenth century, science education needed help greatly; in fact, the entire system of English education at the time of Huxley's advent required revision and improvement. Perhaps one of the clearest pictures of the deplorable condition of education is given by the report of the Newcastle Commission of 1858. This group found that only one in every eight of the population had been at some time in some school; of two and one-half millions who ought to have been at school at the date of the investigation, only 1,675,000 were in public schools of any sort; of the pupils in public schools, only one-half were in schools

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[1] Ibid., p. 5.

receiving any grant, or under any kind of inspection;[1] attendance was only three-fourths of those on the books; assisted schools numbered 6,897 with 917,255 scholars; while 15,750 denominational schools, and about 317 others, with a total of 691,393 scholars, were outside the range of the education department; of the pupils in inspected schools not more than one-fourth were receiving a good education, the instruction given being too much adapted to the elder scholars, to the neglect of the younger ones. The Commission asserted further that inspected schools were superior to the uninspected, that only about one-fourth of the scholars in inspected schools reached the highest class, that teachers were neglecting the younger scholars in the three "R's" and that the religious and moral influence of the public schools was very great. This report preceded the revised code (1861) of Mr. Lowe, Vice-President of the Committee of Council, the code that recommended "payment by results" of examinations for the sake of economy.

Concerning the curriculum, the Report stated that in some of the schools the class work was confined to religious

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[1]Further investigation reveals that, two years prior to the Newcastle Report, of the two million children who were then at school, few more than 500,000 between five and fifteen were subject to inspection. There were nearly eight thousand Church of England head teachers making not more than £28 a year, while there were seven hundred dame school teachers who could not write. Children left school in two out of three cases before nine years of age and forgot all they knew (J. E. G. de Montmorency, The Progress of Education in England [London, 1904], pp. 93-95).

instruction and reading; that fewer than four-fifths of the scholars were taught to write and "to sum," and, in the case of girls, to do needlework; that less than two-fifths learned geography, grammar and history; that only a few were studying drawing, music from notes, and the elements of physical science; and that only a small number of boys studied mathematics beyond the level of arithmetic.[1]

Further light is thrown upon the unsatisfactory status of education in the 1850's by the Reports of Matthew Arnold, who was one of Her Majesty's Inspectors of Schools from 1851 until 1886, a period of thirty-five years. During this time Arnold made three trips to the continent at the request of the Royal Commissions of Enquiry that were interested in improving English education by employing the best practices used on the continent, and some of his conclusions were the result of comparisons between what he saw in continental schools and what was going on in England.[2]

Arnold asserts that young men, whose knowledge of grammar, geography, history and mathematics was surprising, often could not paraphrase a plain passage of prose or poetry with understanding. The students' lack of fundamental training was partly traceable to the lack of infant schools in the

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[1]Final Report of the Commissioners Appointed to Inquire into the Elementary Education Acts, England and Wales, IV (London, 1883), 13.

[2]Matthew Arnold, Reports on Elementary Schools 1852-1882, ed. Francis Sandford (London, 1889), p. 19.

state educational system. This lack of facilities for giving the pupils a good foundation, along with the various other shortcomings of the school system, combined to produce poor and mediocre students. Arnold points out that the role that denominational schools played may be partly realized by reflecting upon the stipulation that held true until passage of the Act of 1870 to the effect that every school was required either to be operated in connection with some religious denomination, or, if undenominational, was required to have the scriptures read daily. In such a situation there is no small wonder that the students did not measure up in their studies.

Despite the interest of so many groups in education, Arnold contends that the reason children of the masses were not being educated was that the rising middle class parents were willing to pay a higher rate for their children than the poor parents could afford to pay, thus causing many of the children of the latter to drop out of school. Their attendance became so irregular that Arnold expressed the conviction that education would never become widespread in the British Isles until made compulsory. Textbooks constituted another problem in that there were so many different ones on the same subject. Arnold argued that this diversity was harmful to the student and suggested that the nexts should be uniformly adopted, and that the many educational societies that had their own books should cooperate. Instruction in

the basic elementary subjects of reading, writing, and arithmetic should be improved by this change. Writing in 1856, Arnold makes further explanations of various difficulties in education by revealing that there was no one body or system in charge of it at that time. Everything depended on special local circumstances, which continually were changing, and on unpredictable individual agencies. This uncertainty of affairs made the problem of school finance very difficult to solve.

For example, the country schools were suffering because of inadequate funds with which to carry on their work. Although the people in the poor communities in which these schools were located had voted for local rates and management, they found that it was well nigh impossible to impose a sufficiently high rate to enable them to get a government supplement[1] ample for the support of an acceptable educational program. They complained that the wealthy city districts that needed help the least, received more government aid because of their ability to levy a higher local rate. The poor districts, in addition to having difficulty in paying the salaries of teachers, found it almost impossible to secure decent

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[1]The Revised Code limited the amount of the annual state grant so that no grant should exceed the amount contributed locally in the form of subscriptions, school fees, and income derived from sources other than the parliamentary grant, including rates and endowments. This meant that the poorer communities operated schools on a minimum per capita expenditure basis for pupils while the prosperous communities had at their disposal a much higher per capita expenditure potential for theirs. This, of course, made for obvious inequities in educational facilities (ibid., p. 29).

school buildings, and were put to it to maintain them properly.[1] Such was the state of education when Huxley came upon the scene.

But if the situation with regard to education in general was regrettable, the status of science was even worse. There was practically no general knowledge of science and hardly any provision for teaching it. Even in the universities, there were in all the British Isles less than a dozen professorships of science apart from special branches of medicine; even in the Scottish universities there were one or two chairs of "Natural and Civil History," the occupiers of which were supposed to give instruction in half a dozen sciences. There was no scientific teaching in the public schools; and there were hardly any good textbooks available for science students, especially beginners.[2] Unquestionably there was need for a champion of the cause of science. Thomas Henry Huxley was this champion.[3]

4. Huxley: Spokesman for Science Education

Although Huxley was interested in general education and in all the subjects it embraced, he was primarily concerned with science and consequently felt especially impelled to

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[1] Ibid., pp. 28, 47-48.

[2] Mitchell, op. cit., p. 167.

[3] John William Adamson, English Education, 1789-1902 (Cambridge, 1930), p. 391. See also: Oliver Elton, Survey of English Literature, 1830-1880, 2 vols., I (London, 1920), 79-80.

make the facts in this field available to both the scholar and the general public. The tremendous pressure exerted by new ideas, inventions, and scientific discoveries made Huxley realize that the people must come abreast of the times.

Accordingly, Huxley launched an attack upon what he considered an outmoded curriculum that was still emphasizing classical learning and virtually ignoring the scientific studies. Huxley charges that the studies in the English schools are so antiquated that the pupils of ancient Rome, for example, studied nearly the same subjects and learned almost the same things as the students of Victorian England. He contends that this type of training does not allow for the great changes that have taken place through the years, and that the classics alone are inadequate, inasmuch as through exclusive attention to them the schools are ignoring the whole field of the physical universe. This situation, avers Huxley, should not be allowed to continue, since modern civilization is based upon physical science and modern thought is steeped in it.[1] He points out that science must be in the curriculum in order for students to be able to understand the changes that are taking place about them. He accuses those in authority of allowing the plan of education to disregard everyday scientific knowledge, thereby making it inevitable that pupils with classical training alone face life insufficiently equipped for the struggle for survival in an

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[1]Thomas Henry Huxley, Collected Essays, 9 vols. (New York, 1894-1897), "The Study of Zoology," VIII, 226.

increasingly science-conscious world. Yet, contends Huxley, the schools have continued to ignore science:

> But of all this your old stereotyped system of education takes no note. Physical science, its methods, its problems, and its difficulties, will meet the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery; and we turn out our children to do battle in it, equipped with the shield and sword of an ancient gladiator.
>
> Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.[1]

Huxley's constant protest against the neglect of science in education was expressive of the general discontent of the men of science of his time, who regarded this inattention as a failure to make use of both a great educational instrument and a powerful aid to the country's industrial progress. Collectively and individually they had done their best to compensate for the deficiencies in the schools and universities and to arouse the country to the serious consequences of neglect.[2] The conviction was that the older learning was now inadequate in the changed and ever-changing conditions of the time; and that vast new fields of knowledge, revealed by the greater study of nature, should be included in any scheme of

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[1] Ibid., p. 230.

[2] Adamson, op. cit., p. 391.

instruction that was intended to prepare men for the struggle of modern life.[1]

Indeed, Huxley looked with alarm upon the neglect of science and determined within himself to dedicate his life and efforts to its promotion, especially in education, regardless of various types of opposition that might be encountered while so doing. He planned to campaign for science, especially in its relation to everyday life, and to improve the condition of his fellow man by the insistence upon a constructive program of action. He resolved to work unselfishly for the promotion of science education for the masses and the students, ever reckoning with theological dogmatism, a long-time adversary of science. In his autobiography Huxley clearly expresses his aims and objectives. It was his purpose, he says:

> To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life in the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.[2]

Then he goes on to say:

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[1]Archibald Geike, "Science in Education," Nature, LIX (December, 1898), 108.

[2]"Autobiography," Essays, I, 16.

> It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame which I may have permitted myself to entertain to other ends; to the popularisation of science; to the development and organisation of scientific education; to the endless series of battles and skirmishes over evolution; and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science.[1]

Here Huxley declares that he actually places his interest in disseminating a knowledge of science through education above his own ambition for fame as a scientist. And he adds that he is fully aware of the opposition that the forces of theological dogmatism will offer his program of science training. Yet, he never turned back.

Instead, Huxley quietly forwarded his plans for science education by successfully running for election to the London School Board in 1870. And, although he held this position for only fourteen months, through hard work and perseverance, he managed to gain more recognition for science training than the conservative educators of the day thought possible. One of Huxley's former pupils, Michael Foster, who later became his assistant, comments upon this phase of Huxley's career, pointing out that, although Huxley was deeply engaged upon his own scientific pursuits, he was nevertheless willing to give of his time and energy to a task which he regarded as a public good. In this connection Foster makes the following assertion:

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[1] Ibid., pp. 16-17.

> Nothing perhaps, in his whole career is more striking than his coming out in 1870 from the tent of the Professor to take his part in the popular battles of the London School Board. Never, perhaps, was he busier than he was at this time; his hands were full of scientific research and scientific teaching; they were full with scientific administration. Yet he knew that he had something to say about the teaching of the people; he refused to keep for the sect of science that which he felt was meant for mankind, and came forward to take his part in what he believed to be a task of great moment.[1]

The Education Act of 1870 by which the London School Board was created had been opposed strongly before it finally became law. Such opposition came from people whom Huxley considered the enemies of all types of progressive legislation. He charges that they condemned all attempts that were made to spread knowledge by the establishment of teaching bodies, examining bodies, libraries, and museums; and they obstructed all endeavors that were initiated to advance art by the establishment of schools of design and picture galleries.[2] Yet despite this militant Philistinism that was stubbornly nurtured by many of his countrymen, Huxley became more determined than ever to ameliorate the deplorable condition of science education.

Huxley's ideas about helping to better the general situation were simple and practical. He suggested improving the science textbooks, and advocated the teaching of the three

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[1]Michael Foster, "Huxley," Huxley Memorial Lectures, ed. Oliver Lodge (Birmingham, 1914), p. 21.

[2]"Administrative Nihilism," Essays, I, 258.

R's, drawing modeling, elementary science, Bible, at least two foreign languages, physical training, domestic science, and both English literature and classical studies. Further, Huxley pointed out that regular training centers for science teachers ought to be set up, that these teachers should be instructed to show their pupils the relationship between theoretical and practical science, and that more museums, which he considered invaluable educational aids, should be established and properly maintained. Finally, Huxley would solicit permanent aid from state and local government and from private organizations for the support of an adequate science education program for student and layman alike.

After conceiving these ideas for improving the educational picture, Huxley proceeded to find ways and means of making these ideas become realities. Putting precept into practice, he taught science, wrote science textbooks, popularized the use of the laboratory as an instructional aid, organized teacher-training centers for science instructors, promoted a program of technical education, and utilized more fully than others before him the museum as an aid to teaching. During his tenure as a member of the Royal Commission on Scientific Instruction and of the London School Board, Huxley recommended successfully a representative number of science courses for the classics-dominated curriculum. While serving as an examiner in science for the Science and Art Department, he made similar suggestions with like results. And Huxley

persuaded the City and Guilds Institute to give financial support to a much-needed program of technical education. It must be added, however, that perhaps Huxley's most effective agents for making his apathetic countrymen actively conscious of the growing necessity for scientific training were his lecturing and his writing. These two potent mediums enabled him to orientate the English people to the important relationship existing between science and everyday life while he was attempting to inaugurate a concrete program of science education for both students and laymen.

Of course Huxley realized that even the beginning of such a program would prove very costly, and its growth would mean a corresponding rise in the program's operating expenses. And, although public and private agencies did give some assistance to scientific education, this aid was still quite inadequate. Too often, because of political maneuvering, the small support that was given for science education went to those wealthy communities that really did not need it. Huxley contends that, regardless of the objections of some people concerning state assistance to the advancement of science, he would consider help from this source indispensable and justifiable because voluntary aid could not be depended upon entirely. He points out that he has never heard any valid reason as to why the state could not do what voluntary efforts had failed to accomplish. Such help could not be considered harmful because every country in Continental Europe had

established universities, public libraries, art galleries, museums, and laboratories within its borders.[1] Further, argues Huxley, the state should also give assistance to promising students so that they might be able to advance in science study just as far as their ability would permit. This would be a worthwhile investment for the state; in fact, it would be worth any money to give financial assistance to the poor but promising young scholar and thereby help him to become an asset to science and the state. The beginning of such a plan had already been made with the offering of scholarships, but Huxley believed that this scheme must be expanded and improved in order to assist all capable students.[2]

Huxley attributed much of the laxity on the part of the state in relation to education in science to negligent and short-sighted officials. He lashes out at these men, holding that there really is no "true state"; instead, it is a composite of many who are ignorant and foolish, some who are knaves, and a few who are honest, with the last in but partial control:

> What do we see, in fact, is that States are made up of a considerable number of the ignorant and foolish, a small proportion of genuine knaves, and a sprinkling of capable and honest men, by whose efforts the former are kept in a reasonable state of guidance, and the latter of repression.[3]

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[1] Ibid., pp. 285-6.

[2] "The Struggle for Existence in Human Society," Essays, IX, 234.

[3] "Administrative Nihilism," Essays, I, 279.

Although realizing that science still had much further to go in order to be considered as having won full recognition in English education, Huxley tries to be generous in his remarks about the strides made by science since 1837. He considers this progress as discernible but not remarkable, even though it was made against strong opposition. He drives home the idea that was the key to his unceasing fight for science: namely, that science is part and parcel of everyday life, and should be available to everybody. He does not neglect to reveal that the universities were more reluctant than other schools to change from emphasis upon the humanities to emphasis on science and its methods,[1] though one would ordinarily expect the former to be leaders in such a move.

5. Divisions of Study

The divisions of this study are designed to reveal to their best advantage Huxley's efforts in behalf of science education in England. The first chapter, after stating the case of science in mid-nineteenth century England, indicates Huxley's resolve to bring this neglected subject into the realm of recognition both in the school and in the everyday life of the people. The next chapter discusses Huxley's efforts toward making scientific knowledge available to the

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[1] "On the Progress of Science," Essays, I, 42-129.

masses of English people who were not undergoing formal training in the schools. It tells of his lectures to the workingmen of various occupations, bringing them useful information about their work and their surroundings, and of his efforts to bring to them and to the public in general the benefits of the museum as a great practical educational medium.

The third chapter shows Huxley advocating and demonstrating the combination of the lecture, the laboratory, and the examination as an effective means for instruction in science. This chapter also records Huxley's service in initiating a teacher-training program for science instructors and in working for an expansion of this program. It records, too, Huxley's contribution as an author of textbooks, when, recognizing the need for appropriate science texts, he promptly writes some to fill the need.

Huxley's work in securing parity for science in the curriculum is treated in the fourth chapter. Connected with this endeavor is his controversy with Matthew Arnold concerning the relative educational value of science and the humanities, and with William Gladstone relative to religious instruction and dogmatic theology.

While working for increased technical education (Chapter V), Huxley warns England of the great need for such training for the benefit of the worker and for the nation's industrial and commercial survival that was openly despaired of

because of the competition from other countries.

Huxley's efforts were fruitful (Chapter VI). By the end of the century science had won much-begrudged recognition; the state was assuming a greater part of the financial responsibility of science instruction; normal schools and other training centers had been established for teachers; and science was gradually recognized as being part and parcel of everyday life. Huxley's advice and warnings, though long ignored by the English, were finally heeded by foe as well as friend.

This study, then, is an attempt (1) to show how Huxley served as a spokesman for science in the schools and for the masses; (2) to point out his method of making clear the relation of science to everyday life; (3) to describe his efforts to convince England of the necessity of technical education to industrial and commercial survival, and (4) to estimate the value of his efforts to gain recognition for science in English education and to make scientific knowledge available to the general public.

CHAPTER II

HUXLEY AND SCIENCE FOR THE MASSES

1. Lectures to Laymen (Workingmen)

Huxley was deeply interested in scientific education in the schools, but he was also a believer in spreading scientific knowledge beyond the confines of the classroom or laboratory to the people in general. A contemporary, Michael Foster, words it this way:

> From the very first, Huxley had felt it as a duty laid upon him to expound by mouth and by pen the teachings of science in general, and of biological science in particular, to that large part of the world which lay outside science, knowing little of it and caring less for it; for there came to him very early the conviction that science was not the study of the few, for the sake of the intellectual gratification of the pursuit or the material benefits of the applications, but a thing to be known and, so far as may be, understood of all men as a sure guide for human life. It was this conviction which led him to devote much time and care to more or less popular lectures and addresses, inculcating the broad uses and value of science . . . .[1]

Here Foster expresses Huxley's interest in bringing science education to the masses and relating it to everyday life.

Huxley's interest in and work with laymen began before 1855, but it was in this year that he initiated his regular course of lectures to workingmen. Through these lectures he

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[1]Michael Foster, "Thomas Henry Huxley," Proceedings of the Royal Society of London, LIX (1895-96), lvi.

did much to disseminate a knowledge of biological science among lay audiences, and at the same time he succeeded in arousing widespread interest in his subject.[1] Huxley took his audiences seriously and they in turn held him in high esteem. Part of the great influence that Huxley wielded over the thought of his time was evidently due to his conviction that even for a man of his intellectual stature it was quite proper to place before a workingman audience some of the most profound truths of science in the simplest terms. Huxley had genuine faith in education as an instrument of good to the many, which explains why, as Foster puts it, "early in life he began to put his shoulder to the wheel in the great task of educating the people, of teaching the great public of all sorts and conditions, high and low, rich and poor, the main truths which in his opinion ought to guide them in the conduct of life"[2] as it really is.

Huxley's early contact with the grim realities of the social problems of his day gave him authority to be heard upon the educational questions in which he became more interested as the years passed. Much of his interest in and sympathy with the common man may be attributed to the experiences he had while working under Dr. Chandler, his brother-in-law, who

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[1]Many people who could not attend Huxley's lectures were able to read his discourses in such magazines as Nature, Saturday Review, and Nineteenth Century.

[2]Michael Foster, op. cit., p. 28.

had a medical practice in the poverty-ridden dock area of East London. Here he saw filth, squalor, and slow starvation all within hearing of the wealth and plenty of the city:

> This early contact with the sternest facts of the social problem impressed him profoundly. And though not actively employed in what is generally called "philanthropy," still he did his part, hopefully but soberly, not only to throw light on the true issues and to strip away make-believe from them, but also to bring knowledge to the working classes, and to institute machinery by which capacity should be caught and led to a position where it might be useful instead of dangerous to social order.[1]

Before and during the time of Huxley's lectures to them, the workingmen did not sit idly by without any action on their own part to obtain much-needed scientific instruction; instead, they openly contended that scientific training was needed by them both as men and as workingmen because they realized, as did Huxley, that science was a part of everyday life and living. This is revealed by the following experience recounted by Huxley in "Scientific Education: Notes on an After-dinner Speech" (1869):

> Only the other day, it was my duty to take part in the reception of a deputation of London workingmen, who desired to learn from Sir Roderick Murchison, the Director of the Royal School of Mines, whether the organization of the institution on Jermyn Street could be made available for the supply of that scientific instruction the need of which could not have been apprehended, or stated, more clearly than it was by them.[2]

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[1] Life and Letters of Thomas Henry Huxley, 2 vols., ed. Leonard Huxley (New York, 1901), I, 17-18.

[2] Thomas Henry Huxley, "Scientific Education: Notes on an After-dinner Speech," Collected Essays, 9 vols. (New York, 1894-1897), III, 112.

These workingmen began to realize more fully the values of such instruction because a man like Huxley was putting everything into an effort to make these values clear, much to the benefit of his audience.

In after years a Professor Howes asked Huxley about the desirability of discontinuing lectures to workingmen on Jermyn Street, since the establishing of workingmen's colleges and institutes was considered by some to have made further lectures unnecessary. Huxley indignantly rejected this idea, insisting that with their central location and facilities they should regard it as an obligation to continue to give the lectures that workmen could not very well get elsewhere.[1]

In order that Huxley's interest in making the general public familiar with the fundamental facts about science might be of value, especially as it related to everyday life and living, this interest had to be translated into action of some sort. This action took several forms. Huxley lectured to the laymen, and at the same time published his speeches so that many who could not attend his lectures might read them, and that the subtle and obvious criticism of apathetic authorities who could but would not help in the training of the laymen might be seen in its true colors. He also campaigned for more and better-planned museums for the purpose of acquainting the public with fundamental scientific

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[1] Letters, II, 438.

information. Huxley's lectures and his efforts toward establishing and improving museums were the result of his interest in the workingmen: interest that he translated into action.

Huxley's determination to help spread scientific knowledge was such that he was willing to pay the price of mastering the, to him, distasteful art of public speaking. Prior to his lectures to the workingmen, Huxley had gone through at least one baptism of fire as a speaker when he addressed an exclusive group of intellectuals at the Royal Institution in 1852. In his autobiography Huxley supplies this critical comment on his early speech-making and on this lecture in particular: " . . . I disliked public speaking, and had a firm conviction that I should break down every time I opened my mouth. I believe I had every fault a speaker could have (except talking at random or indulging in rhetoric), when I spoke to the first important audience I ever addressed, on a Friday evening at the Royal Institution, in 1852."[1] Writing to his sister about this 1852 lecture, he reveals how frightened he was at first and how he gradually grew confident:

> It was the first lecture I had ever given in my life, and to what is considered the best audience in London. As nothing ever works up my energies but a high flight, I had chosen a very difficult abstract point, in my view of which I stand almost alone. When I took a glimpse into the theatre and saw it full of faces, I did feel most amazingly uncomfortable. I can now quite understand what it is to be going to be hanged, and nothing but the necessity of the case prevented me from running away.

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[1] Ibid., I, 15.

> However, when the hour struck, in I marched, and began to deliver my discourse. For ten minutes I did not quite know where I was, but by degrees I got used to it, and gradually gained perfect command of myself and my subject. I believe I contrived to interest my audience, and upon the whole I think I may say that this essay was successful.
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> Thank heaven I can say so, for though it is no great matter succeeding, failing would have been a bitter annoyance to me. It has put me comfortably at my ease with regard to all future lecturings. After the Royal Institution there is no audience I shall fear.[1]

In this account, Huxley reveals a keen sense of humor, an indispensable attribute of a good speaker. In this same vein, with irony added, he laments the fact that when he was a child his nurse closed the window to shut out a swarm of bees that might have settled upon his lips and thereby endowed him with that flowing eloquence which, in England, led more surely than "worth, capacity, or honest work," to the highest positions in church and state. Huxley, however, points out that the opportunity was lost and he had to content himself with saying what he meant in very plain language, a habit most "ruinous to a man's prospects of advancement."[2] But Huxley realized that he had overcome the bugbear of public speaking, and took pains to have more compassion for his future "unfortunate audiences."

Huxley's first course of lectures to workingmen was delivered at the Jermyn Street Museum. In spite of his modesty about his ability as a speaker, Huxley's lectures

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[1] Ibid., pp. 106-7.

[2] Essays, I, 3.

there in 1855 were considered by many to be masterpieces of lay instruction. Perhaps it was his profound interest in the workingmen that made him do so well with them. Relative to some lectures he was about to give, he writes:

> I want the working classes to understand that Science and her ways are great facts for them--that physical virtue is the base of all other, and that they are to be clean and temperate and all the rest--not because fellows in black with white ties tell them so, but because these are plain and patent laws of nature which they must obey "under penalties."
>
> I am sick of these dilletante middle class, and mean to try what I can do with these hard-handled fellows who live among facts.[1]

Huxley's son, Leonard, writes that the lectures and addresses to the public were regularly "thronged by crowds of attentive listeners," thus indicating that the program was well accepted by the people, though we fear that some did not comprehend what was being presented.[2] The attendance at these courses of evening lectures on science which were especially addressed

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[1] Letters, I, 149.

[2] Ibid., II, 440. In a moment of humorous reminiscing, Huxley relates to his friend and fellow scientist, Sir William Flower, an incident that showed that some listeners at lectures did not understand fully what was being discussed: "Huxley told me that on one occasion, after a lecture on the 'Nervous System,' a lady came to the table and said, 'I am so much obliged for your charming lecture; so very interesting and so clear. But there was one point I did not quite understand!' 'Thank you, madam, I shall be very pleased if I can explain to you any point I may have insufficiently expressed.' 'Well, Professor Huxley, what I want to ask is about what you called the cerebellum. I did not quite gather whether it is inside the skull or outside'" (St. George Mivart, "Some Reminiscences of Thomas Henry Huxley," Nineteenth Century, XLIII (December, 1897), 988).

to artizans was good enough to make Huxley have undying faith in the program.

First of all, Huxley realized that the ability to reason well was indispensable to the scientist, and a great aid to those who were merely interested in science. Huxley therefore assumed the obligation of teaching the public something of the fundamentals of reasoning as they might be observed in application of the principles of the inductive process. In order to make his point easy for the workingmen to understand, Huxley tells the story of Zadig.

Zadig, a Babylonian philosopher, was nearly convicted as a thief and sorcerer because of his uncanny ability to make accurate inductions from evidence which was left behind by the Queen's missing spaniel and the King's missing horse. These animals were presumed to have been stolen by Zadig because he gave the royal searching party a detailed description of the dog and horse but denied having ever seen them. This was too much for the searchers, so they took him before the high court and he was sentenced to be flogged and sent to Siberia. At this juncture the lost spaniel and horse were found, but Zadig was fined for "saying he had seen that which he had not seen."

Explaining what had happened, Zadig related that he noticed the tracks of an animal in the sand and could tell they were those of a small dog. Long, faint streaks upon little elevations of sand between the footmarks convinced him

that it was a dog with pendent dugs, showing that she must have had puppies recently. Other scrapings on the sand, close to the marks of the forepaws, indicated she had long ears; and, as the print of one foot was always fainter than those of the other three, he judged that the dog was a little lame.

As for his ability to describe the horse so accurately without having seen him, Zadig said that he had noticed equidistant horse-shoemarks, which led him to conclude that the horse was a famous galloper. Zadig asserted that in an alley, the dust upon the tree trunks was disturbed at three feet and a half from the middle of the path. This literally informed him that the horse's tail was three feet and a half long. Leaves that had been brushed from overhead branches five feet above the path told him the height of the horse. Gold markings on a stone from the bit and silver markings on the pebbles from the shoes thoroughly convinced him that they were made by the king's horse.

Zadig was freed, although many thought he should have been burned as a sorcerer.[1]

Huxley points out that such reasoning as that by Zadig is the foundation of all historical or palaetiological sciences, such as archaeology, geology, and paleontology. And he adds:

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[1]"On the Method of Zadig," Essays, IV, 1-12.

> The whole fabric of paleontology falls to the ground unless we admit the validity of Zadig's great principle, that like effects imply like causes, and that the process of reasoning from a shell, or a tooth, or a bone, to the nature of the animal to which it belonged, rests absolutely on the assumption that the likeness of this shell, or tooth, or bone, to that of some animal with which we are already acquainted, is such that we are justified in inferring a corresponding degree of likeness in the rest of the two organisms. It is on this . . . principle . . . that so-called restorations of the paleontologist are based.[1]

Huxley assures his listeners that inductive reasoning may be used by laymen--as well as by scientists--in everyday life, and should never be thought of as the restricted property of any particular group.

2. Huxley, the Defender of Liberal Thought

For the purpose of this study, a brief examination of a few selected essays will suffice to furnish an idea of the types of scientific knowledge Huxley imparted to the laymen. The first of these will relate to the theory of evolution.

In his lectures to the artizans Huxley was active in guiding and stimulating the growing tendency to tolerate or accept views that were set forth in Darwin's Origin of Species. The series of lectures to workingmen given at the School of Mines in November, 1862, was in this vein. They were printed in 1863 under the title Our Knowledge of the Causes of the Phenomena of Organic Nature.[2] This stand for

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[1] Ibid., pp. 13-14.

[2] Life and Letters of Charles Darwin, 2 vols., ed. by Francis Darwin (New York, 1887), II, 187.

the theory of evolution formed the beginning of a long friendship between Darwin and Huxley; but it brought down the wrath of churchmen and ecclesiastically minded persons upon the hapless head of the latter.

Huxley contends that man's main problem is discovering his place in nature, and his relation to his surroundings; his origin, his powers, and his destiny. Discussing man's relations to the lower animals, he asserts:

> The question of questions for mankind--the problem which underlies all others, and is more deeply interesting than any other--is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things. Whence our race has come; what are the limits of our power over nature, and of nature's power over us; to what goal are we tending; [what] are the problems which present themselves anew and with undiminished interest to every man born into the world.[1]

Huxley points out that many people have ignored these questions for fear of running counter to tradition. Some half-answers had been given but he contends that they had held up for only a short period of time because they were not thoroughgoing and scientific. Although he was conscious of the fact that he was courting censure from theologians and "people of piety," Huxley spoke frankly because he believed that the theory of origin as advanced by Darwin was based upon scientific truth but that which was presented in Genesis was not; hence the latter concept was of no real value.

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[1]"On the Relation of Man to the Lower Animals," Essays, VII, 77-78.

In the same lecture series Huxley discusses man's similarity to the lower animals. After showing how the ovum of the human, the ape, and the dog develop much alike during incubation, he points out that man is identical in early stages of his formation, and in mode of nutrition before and after birth, with animals immediately below him in the scale. Even the adult structure of man resembles closely that of the ape and dog. "He resembles them as they resemble one another--he differs from them as they differ from one another."[1] Huxley here attempts to give the layman some fundamental scientific facts that will help him to understand the reasoning behind the theory of evolution. He advises the people to recognize the fact that it is necessary to improve natural knowledge, regardless of tradition and authority. Otherwise scientific progress would be meaningless because of failure to relate science to the problems of everyday life.

In addition to speaking about evolution, Huxley discusses various facts pertaining to nature, explaining how various changes take place--changes that perhaps are overlooked by many. He discusses the cycle through which matter passes from the organic to the inorganic, and back to the organic. Beginning this cycle with the plant, he states that it would make inorganic materials into its own substance, be eaten by the animal that would appropriate some of the nutritious matter to its own growth and get rid of the useless

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[1] Essays, VII, 92-93.

matter; and, finally, the animal would die, its body would become decomposed and be returned to the inorganic world. Huxley follows this by adding that "the materials of which our bodies are composed are largely, in all probability, the substances which constituted the matter of long extinct creations, but which have in the interval constituted a part of the inorganic world."[1] Such a revelation was unheard of outside the small world of the men of science, but Huxley made it seem fairly simple to the workingmen who were quite familiar with the basic processes mentioned, but had never placed such a far-reaching interpretation upon these everyday facts.

In an effort to inform the laymen about the abundance of scientific knowledge to be found in their immediate surroundings, Huxley relates the story of chalk. He begins his discourse "On a Piece of Chalk" by stating that if a digger (one of the audience, maybe), would sink a well there in Norwich, or anywhere in the county for that matter, he would soon run into chalk:

> If a well were sunk at our feet in the midst of the city of Norwich, the diggers would very soon find themselves at work in that white substance almost too soft to be called rock, with which we are all familiar as "chalk."[2]

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[1]"The Causes of the Phenomena of Organic Nature," Essays, II, 315-16.

[2]Essays, VIII, 1.

Huxley refers to the chalk of the ordinary workman, a commonplace about which everybody knows: "the bit of chalk which every carpenter carries about in his breeches-pocket." He contends that the language of chalk is easier to learn than Latin; he is convinced of the importance of learning the former language because a "chapter of the history of the world" was "written in chalk."[1] Continuing his lecture, Huxley declares that chalk is only a compound of carbonic acid gas and if burned will produce quicklime; hence chalk is nothing but carbonic acid and quicklime. A slice of chalk upon examination, says Huxley, will reveal the presence of chambered bodies called Globigerina, an organic composition, formed by tiny creatures found only on the ocean bed. These tiny creatures formed the Globigerina by separating a small amount of carbonate of lime from sea water. Pointing out that carbonate of lime covers most of the central plain of the ocean bed, Huxley states that chalk represents an ancient sea bottom, which means that England was once a seabottom. The fact that huge reptiles once lived in the sea is revealed by the presence of their remains in the chalk under England. Huxley asserts that long ago the ocean bed rose up, soil formed on top of the chalk, forests grew, animals thrived, then the land settled below the sea. Following this, the "upheaved glacier mud" became Norfolk soil and there were

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[1] Ibid., p. 4.

animals again, but not the reindeer and the elephant; instead, there were the wolf and the beaver and some other types. The remains of many animals, says Huxley, indicated that there were no close descendants of many of them.[1]

Concluding his lecture, Huxley expresses the hope that it has been informative and clear:

> If I were to put the bit of chalk with which we started into the hot but obscure flame of burning hydrogen, it would presently shine like the sun. It seems to me that this physical metamorphosis is no false image of what has been the result of subjecting it to a jet of fervent, though nowise brilliant, thought tonight. It has become luminous, and its clear rays, penetrating the abyss of the remote past, have brought within our ken some stages of the evolution of the earth.[2]

He presents these facts about natural phenomena to people who, for the most part, are oblivious of the scientific implications of their surroundings. This lecture enabled the audience to see beyond the chalk and lime found in the white cliffs of Dover and elsewhere; they learned that chalk is an authentic chronicle of ages past.

In speaking further concerning the origin and use of knowledge, Huxley points out that the basic facts of natural phenomena became known to primitive man when he observed his own physical makeup; when he became aware of the practical geometry of distance, the effect of gravity, the relation of heat and light to the sun, the effect of fire on wood, the

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[1] Ibid., pp. 4-31.

[2] Ibid., p. 36.

growth and death of plants and animals, and the ways of human behavior. Huxley expresses some of these facts in the following passage:

> I cannot but think that the foundations of all knowledge were laid when the reason of man first came face to face with the facts of Nature; when the savage first learned that the fingers of one hand are fewer than those of both; that it is shorter to cross a stream than to head it; that a stone stops where it is unless it be moved, and that it drops from the hand which lets it go; that light and heat come and go with the sun; that sticks burn away in a fire; that plants and animals grow and die; that if he struck his fellow savage a blow he would make him angry, and perhaps get a blow in return, while if he offered him a fruit he would please him, and perhaps receive a fish in exchange. When man had acquired this much knowledge, the outlines, rude though they were, of mathematics, of physics, of chemistry, of biology, of moral, or economical, and political science, were sketched.[1]

Such a presentation of scientific truths tended to make former mysteries of nature become simple, clear facts to the workingmen, who were, through Huxley's efforts, receiving sufficient information over a period of time to become able to begin reasoning about natural phenomena themselves, and to question intelligently many unscientific beliefs and dictates.

Huxley, though often called an irreligious man, gives an excellent example of his religious nature when he next discusses the development of astronomy through man's search for useful natural knowledge. He also shows how this great search always terminates in the dark realms of infinity and

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[1]"On the Improvement of Natural Knowledge," Essays, I, 32.

the unknown, thus demonstrating that there must be some great universal power beyond the ken of man:

> . . . what could seem wiser, from a mere material point of view, more innocent, from a theological one, to an ancient people, than that they should learn the exact succession of the seasons, as warnings for their husbandmen; or the position of the stars, as guides to their rude navigators? But what has grown out of this search for natural knowledge of so merely useful a character? . . . Astronomy, . . . which tells them /men/ that this so vast and seemingly solid earth is but an atom among atoms, whirling, no man knows whither, through illimitable space; which demonstrates that what we call the peaceful heaven above us, is but space, filled by an infinitely subtle matter whose particles are seething and surging, like the waves of an angry sea; which opens up to us infinite regions where nothing is known, or ever seems to have been known, but matter and force, operating according to rigid rules; which leads us to contemplate phenomena the very nature of which demonstrates that they must have had a beginning, and that they must have an end, but the very nature of which also proves that the beginning was, to our conceptions of time, infinitely remote, and that the end is as immeasurably distant.[1]

And Huxley sincerely believes that in man's consciousness of his limitations in understanding the great secret of the universe lies the essence of all religion.[2] And science, far from being antithetical to religious awe, stands in fact as the avenue by which a sense of the spiritual may be reached.

Certainly Huxley's most forceful illustration of the method by which man achieves the spiritual through practical means is the one dealing with man's invention of the practical pump. Without a doubt, the sequence of discoveries

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[1] Ibid., pp. 35-36.

[2] Ibid., p. 33.

emanating from his efforts to perfect it led finally to a mystic infinitude, beyond which man's comprehension could not go. Huxley sums up the discussion thus:

> What more harmless than the attempt to lift and distribute water by pumping it; what more absolutely and grossly utilitarian? Yet out of pumps grew the discussions about Nature's abhorrence of a vacuum; and then it was discovered that Nature does not abhor a vacuum, but that air has weight; and that notion paved the way for the doctrine that all matter has weight, and that the force that produces weight is co-extensive with the universe,--in short, to the theory of universal gravitation and endless force. [And] . . . learning how to handle gases led to the discovery of oxygen, and to modern chemistry, and to the notion of indestructibility of matter.[1]

Huxley believes that at this point man has reached the realms of the mystic infinite beyond which he has no present understanding, and from this point on, his religious nature grows in direct proportion to his perplexity concerning the cosmos. Thus, when man gazes at the lofty mountaintops, the infinite expanse of heavens, and the myriads of stars suspended mysteriously in the blue, his heart becomes glad and his soul is in accord with the wonders of the universe.[2]

These efforts of Huxley's to show the spiritual outcomes of scientific experimentation are quite important. They lay the silly ghost of conflict between science and religion; they establish Huxley's intellectual integrity; they silence the quack claims of zealots that he was an irreligious man;

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[1] Ibid., p. 36.

[2] Ibid., pp. 32-33.

and they constitute some of the finest bits of practical philosophy that one can find.

3. Huxley and the Fishermen

Huxley was practical as well as theoretical in his lectures; he believed that any theory that could not be applied to everyday problems was of little or no use to the average person. His work for fish conservation exemplified this practical side quite forcefully. Being an eminent zoologist and Inspector of Fisheries, he had both the interest and the occasion to deliver a special lecture to the fishermen. His discourse on the herring, delivered April 21, 1881, is referred to by Huxley's son, Leonard, as follows:

> On the 21st (April) he gave an address on the Herring. To describe the characteristics of this fish in the Eastern Counties, he says, might seem like carrying coals to Newcastle; nevertheless the fisherman's knowledge is not the same as that of the man of science, and includes none but the vaguest notions of the ways of life of the fish and the singularities of its organizations which perplexed biologists.[1]

In this helpful address Huxley informed the fishermen about necessary facts relating to their work, and in doing so took occasion to correct various misapprehensions inimical to their best interests. For example: these men thought that fishing would deplete the stock of herring, whereas, in reality the destructive flatfish and codfish were the real menace to the supply of herring; some believed the supply of saltwater

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[1] *Letters*, II, 30.

fish to be inexhaustible because of the limitless expanse of the ocean. These erroneous concepts and many others had to be corrected by Huxley, and this he did with a will deserving of praise.[1]

On another occasion Huxley addressed a group on the conservation of the oyster supply. Speaking on "Oysters and the Oyster Question" (1883) at the Royal Institution he describes the structure of the oyster, tells how it feeds and breeds, and how it is destroyed. Developing this last point he reveals that rays, cod, and starfish are great destroyers and that the worst enemies of the growing oyster are the dogwhelk and whelk tingles. These last mentioned creatures bore through the shell of the oyster, then slowly kill it.

Man, states Huxley, preserves oysters in order to destroy (eat) them later. In gathering oysters, however, the fishermen dredge too much in one bed, or pick up too many at low tide. Here Huxley brings out the fact that it is difficult for oysters to keep abreast of the losses suffered. Oyster culture is resorted to in order to restock the beds. These beds must be carefully chosen because oysters have to be protected from intense heat and cold, predatory fish, muddy water, and strong currents.

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[1]Michael Foster and E. Ray Lankester, The Scientific Memoirs of Thomas Henry Huxley, 4 vols. (London, 1902), IV, 473-92.

Huxley admits that protective measures direct that there be no dredging during May, June, July and August; but in addition to this, he contends one should be required to throw back into the water half-grown oysters when such are caught; and dredging for oysters should be limited in proportion to the estimated number in the bed. If oyster culture is practiced, and beds protected, oysters should increase in number, he adds.

Such information, showing Huxley's practical interest in oysters, proved helpful to both fisherman and consumer. The latter had been complaining about the shortage of this succulent crustacean and the former was confronted with the problem of increasing his haul. Huxley, with his great knowledge of the oyster, was able to make practical suggestions to improve the situation.[1]

4. Museums as Mediums of Science Education

In order to extend scientific knowledge over a broader area, Huxley encouraged the use of the museum by the general public. This, he believed, would enable many people to acquire scientific facts without the help of a teacher and formal instruction.

He began agitating for the proper type of museum for such scientific study as early as 1859. Nine years later he wrote

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[1] Ibid., pp. 572-605.

to the Commissioners of the Manchester Natural History Society, outlining a scheme for a museum that could really serve as a medium of education. In his plan Huxley considers every detail carefully. He urges that: (1) the public exhibition of a collection of specimens be large enough to illustrate the most important truths of natural history, but not so extensive as to make the visitors tired and confused; (2) the collection be easily accessible to the public; (3) specimens not necessary for public exhibition be put in a place apart; (4) all objects contained in the museum be accessible to the curator and to scientific students without interference with the public or by the public; and (5) dust and dirt be thoroughly excluded from the specimens. Huxley also specifies that there should be (6) provision for work rooms, and, if need be, lecture rooms; and a big hall with narrower halls on either side, lighted from the top, with the central hall for the public and the others for the curators and students. Huxley gives exact measurements, the number of cases for types of specimens and makes a request for ample storage space.[1] Huxley is convinced of the importance of museums in the study of biology, but he feels that they can stand much improvement. Expressing his desire for the modernizing of museums, he writes:

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[1] Ibid., pp. 146-47.

> Without doubt there are no helps to the study of Biology, or rather to some branches of it, which are, or may be, more important than natural history museums; but, in order to take this place in regard to Biology, they must be museums of the future. The museums of the present do not, by any means, do so much for us as they might do.[1]

He argues that the museums should be designed with both the public and the scientists in mind, since the former desire easy access to a collection they can understand and appreciate, and the latter want similar access to scientific materials. With this object in view the exhibits should be divided into two sections: one for the public, the other for scientists; and both should be open every day. Such a museum should contain the more important and interesting forms of life. There should be explanatory tablets beneath the various exhibits and clearly written catalogues with additional information about the specimens. Huxley points out that if they are birds, they should be a carefully selected group, artistically set up. In this exhibit birds of different ages should be shown; the nest, the eggs, the young, and the skeleton ought to be set up in the display and legible tablets with explanatory data should be plainly in sight. This collection, thinks Huxley, would be of much "greater value than any many-acred imitation of Noah's Ark."[2]

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[1]"On the Study of Biology," Essays, III, 287.

[2]Essays, III, 288-89.

In 1886 Huxley was still fighting for museums that could be visited by the public. Writing to his friend, Professor Foster, at Cambridge University, he reveals his ideals concerning the public and museums:

> If I had a free hand in Cambridge or anywhere else I should build (A) a Museum, open to the public, and containing three strictly limited and selected collections; one morphologically, one geographically, and one stratigraphically arranged; and (B), a series of annexes arranged for storage and working purposes to contain the material which is of no use to any but specialists. I am convinced that this is the only plan by which the wants of ordinary people can be supplied efficiently . . . .
> . . . . . .
> N.B. --As my meaning seems to have been misunderstood I wish, if you have the chance, you would make it clear that I do not want three brick and mortar museums--but one public museum--containing a threefold collection of typical forms, a biological Trinity in Unity in fact.
> It might conciliate the clerics if you adopted this illustration.[1]

In his lecture to teachers at South Kensington Museum in 1861, Huxley states that people could learn something from the specimens of birds and other exhibits at the British Museum if they were arranged properly. In a note dated 1894 he informs us that the change has been made in the Natural History Museum, a part of the British Museum.[2]

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[1] Letters, II, 140.

[2] "A Lobster; or, The Study of Zoology," Essays, VIII, 231.

Huxley revolutionized thinking about the function[1] and planning of the museum, and was doubtless considered ahead of his time by conservative contemporaries who saw only virtue in the musty and exhibit-strewn museums of the day. This forced him to work hard in order to change the concept of the purpose of the museum from the belief that it was a rendezvous for the fashionable to the belief that it was an educational center for everybody; and he had to change the concept of the plan of the museum from the idea that it should be a bewildering maze of exhibits to one embracing an orderly arrangement and clear explanation of all specimens, as well as the necessary architectural design for such a plan.

That the museums were visited by an ever-increasing number of people during Huxley's time indicates the growing awareness of the importance of the museum as a medium of scientific instruction. During 1869 the museums under the supervision of the Science and Art Department in London, Dublin, and Edinburgh were visited by 1,847,929 persons, as compared with

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[1]In "The Teaching of Biology," a centennial memorial article on Huxley, F. O. Bower reveals that the former had planned to bring simple scientific facts to the attention of the public in a unique manner. He would have taken the pig, for example, and illustrated by well-arranged exhibits in museum cases the manner in which every part of its body is utilized. Some of the products would be: bristles for brushes; the skin for saddle-covers and book-binding; and the rest of the pig for food. This plan shows that Huxley wanted to make "the science of ordinary life real to the general public." (Nature, CXV (May, 1925), 714).

1,798,842 in 1868, an increase of 49,087.[1] At the South Kensington Museum the total number of visitors for 1860 was 610,696; the total for 1870 was 1,014,849, an increase of 404,153 for the ten year period. The number from 1857 to 1870 was 10,071,667,[2] and from 1857 to 1890 was 28,754,746.[3] The South Kensington Museum was founded as a result of Huxley's initial agitation for museum reform twenty years earlier in 1859-60;[4] and many more such centers of science, private, local, or state controlled, were established or reorganized through his efforts.

In lecturing to the laymen and working for the establishment and reorganization of museums for the public, Huxley showed that he was sincerely interested in the workingmen and the general public, despite his being a member of the most exclusive scientific societies of the world. A man who was a member of as many as seventy-five learned societies and ten Royal Commissions at various times would perhaps be expected to lack interest in the "hard-handed fellows who live among facts";[5] but Huxley was just the opposite: he wanted ordinary

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[1] Eighteenth Report of the Science and Art Department of the Committee of Council on Education (London, 1871), p. xxxi.

[2] Ibid., p. 449.

[3] Thirty-eighth Report of the Department of Science and Art of the Committee of Council on Education (London, 1891), p. 325.

[4] Letters, I, 145-46.

[5] "Science and Culture," Essays, III, 144.

people to understand that scientific knowledge was meant for them as well as for others. With the aid of his lectures and the museums he helped the former to obtain this knowledge.

Huxley's program, when thought of in the light of present-day science training, seems rather conservative, but when considered in its Victorian setting, one must admit that his plan was revolutionary. Indeed, it was a definite improvement over few or no lectures at all and ill-planned, disorderly museums for the public, which was the previous status of affairs. In his lectures Huxley sought to bring scientific knowledge to the masses, and he worked diligently to make such knowledge available to them at the various museums.

CHAPTER III

HUXLEY AS A TEACHER

1. The Beginning of Huxley's Teaching Career

In 1854 Huxley officially began his teaching career by accepting the position as lecturer on natural history in the Government School of Mines, a post offered to him by the Director-General of the Geological Survey. He decided, at this time, that he would give up teaching natural history as soon as he could get a post in his favorite study, physiology. He held the job, however, for thirty-one years, although a large part of his work was paleontological.[1] He began with the teaching of those who had entered upon the study of science, but very soon started instructing the many who were interested in the subject in a non-professional manner.

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[1]Thomas Henry Huxley, "Autobiography," Collected Essays, 9 vols., (New York, 1894-1897), I, 15. "Appointed at the age of twenty-nine (1854) Professor of Natural History in the Government School of Mines, Jermyn Street, Huxley at once became a public man as well as a distinguished student and teacher of science. . . ." (John William Adamson, English Education 1789-1902 (Cambridge, 1930), p. 391).

Huxley's position as a spokesman for science in English education was strengthened by his being elected to the London School Board (1870). After fourteen active and fruitful months of service, he resigned because of recurring illness. (Life and Letters of Thomas Henry Huxley, 2 vols., ed. by Leonard Huxley (New York, 1901), I, 363-64).

Huxley gave formal instruction to students and teachers in biology, the idea being to have these courses set up as models to be followed by teachers of the subject in the future. With the aid of his able assistants he worked out teaching plans that became a pattern of biological instruction in England, and assured improved pedagogical procedure for the future. This plan, initiated in the summer of 1871 at South Kensington Museum, was so successful that Huxley began using it at the School of Mines the following year, and thence it spread to other countries.[1]

After his appointment to the School of Mines (1854), Huxley was destined to hold more teaching positions. In 1862 he became a professor at the Royal College of Surgeons; and in 1881 Professor of Biology and Dean of the Royal College of Science, the Royal School of Mines having been just absorbed into what was then called the Normal School.[2]

Huxley did not find teaching the easiest task he had undertaken, but he felt that it offered a distinct challenge that he must accept, if only for experience, despite the various aptitudes possessed by his listeners. Concerning the benefit that he derived from his own lectures, and the different learning abilities of students he says:

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[1]Houston Peterson, Huxley, Prophet of Science (New York, 1932), pp. 187-89.

[2]Edward Clodd, Thomas Henry Huxley (Edinburgh, 1905), pp. xi-xiii, 47.

> . . . my method had this great advantage; it involved the certainty that somebody would profit by my effort to teach properly. Whatever my hearers might do, I myself always learned something by lecturing. And to those who have experience of what a heartbreaking business teaching is--how much the can't-learns and the won't-learns and don't-learns predominate over the do-learns--will understand the comfort of that reflection.[1]

2. Huxley's Teaching Techniques: Lecture Method

The general belief that Huxley understood the basic principles of lecturing is verified by the account of the way he taught by F. O. Bower, a former student and assistant, how to lecture. The writer states that after watching Bower give his first lecture, Huxley gently told him that he must always remember to lecture to the audience and not to the blackboard, demonstrating the proper position to assume while lecturing.[2]

Speaking on the subject of lecturing, Huxley points out the object of this procedure:

> The object of lectures is, in the first place, to awaken the attention and excite the enthusiasm of the student; and this, I am sure, may be effected to a far greater extent by the oral discourse and by the personal influence of a respected teacher than in any other way. Secondly, lectures have the double use of guiding the student to the salient points of a subject, and not merely to that part which takes his fancy. And lastly, lectures afford the student the opportunity

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[1] Essays, VII, vii.

[2] F. O. Bower, "Teaching of Biological Science," Nature, CXV (May, 1925), 713.

> of seeking explanations of those difficulties which will, and indeed ought to, arise in the course of his studies.[1]

He adds that careful notes should be kept by the student because they can grow with the growth of science and will not lag behind as textbooks do. Also, explains Huxley, the teacher should be always ready to help explain statements that tend to puzzle the pupil. Such ideas bore fruit in remarkably effective practice. The great wealth of knowledge gained by constant study and research made Huxley's lectures rich with information that was always up to date; he spoke from a reservoir of fresh, living knowledge and with the certainty and clarity that such knowledge makes possible.

Huxley's plan for the teaching of science was divided into three parts: (1) lecture, (2) laboratory, and (3) examination, each embracing techniques which added to its effectiveness. He followed this pattern religiously and instructed his student-teachers to do likewise. He knew that information gained from the lecture must be verified by experimentation in the laboratory for it to have true significance to the student. He was also convinced that examinations were necessary in order for both the teacher and the student to know how much the latter had learned from the lectures, and from the laboratory. Let us, then, consider the lecture phase of Huxley's teaching, and attempt to ascertain how he employed this method.

[1] "A Lobster; or, The Study of Zoology," Essays, VIII, 220.

To begin with, Huxley was something of a pedagogical disciplinarian. He would tolerate no talking from students during the lectures and demanded that they take notes and pass examinations. Prior to giving twelve weekly lectures to boys and teachers at the London Institution in 1869, he writes the following to a Rev. W. Rogers who had asked him to deliver the lectures:

> All I have to stipulate is that we shall have a clear understanding on the part of the boys and teachers that the discourses are to [be] Lessons and not talkee-talkee lectures. I should like it to be understood that the boys are to take notes and to be examined at the end of the course . . . .
>
> You see my great object is to set going something which can be worked in every school in the country in a thorough and effectual way, and set an example of the manner in which I think this sort of introduction to science ought to be managed.[1]

Thus does Huxley state his serious attitude regarding one of the objectives he plans to achieve as a teacher of science.

Huxley understood the principle of adapting his material to his audience. When lecturing to a group he made allowance for the varying amounts of scientific information represented by his listeners and accordingly attempted to speak in such a way as to make his discourse helpful for all present. In "On the Study of Biology" (1876), he takes cognizance of such a situation, stating that there were many present who would like to know what biology is; that there were others who would know what it is but would want to know why they should study biology; and that there were still others who understood

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[1] Letters, I, 332-33.

these two points but desired to be informed how and when to study it. With the above circumstances in mind, Huxley says: "I shall, therefore, address myself to the endeavor to give you some answer to these four questions--what Biology is; why it should be studied; how it should be studied; and when it should be studied."[1]

After taking precautions to consider the differences in the scientific background of his listeners, Huxley called into service various devices to make his lectures effective. The preparatory step was putting his audience at ease, a practice used to greatest advantage with the laymen. Thus in "Technical Education" (1877) Huxley bridges the gap between the workmen and himself by asserting that he, too, is a handicraftsman and much like them:

> The fact is, I am, and have been, anytime these thirty years, a man who works with his hands--a handicraftsman . . . . I really mean my words to be taken in their direct, literal, and straightforward sense . . . .
>
> In truth, anatomy, which is my handicraft, is one of the most difficult kinds of mechanical labour, involving, as it does, not only lightness and dexterity of hand, but sharp eyes and endless patience.[2]

Huxley tells the workmen that there should be a kinship of interest between them and all scientists who have to use their hands a great deal in their work. Feeling that he has put himself in the same category as the workingmen he says:

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[1] Essays, III, 262, 263.

[2] Ibid., pp. 406-7.

> And now, having, as I hope, justified my assumption of a place among handicraftsmen, and put myself right with you as to my qualification, from practical knowledge to speak about technical education, I will proceed to lay before you the results of my experience as a teacher of handicraft . . . .[1]

On another occasion Huxley puts his audience at ease by using an analogy of the chemist and the baker or butcher: the former a man of science, the latter a workingman. He contends that there is a marked similarity "between the operations and methods of a baker or of a butcher weighing out his goods in common scales, and the operations of a chemist in performing a difficult and complex analysis by means of his balance and finely graduated weights."[2] Throughout his essays Huxley attempts to make the audience feel like participants in the lecture by using the pronoun "we" instead of "I"; in this way he puts himself on the same plane with his listeners.

Next, in order to make his lecture clear and understandable, Huxley used the simple "1, 2, 3" type of outline. For example, in "On the Educational Value of the Natural History Sciences" (1854), he states that the methods of biological sciences are, (1) observation, (2) comparison and classification, and (3) deduction and verification.[3] He again employs the outline in "On the Relations of Man to the

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[1] Ibid., p. 409.

[2] "The Causes of the Phenomena of Organic Nature," Essays, II, 363-64.

[3] Essays, III, 52-53.

Lower Animals" (1863), while discussing the three ways of distinguishing man's foot from his hand, pointing out that the difference may be discerned by noting (1) the arrangement of the tarsal bones, (2) the common feature of a short flexor and a short extensor muscle in the digits of each, and (3) a common muscle, termed peronaeus longus.[1] Here Huxley is attempting to show the similarities and differences between man and the primates, a very popular subject since Darwin's theory of evolution had been propounded. In all of Huxley's essays some type of outline is obvious, and its function--the achievement of clarity--is well demonstrated.

In an effort to be sure that his listeners understood the language he was using, Huxley freely employed the definition of terms as an aid to the comprehension of his scientific lectures. Thus, before launching into the lecture on "Technical Education" (1877) he carefully defines the term thus:

> "Technical education," in the sense in which the term is ordinarily used, and in which I am now employing it, means that sort of education which is specially adapted to the needs of men whose business in life it is to pursue some kind of handicraft; it is, in fact, a fine Greco-Latin equivalent for what in good vernacular English would be called "the teaching of handicrafts."[2]

The use of the technique of definition of terms by Huxley is found in all of his essays, the above example being typical of the others. One can easily understand why this practice was so necessary, especially for scientific terms with which the average person was unfamiliar.

[1] Ibid., VII, 124.

[2] Ibid., III, 405-6.

In such a lecture as "On the Methods and Results of Ethnology" (1865), definition of the term "Ethnology" is absolutely necessary for the benefit of his audience. Huxley explains that

> Ethnology is the science which determines the distinctive characters of the persistent modifications of mankind; which ascertains the distribution of those modifications in present and past times, and seeks to discover the causes, or conditions of existence, both of the modifications and of their distribution. I say "persistent" modifications, because, unless incidentally, ethnology has nothing to do with chance and transitory peculiarities of human structure.[1]

But he has to explain further because of the complexity of the word being defined:

> . . . I speak of "persistent modifications" or "stocks" rather than of "varieties," or "races," or "species," because each of these last well-known terms implies, on the part of its employer, a preconceived opinion touching one of those problems, the solution of which is the ultimate object of the science; and in regard to which, therefore, ethnologists are especially bound to keep their minds open and their judgements freely balanced.[2]

And he defines anthropology as

> . . . the great science which unravels the complexities of human structure; traces out the relations of man to other animals; studies all that is especially human in the mode in which man's complex functions are performed; and searches after the conditions which have determined his presence in the world.[3]

Biology, a term Huxley uses very often, is defined simply as the science that deals with living things, both animals and

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[1] Ibid., VII, 209.

[2] Ibid., pp. 209-10.

[3] Ibid., p. 210.

plants.[1] This last-mentioned study embraced most of the subjects in which Huxley was interested, and hence is usually the guiding spirit of his teaching. And, since many scientific terms unfamiliar to his listeners were used, Huxley would define and explain them before proceeding with the lecture.

Huxley also used illustration as a means of securing complete comprehension of his lecture by the audience. In "A Liberal Education and Where to Find It" (1868) he uses the figure of the chessgame in trying to show how important it is to know about nature and natural phenomena. He contends that in order to play the game of life we must know about nature and her laws. In this extended metaphor, Huxley tries to make his ideas concrete to the listener by pointing out the similarities between the game of life and a game of chess:

> The chess-board is the world, and pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just and patient. But we also know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated--without haste, but without remorse.[2]

In another instance Huxley illustrates some of the basic facts of organic nature. Here he is discussing the cycle of

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[1] Ibid., III, 268-69.

[2] Ibid., p. 82.

plant life from the cell to the mature tree and back to decayed nitrogenous matter--which will give sustenance to the next tree. Huxley asserts:

> If I were to take an oak tree, as a specimen of the plant world, I should find that it originated in an acorn, which . . . commenced in a cell; the acorn is placed in the ground, and it very speedily begins to absorb the inorganic matters . . . adds enormously to its bulk, and we can see it, year after year, extending itself upward and downward, attracting and appropriating to itself inorganic materials, which it vivifies, and eventually . . . gives off its own proper acorns, which again run the same course.[1]

In the same essay Huxley discusses the relation of the horse and the dog, asserting that the horse seemingly resembles no other animals except the zebra or ass. But he hastens to refute this conception:

> But let me ask you to look at these diagrams. Here is the skeleton of the horse, and here the skeleton of the dog. You will notice that we have in the horse a skull, a backbone and ribs, shoulder-blades and haunch-bones. In the fore-limb, one upper arm-bone, two fore arm-bones, wrist-bones (wrongly called knee), and middle hand-bones, ending in the three bones of a finger, the last of which is sheathed in the horny hoof of the fore-foot: in the hind-limb, one thigh-bone, two leg-bones, ankle-bones, and middle foot-bones, ending in the three bones of a toe, the last of which is encased in the hoof of the hind-foot. Now turn to the dog's skeleton. We find identically the same bones, but more of them, there being more toes in each foot, and hence more toe-bones.[2]

Continuing the illustration with the help of such visual aids, Huxley is able to make clear to his listeners things that would otherwise seem quite obscure and elusive. Driving

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[1]"The Causes of the Phenomena of Organic Nature," Essays, II, 320-21.

[2]Ibid., p. 323.

home each point by concrete illustration as the lecture progresses, Huxley enables the listener to have an ever receptive and understanding mind.

Still another device resorted to for assuring effectiveness is the rhetorical question. In "The Study of Zoology" (1861) Huxley discusses the unity of plan found in the skeleton of the lobster and points out that such unity is demonstrable. Then he follows with these questions:

> But I imagine I hear the question, How is all this to be tested? No doubt it is a pretty and ingenious way of looking at the structure of any animal; but is it anything more? Does Nature acknowledge, in any deeper way, this unity of plan we seem to trace?[1]

In "On a Piece of Chalk" (1868) he asks: "What is this widespread component of the surface of the earth? And whence did it come?"[2] And in "On the Educational Value of the Natural History Sciences" (1854), refuting a charge that biological sciences are based on observation alone and not on experiment, he asks:

> Physiology not an experimental science? . . . How did Harvey determine the nature of the circulation, except by experiment? How did Sir Charles Bell determine the functions of the roots of the spinal nerves, save by experiment? How do we know the use of a nerve at all, except by experiment? Nay, how do we know even that your eye is your seeing apparatus, unless you make the experiment of shutting it, or that your ear is your hearing apparatus, unless you close it up and thereby discover that you become deaf.[3]

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[1] Ibid., VIII, 207.

[2] Ibid., p. 3.

[3] Ibid., III, 49-50.

In the above we see the rhetorical question, strengthened by repetition, used to a good advantage. Such methods direct and hold the interest of the listener and form the foundation for discussion.

Closely allied to the use of the rhetorical question is the method of informal argument which Huxley utilized often and effectively. He skillfully uses argumentative terminology and phraseology while informing his Royal Institution audience concerning the theories and speculations of ethnologists, who are of two main schools. In "On the Methods and Results of Ethnology" (1865) he states that Polygenists--believers in plurality of origin--request that the Monogenists--believers in oneness of origin--[1] (a) "show" a single case in which the characters of a human stock have been essentially modified without its being "demonstrable," or, at least highly probable, that there has been intermixture of blood with some foreign stock; (b) "bring forward" any instance in which a part of the world, formerly inhabited by one stock, is now the dwelling place of another, and they will show that modification of character was not obtained by climactic influences; and, finally (c) "prove" that the

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[1]The Monogenists believe that all mankind sprang from a single pair whose progeny spread over the world and became modified into diverse forms by the effect of the climate and other conditions to which they were subjected. On the other hand, the Polygenists maintain that man primitively arose from many stocks, thus accounting for the differences in appearance (ibid., VII, 242-43, 246).

"evidence" in favor of the specific distinctness of many animals, admitted to be distinct species by all zoologists, is any better than that upon which the specific distinctness of men is based.

Huxley continues, stating that if presenting unanswerable objections to your adversary were the same thing as proving your own case, the Polygenists would be well on the way to victory; but Huxley adds that they have not yet brought forth satisfactory positive proof of the diversity of mankind, and are divided among themselves as to the specific manner of origin of the various species of mankind. Concerning these theories, Huxley asserts that the "hypothesis" of man being created in the country in which we find him, and the "hypothesis" of the descent of the different species of man from the different species of ape, are unfounded assumptions. In forensic fashion Huxley completes this portion of his discussion, stating that the granting of the Polygenist premises that Negroes and Australians, Negritos and Mongols are distinct species does not necessitate the Polygenist conclusion that man is descended from more than one primitive stock. On the contrary, one may believe in these Polygenist premises and still be a Monogenist, believing in man's descent from only one primitive stock.[1] In "Scientific and Pseudo-Scientific Realism" (1887) Huxley points out

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[1] Ibid., VII, 246-48.

that men in the middle ages believed that through the church they possessed much more and trustworthy information concerning the nature and order of things in the theological world than they possessed concerning the nature and order of things in the sensible world, which was supposedly under the dominion of Satan, and hence outside the realm of desirable knowledge anyhow. These same men, while endeavoring to reconcile the system of thought which started from the data of pure reason with that which started from the data of Roman theology, produced the system of thought which became known as scholastic philosophy. This end product of the reconciliation, continues Huxley, seems to be a terrible illustration of the wasteful way in which the struggle for existence is carried on in the world of thought. Yet, scholastic philosophy, or scholasticism, deserves much credit because it did manage to keep man's thinking faculty alive and active when the opposing force of ecclesiasticism and the gross neglect of natural knowledge might easily have stifled this faculty.[1] And in "Administrative Nihilism" (1871) he refers to those provincial-minded Englishmen who objected so strenuously to the passage of the Elementary Education Act of 1870 because they feared its revolutionary implications for democratic education. Huxley states the situation thus:

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[1] Ibid., V, 65-67.

> The arguments employed by these objectors are of two kinds . . . It is maintained that the whole fabric of society will be destroyed if the poor, as well as the rich, are educated; that anything like sound and good education will only make them discontented with their station and raise hopes which, in the great majority of cases, will be bitterly disappointed. It is said: There must be hewers of wood and drawers of water, scavengers and coalheavers, day labourers and domestic servants, or the work of society will come to a standstill. But, if you educate and refine everybody, nobody will be content to assume these functions, and all the world will want to be gentlemen and ladies.[1]

Huxley asserts that the well-to-do middle class does most of the objecting to the Elementary Education Act of 1870 even though they themselves always strive to have their own children rise to the class above the one in which they were born. But Huxley contends that it is not true that education makes men unfit for rough and laborious work; moreover, no one comes into the world labeled scavenger, shopkeeper, bishop, or duke, hence all men should have an equal opportunity to succeed. Concluding his criticism of those who opposed the Elementary Education Act of 1870, Huxley makes the following observation:

> That which is to be lamented, I fancy, is not that society should do its utmost to help capacity to ascend from the lower to the higher, but that it has no machinery by which to facilitate the descent of incapacity from the higher strata to the lower.[2]

Here Huxley chides those who would deny opportunity for advancement to some capable persons because of their social

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[1] Ibid., I, 251-52.

[2] Ibid., p. 254.

origin but would at the same time ignore the need for demanding competence of men at the higher levels of endeavor. Huxley's arguments, reiterated and summarized, thoroughly convince his audience while Huxley himself gives the impression of debating with imaginary opponents, men who constantly assailed the forthright stand he took on the vital issues of the day.

Huxley makes constant and adroit use of summation and transition in his lectures, thus keeping his listeners informed at every step of what is going on. In presenting a series of lectures he usually states what he intends to discuss, presents his main points, sums up, and announces what the next lecture will be. The following passage exemplifies the manner in which Huxley begins a lecture:

> I now propose briefly to unfold that argument, and to set forth . . . the chief facts upon which all conclusions respecting the nature and the extent of the bonds which connect man with the brute world must be based: I shall then indicate the one immediate conclusion which, in my judgement, is justified by those facts, and I shall finally discuss the bearing of that conclusion upon the hypotheses which have been entertained respecting the Origin of Man.[1]

And this next excerpt illustrates how Huxley ends a discourse:

> In conclusion, let me, in a few words, recapitulate the positions which I have laid down . . . . We have gradually traced down all organic forms, or, in other words, we have analysed the present condition of animated nature, until we found that each species took its origin in a form similar to that under which

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[1] "On the Relations of Man to the Lower Animals," Essays, VII, 81.

> all others commenced their existence. We have found the whole of the vast array of living forms with which we are surrounded, constantly growing, increasing, decaying and disappearing . . . . We have seen, again, that not only is the living matter derived from the inorganic world, but that the forces of that matter are all of them correlative with and convertible into those of inorganic nature.
>
> This, for our present purposes, is the best view of the present condition of organic nature which I can lay before you: it gives you the great outlines of a vast picture, which you must fill up by your own study.
>
> In the next lecture I shall endeavor in the same way to go back into the past, and to sketch in the same broad manner the history of life in epochs preceding our own.[1]

This procedure helped the listeners to follow and understand the lecture and prompted them to read prodigiously.

In order to keep his audience from becoming restless when he had spoken too long, Huxley apologized for so doing, then politely continued with the lecture. Thus we find him saying at one point in a long lecture:

> I should have been glad to have said a few words about the use of museums in the study of Biology, but I see that my time is becoming short, and I have yet another question to answer. Nevertheless, I must, at the risk of wearying you, say a word or two upon the important subject of museums.[2]

Earlier in this same lecture Huxley had intimated that he would not speak too long, saying: "I might go on multiplying these examples, but I see the clock won't wait for me, and I must therefore pass to the third question . . . ."[3] But

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[1]"On Our Knowledge of the Causes of the Phenomena of Organic Nature," Essays, II, 328-29.

[2]"On the Study of Biology," Essays, III, 286-87.

[3]Ibid., p. 281.

Huxley does not allow time to interfere with the completion of his lectures. Instead, he makes apologies and continues his presentation. Although he often calls himself an "educational bore," he believes that no lecture should be made shorter because of time, since such procedure would necessitate the omission of important material necessary to the understanding of the presentation.

In order to help make his lectures clear and concrete, Huxley used visual aids. This procedure enabled him to picture animals long extinct and to make vivid to his audiences things that words alone were incapable of presenting adequately. St. George Mivart, honorary student and assistant of Huxley, describes the practice thus: "The course was amply illustrated by excellent coloured diagrams, which, I believe, he had made; but still more valuable were the chalk sketches he would draw on the blackboard with admirable facility, while he was talking, his rapid dexterous strokes quickly building up an organism in our minds, simultaneously through ear and eye."[1]

This same pedagogical procedure is referred to by H. G. Wells, one of Huxley's better-known students. After praising his former teacher's ability to inspire and his faculty to stimulate thought by skillful interrogation, Wells adds that Huxley lectured in a firm, clear voice, with easy deliberation,

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[1]St. George Mivart, "Some Reminiscences of Thomas Henry Huxley," Nineteenth Century, XLII (December, 1897), 991.

often turning to the blackboard behind him to sketch some diagram in order to make clear a phase of the discourse.[1]

In addition to diagrams and sketches, Huxley used maps, skeletons of man and beast, mounted specimens of all types, preserved specimens, and reconstructed likenesses of extinct creatures. He would also have various types of plant life on hand when lectures required such aids.

Still another device for making sure that his teaching was understood was the question and answer period held after each lecture. Mivart says that after "the lecture [was] over, he [Huxley] was ever ready to answer questions, and I often admired his patience in explaining points which there was no excuse for anyone not having understood."[2] Thus we see exemplified the determination of a true teacher to follow up his lecture with a period devoted to clarifying points that may not be clear to his listeners. Many lecturers, especially of Huxley's calibre, would never use this procedure but would dash from the classroom or lecture hall as

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[1]H. G. Wells, Experiment in Autobiography (New York, 1934), pp. 161, 184.

Wells comments on Huxley's connection with the Science and Art Department and indicates the great respect that this body had for his ability as a teacher: ". . . [The] vigorous, persistent far-reaching and philosophical mind of Huxley had become very influential with the Department of Science and Art in the sixties and seventies and particularly at South Kensington, and he had been able not only to establish that general scientific survey, physiography, as a subject in the evening class curriculum throughout the country, but he had had also a practically free hand to teach the science of life in his own fashion in the Normal School." (ibid., p. 168).

[2]Mivart, op. cit., p. 991.

soon as possible. But Huxley would invariably remain after the lecture in order to explain to students their hastily-taken notes, and to answer questions. The listener, therefore, had no excuse for not understanding the main points of the discourse.

The various devices discussed above aided in achieving clarity in the presentation of subject matter; and their effectiveness was enhanced by Huxley's excellent literary style, one that is characterized by conciseness and simplicity. Darwin, commenting on the ability of Huxley as a writer, tells the latter that his essays are brilliant: "People complain of the unequal distribution of wealth, but it is a much greater shame and injustice that any one man should have the power to write so many brilliant essays as you have lately done. There is no one who writes like you . . . ."[1]

A brief but striking example of Huxley's clear and fluent style is found in the following passage from "Evolution and Ethics" (1893):

> From very low forms up to the highest--in the animal no less than in the vegetable kingdom--the process of life presents the same appearance of cyclical evolution. Nay, we have but to cast our eyes over the rest of the world and cyclical change presents itself on all sides. It meets us in the water that flows to the sea and returns to the springs; in the heavenly bodies that wax and wane, go and return to their places; in the inexorable

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[1] Life and Letters of Charles Darwin, 2 vols., ed. by Francis Darwin (New York, 1871), II, 294.

> sequence of the ages of man's life; in that successive rise, apogee, and fall of dynasties and of states which is the most prominent topic of civil history.[1]

Huxley's prose, though laden with scientific facts, is imaginative; it is profound, yet simple. Balanced structure, forceful verbs, and effective punctuation vie for supremacy in their contribution to the quality of Huxley's writing, and make his lectures an inimitable medium of instruction. They were models which the prospective teacher was advised to study carefully and emulate precisely.

3. The Laboratory Method

In addition to the lecture Huxley employed the laboratory method, the method of demonstration and experimentation. Huxley believed that this type of instruction is indispensable. It must be carried on (1) under the guidance of trained demonstrators, (2) in small groups, each limited to not more than twenty students--thus, in "Universities: Actual and Ideal" (1874), he names what he considers to be two prime requisites for successful laboratory instruction.[2] In further support of his belief in the vital importance of this method, Huxley states that even though lecturing is important, he considers the essential aid to successful science teaching to be a laboratory properly equipped for dissection. Referring to his own classes he says:

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[1] Essays, IX, 49

[2] Ibid., III, 227.

> We have tables properly arranged in regard to light, microscopes, and dissecting instruments, and we work through the structure of a certain number of animals and plants . . . . The purpose of this course is not to make skilled dissectors, but to give every student a clear and definite conception, by means of sense-images, of the characteristic structure of each of the leading modifications of the animal kingdom . . . .[1]

Huxley continues his explanation of the laboratory method by pointing out that visual aids are--just as in lecturing--of invaluable assistance in laboratory work. Describing his own laboratory, he relates how these aids help the student:

> /There are/ diagrams and . . . preparations illustrating the structure of a frog . . . . Similar diagrams and preparations illustrating the structure of all other forms of life we examine, are either made or in course of preparation. Thus the student has before him, first, a picture of the structure he ought to see; secondly, the structure itself worked out; and if with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts for himself in the materials supplied to him, he had better take to some other pursuit than that of biological science.[2]

He is convinced that simple observation is useless unless proved by experiment. Referring to the circulation of the blood, he states that a hemorrhage may prove the presence of blood but experiment would be needed to prove its circulation. Stating how such a demonstration should be conducted, Huxley gives the following instructions:

> You tie a vein, and you find that the blood accumulates on the side of the ligature opposite the heart. You tie an artery, and you find that the

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[1] "On the Study of Biology," Essays, III, 284-85.

[2] Ibid., p. 286.

> blood accumulates on the side near the heart. Open the chest, and you see the heart contracting with great force. Make openings into its principal cavities, and you will find that all the blood flows out, and no more pressure is exerted on either side of the arterial or venous ligature.
>
> Now all these facts, taken together, constitute the evidence that the blood is propelled by the heart through the arteries, and returns by the veins--that, in short, the blood circulates.[1]

Thus Huxley illustrates the need for experimentation as a means of clarifying and proving things learned through observation and lectures.

Fully aware of the difficulties of the laboratory method, Huxley nevertheless contends that this type of instruction is necessary. There is the unpleasantness of animal dissection and the time it takes, and the difficulty in finding enough specimens. He points out that the botanist has a great advantage over the zoologist because the former can easily obtain specimens; and the dissecting is so much cleaner. In spite of this advantage, Huxley asserts that "if zoological science is to be properly studied, demonstration, and consequently, dissection, must be had. Without it, no man can have a really sound knowledge of animal organization."[2]

In giving laboratory directions to beginning teachers, Huxley tells them how to instruct children who are just

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[1]"On the Educational Value of the Natural History Sciences," Essays, III, 53-54.

[2]"A Lobster; or, The Study of Zoology," Essays, VIII, 223.

being introduced to the mysteries of science. He asserts that the child should be taught about animal and plant life in simple terms. Concerning the former he believes that children should have a fundamental knowledge of physiology based upon observation, and aided by diagrams and models. Huxley believes that such a subject can be taught to children simply by using the following plan:

> . . . the general truths of anatomy and physiology can be taught to young people in a very real fashion by dealing with the broad facts of human structure. Such viscera as they cannot very well examine in themselves, such as hearts, lungs, and livers, may be obtained from the nearest butcher's shop. In respect to teaching something about the biology of plants, there is no practical difficulty, because almost any of the common plants will do, and plants do not make . . . an unpleasant mess; so that, in my judgement, the very best form of Biology for teaching to the very young people is elementary human physiology on the one hand, and the elements of botany on the other; beyond that I do not think it will be feasible to advance for some time to come.[1]

Ironically, however, Huxley's great interest in using the laboratory for science instruction, especially for younger students, ran into a stone wall of opposition.

4. Laboratory Instruction and the Vivisection Controversy

Huxley's advocacy of the laboratory method of teaching science stirred up bitter protests from antivivisectionists who by implication charged that he advocated the practice of vivisection by children or before them. Such charges, made

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[1] Essays, III, 291.

by Lord Shaftsbury and others in 1875, Huxley promptly and stoutly denied, using the same passages from his Physiology as those cited by Lord Shaftsbury in his Parliamentary attack on vivisection. Huxley vainly argued that his qualified advocacy of this laboratory technique did not necessarily mean that he favored its practice by or before children, accusing Shaftsbury of misquotation and misrepresentation, pointing out that the recommendations concerning laboratory work cited by the latter could be done without a single vivisection, and reasserting that he had never suggested or desired the introduction of vivisection in the physiology courses for young beginners.[1]

But Huxley did feel the necessity of vivisection in more advanced classes, in teacher training classes, and in medical schools, and he defends this practice. Major dissections for such classes taught by Huxley were performed by his assistants while he explained each step of the demonstration. He was quite bitter about the hypocritical manner in which the anti-vivisectionists made it appear that he believed in allowing mere children to perform and watch others perform vivisections on such animals as cats and dogs; whereas, the truth of the matter was that such beginners never saw such experiments performed with anything larger than a frog.

In a letter to Sir W. Harcourt (1875) Huxley predicts that if the Vivisection Act is enacted, the progress of

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[1] Letters, I, 459-61.

physiological science instruction will be retarded in England. He laments the fact that many laboratory experiments will have to be eliminated from instruction, adding that all of the facts for physiological instruction have been discovered by experiment on living things.[1] But in spite of Huxley's best efforts the Anti-Vivisection law was passed in 1876, to the embarrassment of Huxley and other practical scientists.

Although it appears that Huxley personally did not dissect any living specimen larger than the frog, he defends the right of others--including his assistants--to perform vivisections on larger animals for the purpose of instruction. Even in dissecting frogs Huxley insisted that the operation be conducted in such a way as to be painless to the subject. In a letter to his friend, Donelly (1874), Huxley states that vivisection is valuable to mankind and that unwarranted opposition to the practice is to be deplored, adding that he practices the use of anesthetics on animals that are being used for experimental purposes: Huxley points out that he always felt it his duty to defend physiologists who, by experimenting on living animals, had not only added much to physiology but also had done much for the alleviation of human suffering, despite the "malicious clamor" raised against them by the antivivisectionists.

Huxley asserts that the performance of experiments upon conscious animals was disagreeable to him, hence he avoided

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[1] Ibid., p. 467.

them as much as possible. However, he adds that he always gave strict instructions to demonstrators who assisted him that such experiments must always be preceded by anesthetization of the subject, and had no reason to believe that his wishes had not been carried out. Huxley, himself a great lover of animals, indignantly states that his dislike for the infliction of pain, both as a matter of principle and of feeling, is quite as strong as that of his critics.[1]

Continuing his defense, Huxley resorts to irony and sarcasm because he had become vexed about the manner in which the antivivisectionists were carrying the day. In this same letter to Donelly, he asks if the prohibition means debarment from inflicting pain in order to observe the action of living matter; "for it might be said to be unworthy quibbling, if, having accepted the conditions of the /antivivisection/ minute, he /the teacher/ thought himself at liberty to inflict any amount of pain, so long as he did not actually cut."[2] This tongue-in-cheek statement was to avail, however, because the foes of vivisection scored a decisive triumph.

In 1877, after the passage of the Vivisection Law, Huxley feels impelled to speak out against it. He reveals the

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[1] Ibid., pp. 463-64. When between thirteen and fourteen years old Huxley spent two or three hours watching a post-mortem examination. He became very ill as a result and suffered hypochrondriacal dyspepsia for the rest of his life. This recurrent ailment caused vivisection to be "constitutionally disagreeable" to him. (Essays, I, 7-8).

[2] Ibid., p. 465.

unfairness of the law in that one may fish with live frog bait for amusement with impunity but the teacher is fined if he dissects a frog for purposes of instruction. The teacher must get a license from the Secretary of State for the Home Department, granted under the authority of the Vivisection Act. Huxley ironically concludes by stating that if these two persons are brought before the magistrate,

> The first offender says "I did it because I find fishing very amusing," and the magistrate bids him depart in peace, nay, probably wishes him good sport. The second pleads, "I wanted to impress a scientific truth, with a distinctness attainable in no other way, on the minds of my scholars," and the magistrate fines him five pounds.
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> I cannot but think that this is an anomalous and not wholly creditable state of things.[1]

Until the very end Huxley maintained his original stand on vivisection, contending that it is permissible and justifiable because of its help to humanity.[2] In the long fight to preserve what he considered the most important and most effective method of teaching, the laboratory method, Huxley gave the antivivisectionists no quarter. His efforts were not in vain because growing tolerance on the part of those issuing licenses for vivisection gradually brought the laboratory method back into use for science instruction. In fact,

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[1] "On Elementary Instruction in Physiology," Essays, III, 302.

[2] Huxley says: "I ask myself--suppose you knew that by inflicting prolonged pain on 100 rabbits you could discover a way to the extirpation of leprosy, or consumption, or locomotor ataxy, or of siccidal melancholia among human beings, dare you refuse to inflict that pain? Now I am quite unable to say that I dare." (Letters, I, 469).

he was "the practical inventor of the laboratory system of teaching zoological science, and all over the world the methods invented by him have been adopted in university laboratories and technical schools."[1]

5. Examinations: General

Just as science lectures should precede laboratory work, so should laboratory work precede examinations. In the first case, one receives information; in the second, he verifies it by experimentation; and in the third, he reveals what he has learned from the first two. Since we have discussed Huxley's use of the lecture and laboratory plans of instruction, let us now attempt to ascertain his attitude toward examinations.

Huxley gave considerable thought to the question of an adequate system of examinations. In a letter to his friend and fellow scientist, Sir J. D. Hooker, eminent botanist, (October 6, 1864), Huxley comments on examinations, considering them a necessity for the spreading of scientific education and "looking upon them . . . as the most important engine for forcing science into ordinary education."[2] Huxley, desirous of having excellent examiners to insure a sound examination program, asked Joseph Hooker to serve for the

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[1]P. Chalmers Mitchell, Thomas Henry Huxley, A Sketch of His Life and Work (New York, 1900), p. 177.

[2]Letters, I, 274.

Science and Art Department as an examiner in botany. Too many unqualified examiners were functioning, much to the discredit of the system of examinations. In the essay "Universities: Actual and Ideal" (1874), Huxley points out that merely knowing a subject does not qualify one to be an examiner. He believes that having been a teacher helps greatly, and should be a prerequisite for an examiner.[1]

Although he was an examiner, Huxley did not overrate examinations in general, arguing that students usually work to "pass" and not to "know" the subject; and finally, they "pass" but do not "know" the subject. In connection with this, Huxley recalls how he himself had passed many examinations without knowing much about what he was writing on his paper at the time. Many students with less capable minds often made better marks than their fellows,[2] hence Huxley states that the more he sees of the examination system, the more convinced does he become that it is a necessary evil that must be dealt with carefully within all its phases: the preparation, the supervision, and the general administration of the examination.

A minimum age for those taking written examinations was proposed by Huxley after he had observed that children through eleven years of age did better on oral tests. Hence he

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[1] Essays, III, 230-1.

[2] Ibid., pp. 228-29.

advises that children under twelve years of age be given an oral and not a written examination because experience had shown that pupils in this age group were more relaxed and made better marks when this procedure was followed.[1]

When questioned on the efficacy of examinations, before the Royal Commission on Science Instruction (1870) of which he was a member, Huxley replied that they were all right ordinarily but in reality were being abused by teachers who "crammed" students just for examinations:

> There is one great evil which we have to contend with from the very commencement. The teachers see that it is possible to make a good deal of money out of it, and there are some of them who seem to have set their minds entirely upon trying to get money out of the system by simply cramming young children, and by putting them up, so to speak, to be shot at, upon the chance that they would get something out of it.[2]

Huxley proposes to abolish the preliminary examination for entrance to school, stating that it should not be given at such a time; instead, he would allow anyone to enter who appeared able to profit by the instruction given. After the first term he would examine the student upon the courses studied and upon no others; and thereby determine his fitness to continue in school. Lecturing in 1876, Huxley points out that this very method has been followed for many years in the Royal School of Mines and has worked very well.[3]

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[1] Royal Commission on Scientific Instruction and the Advancement of Science (London, 1872), I, 25.

[2] Ibid., p. 20.

[3] "Address on University Education," Essays, III, 250-1.

Concerning examinations for teachers, Huxley testified before the Royal Commission on Scientific Instruction (1870) to the effect that poor teaching and its inevitable results could be reduced to a minimum by examining teachers, who had been exempt from this selecting process since 1867, the year that the special examination for teachers was abolished. Such an examination was originally instituted for teachers, and a certificate was issued recognizing the amount of knowledge which they had obtained. But subsequently the Department of Science and Art relied to such an extent upon the examination of the papers of the pupils in the several classes as to regard the special examination of teachers as largely unnecessary. Any student of an elementary science class recognized by the Department, who passed in the advanced classes of the annual May examination, would be deemed qualified to teach, and might, by presenting pupils at a subsequent examination, earn by their success the grants given by the Department.[1] Huxley states that if a student or teacher passes in the advanced stage of an examination, he is authorized to start teaching.[2] But Huxley favors a special examination and objects to this letting-down of the bars:

> I think it has been unfortunate, and I should very much like to see that examination of teachers revived. In spite of all that may be said, I think that

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[1] Royal Commission, I, xx.

[2] Ibid., p. 17.

> the former plan was a very great check upon the system of cramming. I should like to see all the teachers put through a special examination.[1]

Despite Huxley's objections, the special examination for science teachers was for the most part discarded. As late as 1893 the Science and Art Department still allowed the results of the regular May examination to be used for qualifying teachers, and it even dispensed with this requirement for graduates of any one of the universities, regular teachers at the training colleges, and associates of the Royal College of Science.[2]

6. Examinations: "Payment by Results"

A type of examination for which Huxley repeatedly expressed dislike, however, was the one used in the system of "payment by results" which authorized payment to the teacher of a stipulated sum for each student that succeeded in making a passing grade. This led to the cramming of students by unprincipled, and often weak, teachers who were desirous of increasing their salaries, because the bulk of their income was derived from this source. This system resulted from the action taken upon the findings of the Newcastle Commission (1858) that was appointed to inquire into the state of popular education in England and propose steps that might be

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[1] Ibid., p. 21.

[2] Directory of Department of Science and Art (London, 1899), p. 7. See also: Calendar, History and Regulations of Department of Science and Art (London, 1893), p. 11.

required for the extension of sound and cheap elementary instruction. The commission recommended that an examination be given by inspectors to every child in the schools to which grants were to be paid, and that the prospects and position of the teacher be made considerably dependent upon the results of the examination.[1]

It was in 1862 that Mr. Lowe, Vice-President of the Committee of Council, drew up a Revised Code which was based upon the principle of "payment by results." This plan of teacher remuneration Huxley frowned upon partly because of the varying and uncertain amount of income that the teacher could hope to receive. Specifically, the plan of "payment by results" was calculated in the following manner: (1) 1 d. for every attendance after the first one-hundred attendances at the morning or afternoon meetings, and after the first twelve at the evening meetings of the school. One-third of the claimable amount was forfeited if the scholar failed to satisfy the inspector in reading, one-third if in writing, and one-third if in arithmetic.[2]

Also incorporated in the Code were provisions that (1) instituted a lower class of certificates than any previously

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[1]The payments to elementary schools of science were based wholly on oral and practical work under the inspector, and in advanced courses the practical part of the examination was given by the inspector and the theoretical part was written (Directory, p. 55).

[2]Hansard's Parliamentary Debates, Third Series, CLXV (London, 1862), 217.

issued, (2) continued the practice of permitting examination for certificates of untrained, acting teachers recommended by the inspector, (3) licensed ex-pupil teachers for seven years of service in charge of schools of less than one hundred pupils in average attendance, (4) abolished the £10 bonus which had been offered (by the Minute of July 26, 1858) to certificated teachers to take charge of this class of schools on leaving training colleges, (5) enabled certificated teachers to have their certificates raised every five years (provided their schools were reported on satisfactorily) and (6) permitted day school teachers to instruct their pupil-teachers in evening schools.[1]

Immediately after the Revised Code was put into operation, the inspectors and teachers paid less and less attention to "extra subjects," such as science, drawing, and others. The instructors taught largely the three R's, and the inspectors gave examinations mainly in these rudimentary subjects.[2] This trend indicated that science--along with other "extra subjects"--was being neglected in the schools. It also meant that the small amount of science instruction given in regular day schools tended to be of inferior quality, largely because science was not originally one of the subjects in the "results" plan.

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[1] Final Report of Commission on Elementary Education Acts of England and Wales (London, 1888), p. 16.

[2] Royal Commission, I, xiii.

The principle of "payment by results," however, was soon adopted for science subjects and therefore was of great concern to Huxley. In fact, he considered this system a great deterrent to science teaching. In giving his opinion concerning one of the objectionable phases of "results" examinations (October, 1882), Huxley clearly shows his impatience with "cramming":

> There is a pestilent minority of teachers now, and always has been, who have no other object in the world than to earn payments, and what they do is this: they get together all the questions that have been put, and form a notion which questions will be set, and they concoct a set of cut and dried answers, and make their pupils learn them by heart, as if they were learning the catechism. The result is this: that we [examiners] get a whole school whose answers to the questions put are as like one another as a flock of sheep, the answers containing the same phrases and words . . . . Whenever that occurs we reject the whole of them, and tell the department why. We say "This is cramming."[1]

Several years later Huxley shows that his opinion of the "results" examination has not changed for the better when he writes to Mr. Donnelly (May, 1899), further criticizing this type of test:

> I am unable to see my way (and I suppose you are) to any better method of State encouragement of Science teaching than payment by results. The great and manifest evil of that system, however, is the steady pressure which it exerts in the development of every description of sham teaching. And the only check upon this kind of swindling the public seems to me to

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[1] Second Report of Royal Commissioners on Technical Instruction, III (London, 1884), 327.

> lie in the hands of the Examiners.
> . . . . . .
> . . . for every sham they let through is an encouragement to other shams and pot-teaching in general.[1]

As a result of this system the student was constantly under a strain in his efforts to learn or memorize enough to pass the examination. The "successful" teacher increased his income considerably, but the "unsuccessful" teacher barely made enough to subsist upon.[2] The dull student was drilled and coached continuously, whereas the smart student was often left to shift for himself because the instructor felt that such a pupil could pass the examination with very little tutoring. Thus "payment by results" (Code of 1862) tended to make examinations worthless as a measurement of the student's understanding of the subject matter and his investigative ability. And the teacher, whose salary was derived almost completely from "payment by results," no longer taught; instead, he became a driver of students.

The payments to the schools of science on the elementary level were made entirely on the results of inspection, and in the advanced courses partly upon inspection and partly upon examination. First, an attendance grant of £1 10s. was given

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[1] Letters, II, 250-1.

[2] Note the inequity of the method of teacher pay based upon "payment by results." The average payment to teachers of artisans in 1870 was £35, while one teacher earned as much as £227. The Bristol Trade School with three teachers, earned £653 in 1869, an average of more than £217 each (Royal Commission, I, xxvi).

for each 400 attendances[1] on all students who made not less than 250 attendances during the school year. This type of grant was calculated thus: the attendances of all students who were present not less than 250 times were added together and the total was divided by 400. For example, ten students with an attendance of 320 each would make a total of 3,200. This sum, divided by 400 would give 80 unit grants of £1 10s. each, or a total of about £120.

Secondly, a variable grant on each student which would not exceed 35s. was to be made on the condition of the school as a whole, and the grant was calculated on the number of students presented to the inspector. The award was based on the report of the inspector regarding the obligatory science, literary and other authorized subjects. Grants were also made for (3) practical work, the amount not exceeding 30s. for elementary courses in physics, chemistry, biology, and not exceeding 50s. for advanced courses in physics and biology. The amount of the grant depended upon the (1) efficiency of the laboratory, (2) the excellence of the equipment, and (3) the effectiveness of the practical instruction.[2]

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[1]An "attendance" was construed as the presence of a pupil in a science class. The attendance of a student could be registered on any one day for lessons in a maximum of two science subjects or for one lesson in any one science subject or group of art subjects. On Saturdays, however, one lesson in each of three science subjects or groups of art subjects could be registered (Directory, p. 11).

[2]Ibid., pp. 55-57.

The written examinations for specific advanced courses were held simultaneously throughout the kingdom. The examinations were administered by Department examiners or paid local secretaries and assistants, one-half of the cost being provided by the locality and the other by the Department of Science and Art.[1]

In the course of qualifying for payments, both elementary and advanced groups had to be rated by the inspector. This representative of the Department would from time to time visit the school or class and report on the condition and suitability of the premises and fittings, the sufficiency of the apparatus used in the instruction of the school, the character and quality of the instruction, the sufficiency of the teaching staff for the number of students under instruction, the constitution and working of the managing body, and the manner in which the regulations for registration and examination were carried out. The inspector was empowered to call a meeting of the managers, and he could require the production of such accounts as related to the receipts and expenditures in respect of subjects aided by the Department.[2]

Operating in a slightly different manner were the classes in technology fostered by the City and Guilds of London Institute. The work done by the students in these

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[1]Calendar, p. 14.

[2]Directory, p. 24.

classes was inspected and examined by the Institute, and, on the results of the annual examinations, certificates, prizes, and scholarships were granted, which were regarded as diplomas of proficiency, and were said to enable students to obtain better employment and higher remuneration.[1] But the teachers usually received fixed salaries instead of "payment by results." This, perhaps, is the most striking difference between the Science and Art Department and the City and Guilds of London Institute relative to the teaching of science at the elementary level. But at the college and university level the teachers were all paid set salaries, regardless of which of these schools (Department or Guilds' Institute) offered and had charge of the science courses, because the state and Guilds provided annual salary appropriations for such institutions.[2]

7. Examinations for Medical Students

Examinations for medical students also caused Huxley deep concern: first, because he was a doctor and therefore had a special interest in effective methods for the training of medical students; and second, because as a teacher and examiner he had professional interest in examinations in general. In "The State and Medical Education" (1884), Huxley contends that the medical examinations for license to practice

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[1] Second Report, I, 402.

[2] Ibid., p. 433.

should be in line with what the student has prepared himself in, and nothing else:

> My own belief is that if the Medical Council instead of insisting upon that examination in general education which I am sorry to say I believe to be entirely futile, were to insist upon a knowledge of elementary physics, and chemistry, and biology, they would be taking one of the greatest steps which at present can be made for the improvement of medical education.[1]

In "The State and the Medical Profession" (1884) Huxley asserts that, although much improvement has been made relative to the quality and integrity of examining bodies, some are still somewhat below the standard:

> Unfortunately there remain two or three black sheep-licensing bodies which simply trade upon their privilege, and sell the cheapest wares they can for shame's sake supply to the bidder. Another defect in the existing system, even where the examination has been so greatly improved as to be good of its kind, is that there are certain licensing bodies which give a qualification for an acquaintance with either medicine or surgery alone, and which more or less ignore obstetrics.[2]

Huxley deplores this situation as archaic, pointing backward to the day when barbers did surgery and midwives obstetrics. He feels that a prospective doctor should be required to pass examinations in medicine, surgery, and obstetrics in order to qualify for practice. Thus does Huxley expose the inadequacies and abuses of the examinations for medical students.

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[1] Essays, III, 341.

[2] Ibid., p. 333.

8. Training of Science Teachers

A factor of much concern to Huxley as contributing to the deplorable status of science instruction was the appalling dearth of qualified science teachers.[1] This condition was partly due to the fact that though in 1867 the examinations of the Science and Art Department were opened to students in training to become elementary school teachers and financial support had been given to the teaching of science[2] --which was officially added to the school curriculum by the Education Act of 1870--no provision was made for the trainers of teachers of science.

Aspiring teachers were forced to instruct themselves or study under some man of science in order to take the qualifying examination. Such preparation, however, proved quite inadequate because many failed the test. In "Minutes of Evidence" (March, 1871), Huxley questions Professor Roscoe concerning the status of science instruction in Manchester.

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[1]Even science teaching in the medical schools was quite inferior to what it should have been, and caused Huxley deep concern. Salaries were so low that a good teacher would stay on the medical faculty just long enough to find a better paying position. Or, if he remained, usually he had to work elsewhere in order to supplement his income, thus making it nearly impossible to do justice to his teaching. Huxley asserts that "the incapacity of teachers is the weak point in the London schools," adding, "But what is to be expected when a man accepts a lectureship in a medical school simply as a grappling-iron by which he may hold on until he gets a hospital appointment?" (Letters, II, 279-80).

[2]Royal Commission, I, 513.

Roscoe answers: "I believe that teachers are, as a rule . . . exceedingly ill educated; at any rate, that they are certainly not up to the mark of teaching science properly."[1]

Joseph Hooker, writing to Huxley (December 25, 1872), deplores the poor quality of teaching at the International College, saying: "I am disgusted with the so-called Science teaching at the International, and have written a sharp remonstrance to Schmitz: it is an utter sham, worse by far than nothing, and calculated to bring the thing into contempt."[2] Matthew Arnold (Report of 1878) decries the situation, saying: "Of course the best agency for effecting this /teaching of Naturkunde/ would be a gifted teacher; but as gifted teachers are rare, what we have most to wish for is the guidance of a good text-book."[3] As we have seen, Huxley not only recognized the need of good textbooks but he did something about it. He also realized fully the need for more capable teachers; hence, in addition to writing texts, he devoted much time and effort to the instruction of science teachers.

In June, 1871, Huxley began the teacher-training phase of his educational activity by inaugurating a six-weeks'

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[1] Ibid.

[2] Life and Letters of Sir Joseph Dalton Hooker, ed. by Leonard Huxley, 2 vols. (London, 1918), II, 182.

[3] Matthew Arnold, Reports on Elementary Schools, 1852-1882, ed. by Francis Sandford (London, 1889), pp. 206-7.

course in Biology for science teachers at the South Kensington Museum; and repeated it the following summer in the new laboratories of the Royal School of Science at South Kensington. In "Minutes and Correspondence" (December 30, 1870) relative to special training for science teachers, it was brought out that already the quota for the courses to be given in the summer of 1871 had been passed. The Science and Art Department, being the source of finance for the teachers who attended the training school, decreed that all prospective matriculants must pass a qualifying examination before being accepted for the course. By this means the number of teachers was limited primarily to those showing some promise as science instructors.[1] These initial efforts were so successful that Huxley immediately made teacher training part of the regular course at the School of Mines, beginning in October, 1872, and "thence it spread throughout the English-speaking world."[2]

Qualifications and procedures concerning the prospective teacher were quite important in Huxley's estimation, and should be duly emphasized. The first thing an instructor must do is to master the subject matter that he is to teach, and refrain from relying on books. Castigating bookish

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[1] Eighteenth Report of the Science and Art Department (London, 1871), p. 29.

[2] Peterson, op. cit., p. 188. Also: "By 1881 the teachers' courses which Huxley had initiated as a purely private venture had reached such magnitude as to demand formal recognition, and a new institution was created, the Normal School of Science, to which the Royal School of Mines was affiliated." (Clarence Ayres, Huxley (New York, 1932), p. 154.

teaching methods of instructors who do not know their subject, Huxley makes the following charge:

> The great blunder that our people make, I think, is attempting to teach from books; our schoolmasters have largely been taught from books and nothing but books, and a great many of them understand nothing but book teaching, as far as I can see. The consequence is, that when they attempt to deal with scientific teaching, they make nothing of it. If you are setting to work to teach a child science you must teach it through its eyes, and its hands, and its senses.[1]

When making the above accusation, Huxley was thinking of the use of raised maps and models in the Swiss and German schools in teaching physical geography, beside which mere book teaching was decidedly outmoded. But Huxley realized that the best methods are of small value unless the teacher is well prepared in his subject. He points out that object lessons usually fail because the teacher does not know the subject matter thoroughly, a fact which may be attributed to the "detestable" way of training teachers at the time.[2] Elsewhere Huxley drives home the idea that teachers should know things first hand, keeping this knowledge refreshed by observation and experiment, and he implores the instructors to know their material:

> But let me entreat you to remember my last words. Addressing myself to you, as teachers, I would say, mere book learning in physical science is a sham and a delusion--what you teach, unless you

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[1] Royal Commission, I, 23.

[2] "The Struggle for Existence in Human Society," Essays, IX, 221.

> wish to be impostors, that you must first know; and real knowledge in science means personal acquaintance with the facts, be they few or many.[1]

Huxley did not believe that people with only elementary training made capable elementary teachers. On the contrary, he was of the opinion that a good teacher of beginners must know far more than mere elementary training embraces, because the naive and credulous pupils would not know enough to disagree with anything pronounced as fact by their instructor. Huxley took this position because of the use of the pupil-teacher in many schools, a practice that was, in his estimation quite harmful to the pupils. Huxley contends that the pupil-teacher is drilled and worked too hard to be able to impart much knowledge to anyone. His criticism of the system of using pupil-teachers is vigorous and picturesque:

> For . . . the obtaining of teachers of science and technical classes, the system of catching a boy or girl young, making a pupil-teacher of him, compelling the poor little mortal to pour from his little bucket, into a still smaller bucket, that which has just been poured into it out of a big bucket; and passing him afterwards through the training college, where his life is devoted to filling the bucket from the pump from morning till night, without time for thought or reflection, is a system which should not continue.[2]

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[1] "A Lobster; or, The Study of Zoology," Essays, VIII, 227-28.

[2] "Address on Behalf of the National Association for the Promotion of Technical Education," Essays, III, 442-43. Huxley advocated Normal School Training for all teachers. (Royal Commission, I, 22).

Because Huxley saw the problem as one of a mechanical and ineffective mode of teaching, it is not strange that he felt that this type of instruction should be abandoned.

Huxley believes that the teacher of industrial science should have some specific knowledge about the industry of his district, and should try to refrain from generalizing concerning the application of science to industry unless he has had some such training. Such an instructor, after finishing normal school, should attend the School of Mines, in order to acquire specific knowledge about mining processes and thus become able to speak with authority concerning the application of science to industry. Likewise, instructors in other fields, such as textiles, engineering, and agriculture, should also follow up their normal school course with technical training in their areas of specialization. Such instructors would then be acquainted with both the theoretical and practical side of their work; they would know principles, but they would also know enough about their home industries to be able to teach those connected with them concerning the latest trends in methods of production and management.[1]

Huxley trained teachers how to lecture, how to conduct and supervise experiments, and how to prepare and administer examinations. He also taught them how to prepare drawings, specimens, and other illustrative materials, and how to

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[1]Ibid., I, 25.

improvise whenever such aids could not be secured. We see, then, that Huxley's techniques as a lecturer, his methods as a demonstrator in the science laboratory, and his technique of administering examinations all became available to the prospective teacher while he was receiving instruction.

9. Huxley's Textbook Writing

The deplorable status of science teaching, which prompted Huxley to initiate a teacher-training program, may be attributed, in part, to the lack of good textbooks. One can imagine how much pupils suffered if they were unfortunate enough to have had both a bookish teacher and a bad text. This was often the case, and the bad results were evident in the increase of failures on examination.

Realizing the need for good textbooks in the schools, Huxley set himself to the task of remedying this lack, especially as it applied to books for beginners. These texts were designed to supplant those that were outmoded but still in use. The latter were mechanical, feeble, and uninteresting, largely made up of questions and answers that had to be learned by heart, such as the following: "What is a horse? The horse is termed Equus Caballus; belongs to the Mammalia; order, Pachydermata; family, Solidungula." Huxley believed that such a text misled pupils and teachers into thinking that by learning a magic formula one became wiser,

whereas in reality he was mistaking words for knowledge.[1] Recognition of the need for better texts was rather general. Matthew Arnold, in his report for 1871, states that "better textbooks than those now in use will have to be created."[2] Huxley's friends entreated him to write a simple text for beginners in biology, and one of these friends, Charles Darwin, seems more than anyone else to have influenced him to comply. In a letter to Huxley in 1864, Darwin asks him to consider writing such a text, and informs him that he is about the one man who can do it. Darwin concludes by stating that general and popular treatises are just about as indispensable for the advancement of science as is research. He continues:

> Now, with your ease in writing, and with knowledge at your fingers' ends, do you not think you could write a popular treatise on Zoology? . . . . I have been asked more than a dozen times to recommend something for a beginner and could only think of Carpenter's Zoology. I am sure that a striking treatise would do real service to science by educating naturalists . . . . I believe such a book might have a brilliant success. . . .[3]

Huxley responded by preparing a number of textbooks in science.

The four best known texts written by Huxley are Elementary Physiology (1866),[4] Elementary Biology (1875),[5]

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[1] Essays, III, 170.

[2] Arnold, op. cit., p. 157.

[3] Darwin, op. cit., II, 188.

[4] Thomas H. Huxley, Lessons in Elementary Physiology, sixth edition (London, 1872).

[5] T. H. Huxley and H. N. Martin, A Course in Elementary Instruction in Practical Biology (London, 1882).

Physiography (1877),[1] and Introductory Science Primer (1880).[2] The first text marked a change in the concept of human anatomy, a knowledge of which had heretofore been accessible only to students of medicine and doctors because the subject was thought to be unnecessary and a bit coarse for people not in the medical profession.

In the "Preface to the First Edition" Huxley states that the text is primarily for teachers and learners in boys' and girls' schools. His object is to state the principles of human physiology in plain and concise language. In the preface to the second edition he tells the reader that beginners will have to use the organs of domestic animals for most experiments since they cannot study the human subject. The frog may be used to show blood circulation. And in the "Preface to the Sixth Edition" Huxley informs us that many illustrations have been added, several being taken from the rabbit, the sheep, the dog, and the frog.

The chapter headings indicate Huxley's selection and division of material. There are twelve "Lessons": (1) "The Structure and Functions of the Human Body," (2) "The Vascular System and the Circulation," (3) "The Blood and the Lymph," (4) "Respiration," (5) "The Sources of Loss and of Gain to

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[1]T. H. Huxley, Physiography, An Introduction to the Study of Nature (London, 1897).

[2]Thomas Henry Huxley, Introductory (Science Primer) (New York, 1887).

the Blood," (6) "The Function of Alimentation," (7) "Motion and Locomotion," (8) "Sensations and Sensory Organs," (9) "The Organ of Sight," (10) "The Coalescence of Sensations with One Another and with Other States of Consciousness," (11) "The Nervous System and Innervation," and (12) "Histology." These lessons are subdivided into numbered units, each with a heading listed in the table of contents. Emphasis and clearness are aided by the use of upper case and italics in spelling important words, and by short, pithy paragraphs. This well-indexed book of 319 pages proved to be a pioneer text in elementary physiology and was so widely used that it passed through many editions. It was an incentive for those desiring to specialize in science, medicine, and related fields.

The second text--Biology--by Huxley (and H. N. Martin) was the published course of lectures for teachers in general biology, delivered during the summer of 1873 and repeated the following summer. This text, well-indexed, and for the most part carefully outlined, is written in a simple, straightforward manner, and without the aid of illustrations (1882 edition) presents clearly the basic truths about biology.

Huxley states that the object of this text is to serve as a laboratory guide. An easily obtainable number of animals and plants are described and directions given for their dissection. The following chapter headings will give a clear idea of what is to be experimented on by the student: (1) "Yeast," (2) "Protococcus," (3) "Colorless Blood Corpuscle,"

(4) "Bacteria," (5) "Moulds," (6) "Stonewarts," (7) "The Bracken Fern," (8) "The Bean Plant," (9) "The Bell Animalcule," (10) "Fresh-water Polypes," (11) "The Fresh-water Mussel," (12) "The Fresh-water Crayfish and the Lobster," and (13) "The Frog." The first part of each chapter gives the fundamental explanatory data on the subject, and the second part gives directions for laboratory work for verifying this data. In following these directions the student must dissect, observe, and draw what he sees, thus making sure that he understands the subject matter.

This text was quite adequate for its purpose and undoubtedly influenced many students to go farther in the study of science than would have ordinarily been the case. Commenting on this text Darwin writes Huxley (1875): "Many thanks for your biology, which I have read. It was a real stroke of genius to think of such a plan. Lord, how I wish that I had gone through such a course."[1]

The third textbook, Physiography, is a simplified presentation of a study of the universe based largely upon the Thames River because of its being so familiar to the English. It was designed to facilitate and encourage the subsequent entrance of pupils into special branches of science. It is an indexed study of snow and ice, the composition of natural waters, the sea and its work, of volcanoes, and many other natural phenomena.

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[1]Letters, I,410.

This text is well-indexed, and it is written simply and clearly. The main chapter headings are: (1) "The Thames," (2) "Springs," (3) "Rain and Dew," (4) "The Crystallization of Water: Snow and Ice," (5) "Evaporation," (6) "The Atmosphere," (7) "The Chemical Composition of Pure Water," (8) "The Chemical Composition of Natural Waters," (9) "The Work of Rain and Rivers," (10) "Ice and Its Work," (11) "The Sea and Its Work," (12) "The Sun," and nine others nearly as important. Huxley wrote on these topics with the avowed purpose of informing the beginner about his familiar surroundings in terms of science so that he could better understand things which he saw about him in everyday life. Many excellent illustrations assist the reader considerably in comprehending what is being discussed.

This text--like the others--went through many editions. Leonard Huxley writes that 3,386 copies of the book were sold during the first six weeks. And he goes on to point out that it was fruitful in two ways: it demonstrated that a geographical subject could be made interesting, and it started what was nearly a new branch of teaching in natural science. Even in Germany it was proposed to publish an adaptation of the book, substituting the River Elbe for the Thames.[1]

The Introductory Science Primer, begun by Huxley in 1871, was finished nine years later. He states that the aim

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[1] Ibid., pp. 510-11.

of the text is "to develop Science out of common observation, and to lead up to Physics, Chemistry, Biology, and Psychology."[1] This book, just as were the others, was written in simple language, suitable for those with no preliminary knowledge of science.

The simplicity of the organization of material may be illustrated by the first chapter--"Nature and Science"--under which comes (1) "Sensations and Things," and (2) "Causes and Effects." Under the first sub-heading the author explains that while awake we are learning by our senses about the world in which we live and of which we form a part; and under the second he asserts that we say all of these things or objects are the causes of the sensations in question. Then Huxley develops each point, using word illustrations to help clarify his statements. This same procedure is followed in the second and third chapters--"Material Objects" and "Immaterial Objects"--of this three-chapter text. In this little book we appear to have a precursor of the modern text in general science.

Huxley believed in the kind of texts that he had written--books especially designed for the classroom--and was convinced that the teaching of science would be improved considerably by their use. The instructor need no longer worry about the dullness of the text, nor should the students be

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[1] Ibid., II, 2.

concerned about its possible obscurity. Instead, scientific knowledge was presented so clearly and concisely that all might read and understand. These books proved to be so successful that poor texts were gradually forced from the classroom.

10. In Retrospect

In his campaign for the recognition of science in education, Huxley was primarily interested in the task of disseminating requisite scientific knowledge. But he realized that if this objective was to be achieved, he and others must give due attention to the pedagogical problems involved. By precept and by practice he showed the value and the technique of the lecture as a teaching device, he illustrated the importance of laboratory experimentation, and he did much to clarify the part that examinations should play in teaching. Deploring the regrettable status of science instruction, he inaugurated a teacher training course which was made permanent because of its great success. And, finally, he wrote modern textbooks as aids to both teachers and students of science. In such ways Huxley effectively translated into action his great interest in science as an integral part of the whole system of British education.

CHAPTER IV

THE CURRICULUM

Along with his criticism of the deplorable status of science in English education, Huxley repeatedly recommended state assistance for scientific instruction. By means of lectures and published discourses, he disseminated previously exclusive scientific information to the workingmen and general public, and he led a movement for the establishment of a system of museums, pointing out that the museum, if properly planned, could be an invaluable medium of scientific education for the untrained masses, as well as for students and teachers. He engaged in the teaching of regular pupils, the writing of textbooks, and the instruction of science teachers in pedagogical methods. Although running into a bitter controversy with antivivisectionists, who were opposed to the laboratory method on humane grounds, Huxley never gave up the fight for experimentation (demonstration). He criticized examinations in general, placing them in the category of necessary evils, but did what he could to improve them. This hard work would have been in vain, however, if Huxley had not made a determined fight to gain recognition for science in the curriculum.

1. General Position: Criticism and Theory of the Curriculum

The fact that Huxley was elected to the London School Board (1870) gave him an opportunity to show, in theory and practice, how scientific training might be introduced into the general system of education.[1] Ainsworth-Davis states that even before his election to the Board Huxley had been quite an effective force relative to improving the teaching of science and establishing this subject as a regular course in the schools:

> Before 1870 Huxley had not been content merely with demonstrating, by the example of his own courses, the methods which ought to be employed in order to make the specialist teaching of science really efficient, but he had also taken every opportunity of expressing his views as to the place of science in a school curriculum, and as to the unsatisfactory nature of school education in Britain.[2]

After 1870, as a member of the School Board, Huxley's direct concern was the curriculum of the elementary schools, although he showed great interest in the curriculum of the secondary schools, the colleges, and the universities as well. His general position on the subject may be found in one of his lectures, "A Liberal Education" (1868). Here he asserts that the pupil should be taught concerning the factors of

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[1] Life and Letters of Thomas Henry Huxley, 2 vols., ed. by Leonard Huxley (New York, 1901), I, 347.

[2] J. R. Ainsworth-Davis, Thomas H. Huxley (London, 1907), p. 99. See also: John William Adamson, English Education, 1789-1902 (Cambridge, 1930), p. 395.

cause and effect in the physical world; that the ill health of the workman is due to poorly prepared food, bad ventilation, bad drainage, and over-work. He complains that, on the contrary, the children and workmen are told that these conditions are the will of God.[1] The facts indicate, he goes on to say, that the elementary school system as a whole is bad, both as to program and results: a child learns to read, write and cipher to a certain extent, then he acquires a slight knowledge of dogmatic theology, though without really understanding it; he next studies principles of morality; he studies Jewish history and Syrian geography, and maybe some English history and local geography, but usually without the benefit of a map; and finally the pupil learns about regularity; attentive obedience, respect for others, which is obtained by means of "fear, if the master be incompetent or foolish; by love and reverence, if he be wise."[2] Though having no science, the child, after completing such a course is considered educated. This did not make sense to Huxley.

In the same lecture--"A Liberal Education; and Where to Find It"--he blasts the repetitious teaching in the higher schools, and deplores the fact that they ignore science even more than the elementary schools; he is also convinced that

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[1]Thomas Henry Huxley, "A Liberal Education; and Where to Find It," Collected Essays, 9 vols. (New York, 1894-1897), III, 88-91.

[2]Ibid., pp. 87-88.

these institutions are doing a very poor job of educating the middle classes. Huxley feels that there may be a little more reading and writing of English in the higher schools but that it is a rare thing to find a boy of the middle or upper classes who can read aloud decently, or who can express himself clearly in correct English. He argues that "ciphering" becomes elementary mathematics, but he feels sure that only rarely has a boy heard the explanation of a rule of arithmetic or learned anything of Euclid except by memory. The student is subjected to the ordeal of learning collects and the catechism by heart as his portion of theology. But to Huxley the most lamentable part of the picture is that "modern geography, modern history, modern literature; the English language as a language; the whole circle of the sciences, physical, moral and social, are even more completely neglected in the higher than in the lower schools," for "Up till within a few years back," avers Huxley, "a boy might have passed through any one of the great public schools with the greatest distinction and credit, and might never so much as heard of one of the subjects I have just mentioned."[1] Thus Huxley sharply criticizes the overall curriculum of the English schools.

The part of the curriculum that Huxley considered overemphasized and of little practical value was that which

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[1] Ibid., pp. 92-93.

embraced the classics. He uses masterful irony in reference to the atrocious verse-making that was demanded of the pupils by the authorities in the middle-class schools. In his "Liberal Education" he points out that there is a close parallel between classical training and paleontology, drawing the following satirical analogy between verse-making and the latter:

> In the first place I could get up an osteological primer so arid, so pedantic in its terminology, so altogether distasteful to the youthful mind, as to beat the recent famous production of the headmasters out of the field in all these excellencies. Next, I could exercise my boys upon easy fossils, and bring out all their powers of memory and all their ingenuity in the application of my osteo-grammatical rules to the interpretation, or construing, of those fragments. To those who had reached the higher classes, I might supply odd bones to be built up into animals, giving great honour and reward to him who succeeded in fabricating monsters most entirely in accordance with the rules. That would answer to verse-making and essay-writing in the dead languages.[1]

Huxley continues his criticism of the emphasis on the classics --and the neglect of science--in the middle-class schools by stating that such studies involve the memorizing of various forms and rules, and translating Greek and Latin into English just for the sake of being able to do so. After about twelve years of this grueling work, largely due to ineffective teaching, the student has learned to loathe Latin and Greek, and very likely will not have learned to read in the original well enough to derive any clear knowledge of antiquity at

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[1]Essays, III, 99.

first hand.[1] Huxley, adding that the manner in which the students attempt to dramatize the classics is a travesty upon English education, asks:

> What, think you, would Cicero, or Horace, say to the production of the best sixth form going? And would not Terrence stop his ears and run out if he could be present at an English performance of his own plays? Would Hamlet, in the mouths of a set of French actors, who should insist on pronouncing English after the fashion of their own tongue, be more hideously ridiculous?[2]

These remarks indicate that Huxley was quite disturbed concerning the poor teaching of the classics and the inevitable results of such instruction. Yet, always hopeful of improvement in pedagogical techniques and ever cognizant of the humanizing influence of the classics, Huxley believed that provision for a fair representation of both science and the classics in the curriculum should be effected by those in authority. Huxley's next move was to show to his critics that children could, and should be taught science, despite the fact that many people objected to such instruction.

In response to criticism to the effect that science is too difficult a subject for children, Huxley points out that these children are forced to learn the difficult catechism. In refuting the argument that the alleged stupidity of children has not been taken into account, he reminds the critics that in nine cases out of ten stupidity is made, not born;

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[1] Ibid., pp. 100-1.

[2] Ibid., p. 99.

hence, most of the burden rests upon the teacher who, however well he may know his subject, must refrain from becoming dogmatic.[1] Hitting at theology again in his defense of science instruction for children, Huxley answers the question as to whether or not a child could be taught science before eleven years of age. In "Minutes of Evidence" (June 15, 1870), he replies:

> Considering the difficult matters with which elementary education is now made to deal, such as the exceedingly difficult problems connected with dogmatic theology and the like, I think science might be taught quite as well. I think that the time which is devoted to the one might with equal success be devoted to the other.[2]

Huxley is further convinced of the necessity and logic of science instruction for the child because, ordinarily, he spends very few years in school; usually before the child gets beyond the primary school, he is forced to drop out and go to work, thereby losing an opportunity to learn the fundamentals of science unless he later goes to an evening school or enrolls in various science lecture series. Huxley admits that the establishment of science classes under the

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[1] Ibid., pp. 128-29.

[2] Royal Commission on Scientific Instruction and the Advancement of Science (London, 1872), I, 23.

Department of Science and Art[1] had proved to be helpful and promising. Under this plan a schoolmaster could set up a class in one or more branches of science, and his students would be duly examined. For those passing, the state paid the schoolmaster a certain stipulated sum. This plan, says Huxley, helped considerably in making it possible for children who had dropped out of school to continue the study of science.[2] But Huxley would rather instruct the child while he can be taught full time in elementary day school, thus enhancing the probability of the pupil's completing the study of science before having to leave school. Huxley states that the only way to help such children and others to become acquainted with modern problems, progress, and natural phenomena is to make the elements of physical science an integral part of primary education, adding that he looks forward to the day when every schoolmaster will help to foster scientific training throughout the country.[3]

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[1] Ibid., I, xix. Concerning this plan for science classes at evening school and elsewhere outside of day school, note the following: "In 1859, the Department . . . originated a system of teaching by means of Elementary Science Classes and of payment on the results of the examination of the scholars . . . . The object of the system introduced by the Science and Art Department was . . . comprehensive, for it proceeded to encourage the formation of a class of teachers in elementary science, and to stimulate and reward their activity by granting a payment, proportionate to attainments, for every pupil who passed an examination in one of certain successive stages of proficiency" (ibid.).

[2] "Scientific Education: Notes of an After-dinner Speech," Essays, III, 131-32.

[3] Ibid., VIII, 230.

One eminent schoolmaster, a Mr. Tregarthen, in his General Report of 1870 quotes from the letter of a Mr. W. W. Tylor, also a schoolmaster, who, writing in behalf of the teaching of elementary science in the schools, echoes the ideas expressed by Huxley in his masterful lecture "On a Piece of Chalk." Tylor is quoted as having stated that in a locality where the roads are made of flint and limestone, the teacher often finds that the fifth and sixth standard children have no conception of the difference between them, and would scarcely be surprised if they were told that one could strike fire from limestone and burn flint into lime. These children do not know the difference between cast and wrought iron; nor do they know that salt and soda will dissolve in water. W. W. Tylor is quoted further in an effort to show his belief in the necessity of teaching the basic facts of science to the students because it is part of their everyday life. Having taught science successfully himself, he feels that he can speak with some authority on the matter.[1]

Also actively interested in Huxley's campaign to secure recognition for science courses in the curriculum was Sir

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[1]Report of the Committee of Council on Education, 1870-71 (London, 1871), p. 223.

John Lubbock,[1] who, while making observations on the curriculum before Parliament (1877), speaks out for science in the spirit indicated by Huxley, stating that this subject should be taught to the young scholar at the beginning of his school career and that "more substantial encouragement should be given to the teaching of the rudiments of science" in the elementary schools. Creating an interest in the subject, he continues, and laying a foundation for further study of science must be accomplished when the child's mind is more receptive, more impressionable.[2]

Such statements show that Huxley's ideas were gaining ground. But progress was slow, and Huxley was far from satisfied. In his lecture "Technical Education," (1877) he tells his audience--the Working Men's Club and Institute Union--that there has been a great advance in general education, but science and art are not faring as well as they should. In a subtle, satirical thrust at three important leaders of the day, Huxley ends upon a note of doubtful optimism:

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[1]Sir John Lubbock (1834-1913), eminent in the field of natural science, was a member of the Royal Institution, Fellow of the Royal Society, Public School Commissioner, Member of Parliament, Vice-Chancellor of London University, Trustee of the British Museum, and Privy Councillor. He served on the Royal Commission on Scientific Instruction (Horace G. Hutchinson, Life of Sir John Lubbock, Lord Avebury, 2 vols. (London, 1914)).

[2]Hansard's Parliamentary Debates, Third Series, CCXXXV (1877), 1060-2.

> I want to see instruction in elementary science and in art more thoroughly incorporated in the educational system. At present, it is being administered by driblets, as if it were a potent medicine, a 'few drops to be taken occasionally in a teaspoon.' Every year I notice that that earnest and untiring friend of yours and mine, Sir John Lubbock, stirs up the Government of the day in the House of Commons on this subject; and also that, every year, he, and a few members of the House of Commons, such as Dr. Playfair,[1] who sympathise with him, are met with expressions of warm admiration for science in general, and reasons at large for doing nothing in particular. But now that Mr. Forster,[2] to whom the education of the country owes so much, has announced his conversion to the right faith, I begin to hope that, sooner or later, things will mend.[3]

In this passage Huxley mentions the efforts being made in the House of Commons on behalf of science in the schools but points out that many people give only lip service to the science instruction program. Huxley is hopeful, however, that Forster will help to give this much-needed program the desired impetus.

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[1]Dr. Playfair (1818-98), was an outstanding chemist. He taught at the Royal Institution, became a Fellow of the Royal Society, was appointed Secretary for Science in the newly formed Science and Art Department, helped to organize the Royal College of Science and the South Kensington Museum. While serving in Parliament, he, like Lubbock, championed the cause of education and served on many commissions of inquiry into the state of education. (Wemyss Reid, Memoirs and Correspondence of Lyon Playfair /London, 1899/).

[2]W. E. Forster (1818-86), served in the House of Commons from 1861 until his death. He introduced the Elementary Education Bill of 1870 which authorized the creation of a school board whose members would be chosen by popular election and he worked to establish the principles of national education and compulsory attendance. The office of Minister of Education which he held for many years helped him to be a great force in shaping English educational policy (Wemyss Reid, Life of William Edward Forster, 2 vols. /London, 1888/).

[3]Essays, III, 418.

2. Huxley's Proposed Curriculum: Science

The courses that Huxley would recommend for the curriculum would be well chosen. He would have elementary drawing, physical training, domestic economy for girls, and agriculture.[1] In "Minutes of Evidence" (June 15, 1870) he proposes mathematics, physical geography (Erdkunde), elementary physics, chemistry, botany, and human physiology in day schools, stating:

> My reason for recommending them is obvious. Of course without mathematics it is impossible to go very far; in fact its importance as a matter of general training is immense; then, without a knowledge of elementary physics and chemistry, all further progress in science comes to an end . . . . Botany I recommend because it is the only branch of natural science which can be taught at first hand conveniently; you cannot teach zoology conveniently, but flowers and plants are always to be had and you can teach botany properly. Human physiology I recommend the teaching of for its practical importance, and it may be taught thoroughly and well.[2]

These subjects, then, are advocated by Huxley because he is sure that they merit being included in the curriculum.[3]

Biology, avers Huxley, is a subject that is valuable to everybody if only because of its connection with war against

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[1] Ibid., pp. 184, 389-400.

[2] Royal Commission, I, 26.

[3] Regarding the time to be allotted to science, Huxley, in "Scientific Education: Notes on an After-dinner Speech" (1869) asserts: " . . . we demand no more than that science shall have as much time given to it as any other single subject--say four hours a week in each class of an ordinary school." (Essays, III, 129).

diseases, and with the study of agriculture. He believes that biology fully deserves recognition in the scheme of education for its proven usefulness, pointing out that if the physiological sciences were not placed in the curriculum, the student would be deprived of the discipline and power of observation derived from studying them. In the essay "On the Educational Value of the Natural History Sciences" Huxley continues by asserting that such a student would be ignorant of facts concerning his own welfare and that of others as well; he would be oblivious of "a living law," and evolutionary change. Huxley drives home his argument by reiterating the basic advantages of the study of biology, especially for children, and by stating how easily they grasp the subject:

> . . . it appears to me that, as with other sciences, the common facts of Biology--the uses of parts of the body--the names and habits of the living creatures which surround us--may be taught with advantage to the youngest child. Indeed, the avidity of children for this kind of knowledge, and the comparative ease with which they retain it, is something quite marvelous.[1]

Concerning the time when one should study biology, Huxley has this to say in "On the Study of Biology" (1876):

> Lastly comes the question as to when biological study may best be pursued. I do not see any valid reason why it should not be made, to a certain extent, a part of ordinary school training. I have long advocated this view, and I am perfectly certain that it can be carried out with ease, and not only with ease,

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[1] Ibid., p. 64.

> but with very considerable profit to those who are taught; but then such instruction must be adapted to the minds and needs of the scholars.[1]

Here Huxley shows both the recognition of the great value of science in the curriculum and the need for instructing students as individuals and not as a group. This indicates his constant awareness of basic pedagogical principles that helped to guide his work as an educator; also, it indicates that he is desirous of having students understand biology whenever it is taught to them.

In proposing physiology for the curriculum, Huxley points out its practical value to man and criticizes man's lack of knowledge of the subject, especially as it relates to everyday life. He asks why it is that educated men maintain that a slaughterhouse located in the midst of the city is to be desired; why mothers dress their children improperly for the cold weather and then become indignant when their offspring become ill and die of bronchitis and gastric fever; and why quackery and spirit-rapping are rampant in a land ruled by supposedly intelligent people, who invariably ascribe it all to Satan. Huxley is convinced that the real cause of

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[1] Ibid., pp. 289-90. Despite recurring illness Huxley shows a keen sense of humor and satire. Writing to a Dr. Dorn (July 7, 1871) he refers to how he and one of his assistants are working to spread science: "He /Lankester/ is helping me as Demonstrator in a course of instruction in Biology which I am giving to Schoolmasters--with the view of converting them into scientific missionaries to convert the Christian Heathen of these islands to the true faith" (Letters, I, 389).

these happenings is an absolute ignorance of the simplest laws of physiology, prevalent among the most highly educated people in the country. If people, says Huxley, especially the younger folk, could have the opportunity to study physiology, many such ills would be eradicated.[1] In advocating instruction in elementary physiology in the schools ("On Elementary Instruction in Biology," 1877), Huxley attempts to make its values appear as concrete and as closely related to everyday life as possible:

> The chief ground upon which I venture to recommend that the teaching of elementary physiology should form an essential part of any organized course of instruction in matter pertaining to domestic economy, is, that a knowledge of even the elements of this subject supplies those conceptions of the constitution and mode of action of the living body, and of the nature of health and disease, which prepare the mind to receive instruction from sanitary science.
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> It is, I think, eminently desirable that the hygienist and the physician should find something in the public mind to which they can appeal; some little stock of universally acknowledged truths, which may serve as a foundation for their warnings, and predispose towards an intelligent obedience to their recommendations.[2]

Huxley believes in the preservation of public health but he realizes that in order for the hygienist and the doctor to be effective in their work, the people must be taught the basic facts of physiology. Otherwise there will be nothing to which the former may appeal in their efforts to get the proper response and cooperation from the latter. Huxley's

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[1] Essays, III, 61.

[2] Ibid., p. 294.

suggestions clearly indicate his belief in the need by the people of a knowledge of physiology before there can be a successful program of public health carried out. This alone was enough to justify his insistence upon the placing of physiography in the curriculum.

Art is a subject that Huxley considers such an inseparable auxiliary of science that he constantly presses for its inclusion in the curriculum. In the lecture, "On Science and Art in Relation to Education" (1882), Huxley enunciates a belief that drawing of one degree or another is necessary, especially in studying the sciences, stating emphatically that anyone who can write can learn to draw:

> . . . I should make it absolutely necessary for everybody, for a longer or shorter period, to learn to draw. Now, you may say, there are some people who cannot draw, however much they may be taught. I deny that <u>in toto</u>, because I never yet met with anybody who could not learn to write. Writing is a form of drawing; therefore if you give the same attention and trouble to drawing as you do to writing, depend upon it, there is nobody who cannot be made to draw, more or less well . . . . I do not think its value can be exaggerated, because it gives you the means of training the young in attention and accuracy, which are the two things in which all mankind are more deficient than in any other mental quality whatever.[1]

Later, Huxley in the "Address on Behalf of the National Association for the Promotion of Technical Education" (1887) indicates that people of science are still handicapped in many instances because of their inability to draw. "Nothing has struck me more in the course of my life than the loss

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[1] <u>Ibid</u>., pp. 183-84.

which persons, who are pursuing scientific knowledge of any kind, sustain from the difficulties which arise because they never have been taught elementary drawing," adding, "and I am glad to say that in Eton . . . we some years ago made drawing imperative on the whole school."[1] Huxley pleads for the teaching of drawing, especially for the masses, because of its helpfulness in industry and trades. He points out that it is an inexpensive course, is of practical utility to the student, and provides an excellent introduction to technical education. He insists upon the appointment of an efficient instructor for such a course, again showing his belief in the importance of good teaching to the effectiveness of any courses that might be offered. Such arguments had practical effects.[2] In 1890, drawing became "an obligatory subject for boys in schools for older scholars, and an optional subject for boys in infant schools and classes."[3]

3. Non-scientific Subjects in the Curriculum

Showing that he is fully aware of the fact that a well-balanced course of study contributes to the making of a well-rounded student, Huxley recommends the permanent inclusion of

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[1] Ibid., p. 432. Huxley was a Governor of Eton College from 1879 to 1888. It was during this period in office that drawing and science were put into the regular course of study (ibid., IX, 222; Letters, II, 3).

[2] Essays, IX, 221-22.

[3] Special Reports on Educational Subjects, 1896-97 (London, 1897), I, 39.

music, or painting, and literature in the curriculum. In the essay "On Science and Art in Relation to Education" (1882), he states that he would add instruction in music or painting but if the student showed no aptitude for either of these, he would see what could be done with literature alone. He is convinced that England has an abundance of excellent art and literature, and believes that a person who cannot derive literary culture from the Bible, Chaucer, Shakespeare, Milton, Hobbes and others, can not get it out of anything else. Huxley would have the pupil study English models in order to see how correct and forceful English is written. Translation would be included because few pupils, claims Huxley, ever learn to read the ancient languages well enough to be able to enjoy the literary masters of antiquity. He concludes by asserting that he would provide, in the fullest sense, for the aesthetic development of the student, especially the child.[1]

Huxley would add German and Latin to the curriculum, but only if time would permit such additions. Thus qualifying this suggestion, he elaborates upon his idea, giving reasons in support of it:

> So, I say, if the time given to education permits, add Latin and German. Latin, because it is the key to nearly one-half of English and to all the Romance languages; and German, because it is the key to almost all the remainder of English, and helps you to

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[1] Essays, III, 184-86.

> understand a race from whom most of us have sprung, and who have a character and a literature of a fateful force in the history of the world . . . .[1]

Thus, Huxley gives evidence of a belief in German and Latin, but he makes it clear that they are to be added to the curriculum only if there is time for them. German was considered essential to any person who planned to specialize in science because many of the leading scientists were German and their learned discourses were invariably to be had only in the original. A knowledge of Latin was considered necessary to one desirous of reading the classics in the original and of better understanding his own native tongue and Romance languages as well. And Huxley would recommend that translations of the classics be made available for those who could not read them in the original.

Following out his argument that the development of the whole child is essential, Huxley recommends physical training as an aid to the training of the eye, ear, and hand, especially of the biological student. "In the broader training of the growing child," writes Foster, "physical training seemed to him to be one of the first of needs, not for the sake only of what some call the body, but for the sake of the whole child."[2] Physical training was of special interest to Huxley because of its connection with public health, and he was

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[1] Ibid., p. 187.

[2] Michael Foster, "Huxley," Huxley Memorial Lectures, ed. by Oliver Lodge (Birmingham, 1914), p. 23.

determined to induce the School Board to give every child under its jurisdiction an adequate program of physical training and drill. Huxley contends that it is impossible to insist too much upon the necessity of such training, especially for the children from poor families in the large towns. He points out that these children live in unsanitary homes and neighborhoods; they have no playgrounds but must amuse themselves with marbles and the like with no chance to play cricket; and their lives are in constant danger because of having to use the streets that are constantly traversed by cab-horses.

Anticipating possible objections based on the assumption that the subject was too difficult to teach, Huxley points out that there is no real obstacle to instruction in drill and the simpler kinds of gymnastics, asserting that the North Surrey Union schools were successfully presenting the course and it was proving quite helpful to the "waifs" and "strays of humanity" who were becoming healthy and useful to society.

Huxley admits that Parliament has shown an interest in the health of the children but he insists that more needs to be done. If Parliament can refuse to make a grant to a school that does not come up to space requirements relative to the number of pupils in a room, then Parliament is able likewise to refuse to give a grant to a school in which physical training is not taught, or "offer to pay upon such training." Huxley states ironically that "If something of this kind is

not done, the English physique, which has been, and is still, on the whole, a grand one, will become as extinct as the dodo in the great towns."[1]

Another subject that Huxley proposes to make an established part of the curriculum is domestic science. He considers this branch of instruction to be helpful to girls because it enables them to run their own homes efficiently and prepares them to serve in the capacity of domestics in the homes of potential employers. Huxley charges that English housewives are notoriously wasteful and are poor cooks; also that "English feeding is either wasteful or nasty, or both." Continuing his criticism of the deplorable status of domestic science, Huxley asserts:

> And as to domestic service, the groans of the housewives of England ascend to heaven! In five cases out of six the girl who takes a "place" has to be trained by her mistress in the first rudiments of decency and order; and it is a mercy if she does not turn up her nose at anything like the mention of an honest and proper economy. Thousands of young girls are said to starve, or worse, yearly in London; and at the same time thousands of mistresses of households are ready to pay high wages for a decent housemaid, or cook, or a fair workwoman; and can by no means get what they want.
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> Surely, if the elementary schools are worth anything, they may put an end to a state of things which is demoralising the poor, while it is wasting the lives of those better off in small worries and annoyances.[2]

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[1] "School Boards: What They Can Do and What They May Do," Essays, III, 390-91.

[2] Ibid., pp. 392-93.

Apparently training in domestic science was lagging behind the demand, and Huxley argued that the School Board should try to get Parliamentary grants for this work as well as for physical training and the study of the elementary laws of conduct.

Huxley contended that it was impossible to insist too much upon the teaching of physical training and drill to the children of the large cities because all surrounding conditions were unfavorable to their physical well-being. These urban children were badly housed, poorly fed; moreover, they lived in need of fresh air. There were no playgrounds except the dangerous streets. The School Boards should make provisions, then, for courses in physical training and for organized playgrounds.

4. Huxley's Stand on Bible Study in the Schools: Religious Controversy

In addition to physical training Huxley urged the introduction of moral training, because he believed that the teaching to children of the elementary laws of conduct was quite necessary. This training should impel the boys and girls to deport themselves in such a way that they would achieve the highest good for their fellow-man and for themselves. An invaluable aid to this endeavor, thought Huxley,

was the Bible. Accordingly he proposed that it be employed as a source of moral and spiritual guidance.[1]

Moreover, Huxley's proposal throws more light on his attitude toward science and indicates no change in his hostility toward dogmatic theology, a subject which he considered the very antithesis of science. In short, Huxley advocated the teaching of the Bible but only in a non-denominational manner. This self-styled agnostic, acting upon his honest convictions, enunciates his stand relative to making the Bible one of the subjects of the curriculum and points out both the proper and the improper way to teach such a course:

> On the whole, then, I am in favor of reading the Bible, with such grammatical, geographical, and historical explanations by a lay-teacher as may be needful, with rigid exclusion of any further theological teaching than that contained in the Bible itself. And in stating what this is, the teacher would do well not to go beyond the precise words of the Bible; for if he does, he will, in the first place, undertake a task beyond his strength, seeing that all the Jewish and Christian sects have been at work upon that subject for more than two thousand years, and have not yet arrived, and are not in the least likely to arrive, at an agreement; and, in the second place, he will certainly begin to teach something distinctively denominational, and thereby come into violent collision with the Act (1870) of Parliament.[2]

The thing that most people either did not understand or would not understand was that he proposed the proper teaching

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[1] Ibid., pp. 391-94.

[2] "The School Boards: What They Can Do and What They Will Do," Essays, III, 398-99.

of the truths of Christian life and conduct, and not the teaching of theological dogma. Writing to his friend and biographer, Mr. Clodd (1879), Huxley recalls what happened back in 1870:

> . . . when I was a member of the London School Board I fought for the retention of the Bible, to the great scandal of some of my Liberal friends--who can't make out to this day whether I was a hypocrite, or simply a fool on that occasion.[1]

Huxley felt that the Bible was of too great a literary value to the masses for it to be summarily discarded, despite the fact that the Education Act of 1870 held that "no religious catechism or religious formulary which is distinctive of any particular denomination shall be taught in the school"[2] if under school management.

In a fairly weak, though sincere defense of his stand on the matter, Huxley assures us that he would send one of his own children to a school offering religious instruction in preference to one not doing so:

> . . . if I were compelled to choose for one of my own children, between a school in which real religious instruction is given, and one without it, I should prefer the former, even though the child might have to take a good deal of theology with it. Nine-tenths of a dose of bark is mere half-rotton wood; but one

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[1] Letters, II, 9.

[2] Hugh Owen, The Elementary Education Acts, 1870-1891 (London, 1891), p. 79. This is known as the Cowper-Temple clause pertaining to board schools only; this clause removed the necessity of giving religious subjects to get parliamentary annual grants. The offering of such subjects was left to the discretion of the board of the school and attendance was not compulsory.

> swallows it for the sake of the particles of quinine, the beneficial effect of which may be weakened, but is not destroyed, by the wooden dilution, unless in a few cases of exceptionally tender stomachs.[1]

In further proof of his dislike for theology only, and not for the Bible, Huxley decries the fact that theology, a subject based upon dogma, had (along with philosophy) dominated the schools and universities for a very long time,[2] and contends that it had no right to such a position, especially when it meant exclusion or neglect of science, a subject based upon truth. This constant fight against dogmatic theology had several focal points, but a discussion of two of these will suffice for this study.

The basic tenets that Huxley attacked were (1) the Biblical theory of origin, which held that creation took place in six days and (2) miracles. Concerning the first, Huxley contends that there is nothing scientific about it, and because of this, he would ignore it. In "The Darwinian Hypothesis" (1859) he points out that many believe that the writer of the Pentateuch was given the power and authority to teach people scientific and other truth, and that the account of creation is correct. Further, they feel that anything that contradicts the Biblical theory of origin is false. Huxley contends that the belief that every species was produced by "A distinct

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[1]"The School Boards: What They Can Do, and What They Will Do," Essays, III, 396.

[2]"Science and Morals," Essays, IX, 144.

creative act" cannot be proved or disproved, because the "direct operations of the Creator" are not subjects of science.[1] Referring to one of his most astute critics, Huxley says that "It is Mr. Gladstone, and not I, who will have it that the pentateuchal cosmogony is to be taken as science," adding, "My belief, on the contrary, is, and long has been, that the pentateuchal story of creation is simply a myth."[2] In a later essay Huxley indicates that his position is unchanged, asserting: "Now, not only do I hold it to be proven that the story of the Deluge is a pure fiction; but I have no hesitation in affirming the same thing of the story of the Creation."[3]

It was Huxley's conviction, so ably expressed in "Origin of Species" (1859), that Darwin's hypothesis of creation was easily understood, its essential positions being:

> . . . all species have been produced by the development of varieties from common stocks; by the conversion of these, first into permanent races and then into new species, by the process of natural selection, which process is essentially identical with that artificial selection by which man has originated the races of domestic animals--the struggle for existence taking the place of man, and exerting, in the case of natural selection, that selective action which he performs in artificial selection.[4]

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[1] Essays, I, 10-11.

[2] Ibid., IV, 180.

[3] "Lights of the Church and Science," Essays, IV, 234. In "Hasisadra's Adventure" (1891) Huxley goes to great lengths to disprove the story of the Noachian deluge (ibid., pp. 239-86).

[4] Essays, I, 71.

In 1892 Huxley reaffirms his earlier stand on the question of origin, stating that "The first chapter of Genesis teaches the supernatural creation of the present forms of life; modern science teaches that they have come about by evolution."[1]

As a result of his stand for evolution, Huxley was accused of saying that man was descended from the ape, a charge that is usually associated with his memorable encounter with Bishop Wilberforce at the meeting of the British Association at Oxford in 1860. Bishop Wilberforce, in discussing a paper[2] that had just been read, criticized its similarity in principle to Darwin's theory of evolution, and ridiculed Darwin and Huxley savagely. Being a leading churchman and bitterly opposed to the theory of evolution, he turned to Huxley and asked him if it was through his grandfather or his grandmother that he claimed descent from a monkey. Huxley reportedly gave the following reply:

> I asserted--and I repeat--that a man has no reason to be ashamed of having an ape for his grandfather. If there were an ancestor whom I should feel shame in recalling it would rather be a man--a man of restless and versatile intellect--who, not content with an equivocal success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless

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[1] Ibid., V, 34.

[2] This controversial paper on the "Intellectual Development of Europe Considered with Reference to the Views of Mr. Darwin" was read by a Dr. Draper, scientist of New York (Letters, I, 195-96).

> rhetoric, and distract the attention of his hearers from the real point at issue by eloquent digressions and skilled appeals to religious prejudice.[1]

Thus masterfully rebuked, Wilberforce held his peace, now painfully aware of the fact that he had boldly but not wisely stepped out of his field, and that he was still vainly pitting religious authority against scientific truth.

Huxley opposed the teaching of miracles on grounds similar to those which actuated his hostility toward the story of creation: they have no scientific foundation. Miracles had found an able champion in William Gladstone who had been extremely annoyed by Huxley's treatment of Genesis. Gladstone, well known for his services as Prime Minister, took an orthodox stand in the controversy over the miracle of the Gadarine swine. This was the Biblical story stating that a man, possessed of many devils was made whole by the transmission of the devils into a herd of swine that madly plunged over a cliff into the sea.[2] Huxley contends that if Jesus did this, he was no better than a lawbreaker in that he had deliberately destroyed the property of another. Showing a rare sense of humor and a fine gift for sarcasm, Huxley maintains that the story of the Gadarine swine could not stand up under scientific scrutiny. The "renowned warrier," Huxley satirically asserts, is on the warpath:

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[1] Ibid., pp. 197-99. Just before rising to answer the challenge, Huxley said to a Mr. Brodie who was seated beside him, "'The Lord hath delivered him into mine hands'" (ibid., p. 197).

[2] W. E. Gladstone, The Impregnable Rock of Holy Scripture (Philadelphia, 1891), pp. 322-29.

> The weapon has been wielded with all the dexterity which long practice has conferred on a past master in craft, whether of wood or state. And I have reason to believe that the simpler sort of the great tribe which he /Gladstone/ heads, imagine that my scalp is already on its way to adorn their big chief's wigwam. I am glad therefore to be able to relieve any anxieties which my friends may entertain without delay. I assure them that my skull retains its normal covering, and that though, naturally, I may have felt alarmed, nothing serious has happened.[1]

Huxley is of the opinion that emphasis on the "antagonism" that exists between science and religion is not the way to get at the real truth of the situation because this "antagonism" is fabricated by short-sighted religious people who confuse theology with religion, and by scientific people who forget that science deals only with that which is susceptible of intellectual comprehension.[2]

Huxley was consistent in his attitudes, and as a result he was constantly engaged in controversies because of favoring the teaching of the Bible in the schools and at the same time opposing the teaching of dogmatic theology. As late as 1893, only two years before his death, he shows his concern about the continued efforts on the part of some to revive the teaching of theological dogma, despite the forbidding of such practice by the Education Code of 1870; and he is resolved to oppose "the desperate attempt now set afoot to force biblical

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[1] "The Keepers of the Herd of Swine," Essays, V, 366-67.

[2] "The Interpreters of Genesis and the Interpreters of Nature" (1885), Essays, IV, 160-61.

and post-biblical mythology into elementary instruction,"[1] regardless of the enormity of the undertaking. In this same year he answers a letter in the Times that charged him and others who framed the rule concerning religious teaching in 1871 with intending it to permit definite teaching of theological dogmas:

> I cannot say what may have been in the minds of the framers of the rule; but, assuredly, if I had dreamed that any such interpretation could fairly be put upon it, I should have opposed the arrangement to the best of my ability. In fact, a year before the rule was framed I wrote an article in the Contemporary Review, entitled "The School Boards--what they can do and what they may do," in which I argued that the terms of the Education Act excluded such teaching as is now proposed to include.[2]

5. Huxley-Arnold Controversy: Science Versus the Classics

Certainly no account of Huxley's relation to the curriculum would be complete without a summary of the controversy between Huxley and Matthew Arnold on the question of science versus belles lettres in the curriculum. In fact, he and Arnold for some time carried on a rather polite and restrained quarrel concerning the relative merits of science and the humanities in the schools. Both men were officially connected with English education, Arnold as an inspector of schools and

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[1] Ibid., V, x.

[2] T. H. Huxley, "On Religious Teaching in Board Schools," The Times (London), April 29, 1893, p. 7.

Huxley as a member of various educational bodies. And both were deeply concerned about the relative status of science and the classics in education, Huxley because the classics dominated the curriculum and Arnold because he believed that Huxley--along with other scientists--was determined to win curricular priority for science.

The respective positions of Huxley and Arnold were clearly defined. The former contended that scientific education was preferable to classical training and the latter argued that just the opposite was true. Both men, however, believed that a felicitous combination of scientific and classical studies would constitute an even more effective curricular program.

The dispute between Huxley and Arnold was brought into the open by the former in an address delivered at the opening of Sir Josiah Mason's Science College in Birmingham (1880).[1] In this speech Huxley accuses the Humanists of holding classical education to be the sole avenue to culture, and charges these "Levites of Culture" with having a monopoly on liberal education while they were at the same time opposing the introduction of physical science into the educational scheme.[2] Further, Huxley disagrees with Arnold's contention

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[1] "Science and Culture," Essays, III, 149.

[2] Ibid., pp. 136-37. One writer asserts that "the monopoly accorded to Greek and Latin rendered modern studies impossible, and . . . the neglect of science was scandalous" (Adamson, op. cit., p. 309).

that literature contains the materials which suffice for the construction of a criticism of life, and argues that literature alone is not competent to supply this knowledge, but must have help from science.[1]

Continuing to point out the inadequacy of literature, Huxley states that one must study modern science in order to learn what is going on in the present and what has happened in the past, adding that a thorough literary education, such as that proposed by Arnold, is out of the reach of most students:

> . . . if you look upon the literature of a people as a chapter in the development of the human mind, if you work out this in a broad spirit, and with such collateral references to morals and politics, and physical geography, and the like as are needful to make you comprehend what the meaning of ancient literature and civilization is,--then, assuredly, it affords a splendid and noble education. But I still think it is susceptible of improvement, and that no man will ever comprehend the real secret of the difference between the ancient world and our present time, unless he has learned to see the difference which the late development of physical science has made between the thought of this day and the thought of that, and he will never see that difference, unless he has some practical insight into some branches of physical science; and you must remember that a literary education such as that which I have just referred to, is out of the reach of those whose school life is cut short at sixteen or seventeen.[2]

Here Huxley repeats an argument he had previously made (1868) that very few students stay in school long enough to learn to read the classics with the facility required of one who

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[1]"Science and Culture," Essays, III, 142-44.

[2]Ibid., p. 182.

seeks a literary education.[1] This meant that the so-called humanists were linguistically incapable of going into the knowledge stored in the archives of antiquity, such as the mathematics and astronomy of Hipparchus and Ptolemy, physics from Democritus and Archimedes, and biology by Aristotle, Theophrastus, and Galen. More than that we must realize the differences which the development of science has made between the thought of our day and that of antiquity. These differences, however, will be difficult--if not impossible--for us to see because, avers Huxley, the humanists have not fully understood and explained the culture of the Greeks.

In a lighter vein Huxley criticizes Arnold's opposition to science, stating in "Science and Culture" (1880), with mock dignity, that the latter speaks against science by implication:

> I am too well acquainted with the generous catholicity of spirit, the true sympathy with scientific thought, which pervades the writings of our chief apostle of culture to identify him with these

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[1]Huxley declares that the schoolboy "finds Parnassus uncommonly steep . . . . And nine times out of ten he does not get to the top." (T. H. Huxley, "A Liberal Education" (1868), Essays, III, 100). Oddly enough, in this same year (1868), Arnold makes a very similar assertion concerning the students who actually learned to read the classics well enough to acquire the knowledge of the spirit and power of Greek and Roman antiquity: "Such students are rare; and nine out of ten, especially in England, where so much time is given to Greek and Latin composition, never get through the philological vestibule at all, never arrive at Alterthumswissenschaft, which is a knowledge of the spirit and power of Greek and Roman antiquity learned from its original works." (Matthew Arnold, Higher Schools and Universities in Germany, 2nd ed. (London, 1892), p. 163).

> (adverse) opinions; and yet one may cull from one and another of those epistles to the Philistines, which so delight all who do not answer to that name, sentences which lend them some support.[1]

Here Huxley contends that Arnold is guilty of adversely criticizing science and at the same time proclaiming himself to be kindly disposed toward the subject.

Arnold, however, defends his stand by charging Huxley with implying that belles lettres--a term connoting a "superficial humanism" as opposed to positive science and truth-seeking--is being discussed;[2] in short, Arnold accuses Huxley of confusing the issue, and adds that he (Arnold) is referring to something much more substantial and pertinent than "superficial humanism";

> When I speak of knowing Greek and Roman antiquity, therefore, as a help to knowing ourselves and the world, I mean more than a knowledge of so much vocabulary, so much grammar, so many portions of authors in the Greek and Latin languages. I mean knowing the Greeks and Romans, and their life and genius, and what they were and did in the world; what we get from them, and what is its value.[3]

Further explaining his position relative to the definition of terms, Arnold asserts that he is referring to literature in the truly broad sense:

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[1] Essays, III, 142.

[2] Matthew Arnold, Discourses in America (London, 1912), pp. 85-86.

[3] Ibid., p. 88.

> But as I do not mean, by knowing ancient Rome knowing merely more or less of Latin belles lettres, and taking no account of Rome's military, and political and legal, and administrative work in the world; and as, by knowing ancient Greece, I understand knowing her as the giver of Greek art, and the guide to a free and right use of reason and scientific method, and the founder of our mathematics and physics and astronomy and biology,--I understand knowing her as all this, and not merely knowing certain Greek poems, and histories, and treatises, and speeches,--so as to the knowledge of modern nations also. By knowing modern nations, I mean not merely knowing their belles lettres, but knowing what has been done by such men as Copernicus, Galileo, Newton, Darwin.[1]

Here Arnold, in his argument based upon the assumption that one can only understand the present by knowing the culture of the past, does not refute Huxley's contention that even the most elementary acquaintance with the results of scientific investigation shows a broad contradiction to the teachings of the middle ages; that training in the culture of antiquity is therefore for the most part undesirable because of this great contradiction between the teachings of the present and those of earlier ages. Moreover, the ability of students to read the classics well enough to derive any great benefit from the works of antiquity is often despaired of by Arnold as well as Huxley. Unskilled teachers were incapable of preparing students adequately in the classics and were largely responsible for the inability of many potential classical scholars to scale the heights in the field of the humanities. On the whole, however, in practical matters Arnold differs

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[1] Ibid., pp. 91-92.

little from Huxley as long as the latter will accord science and the classics equal importance in the regular course of studies. In short, both see the need for science and the classics in the curriculum. When, however, Huxley expresses a desire to give science the more important role in education, Arnold quickly objects.

In his "Science and Culture" delivered at Josiah Mason College (1880), Huxley speaks with playful sarcasm of the humanists relative to their belief in the all-encompassing completeness and sufficiency of classical training, calling them "Levites in charge of the ark of culture."[1] Throughout this provocative lecture his criticism of the classics is less lenient than usual, and in it, he sums up his views in the controversy between Arnold and himself:

> For I hold very strongly by two convictions--the first is, that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time upon either; and the second is, that for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education.[2]

Huxley adds pointedly that the humanists consider those who have studied the classics as educated, but decree that the specialists in science are "not admissible into the cultured caste."

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[1] T. H. Huxley, "Science and Culture," Essays, III, 137.

[2] Ibid., p. 141.

[3] Ibid., p. 142.

After Huxley's speech at Josiah Mason College, Arnold was convinced that more than a supplementary role was being sought for science by the "reformers of education," and he set forth a powerful argument for his own position on the subject in his carefully prepared "Literature and Science." He charges that Huxley and other scientists plan to make natural science the main part of education for the majority, and relegate the classics to a position of minor importance. This near exclusion of the humanities was more than Arnold could countenance. For this reason he states that he must part company with the friends of physical science with whom, up to this point, he has been in agreement.[1] Continuing in an ironic tone, Arnold admits that the smallness of his acquaintance with the disciplines of natural science is ever before his mind and that he is fearful of doing these disciplines an injustice. He points out that he will take the tone of tentative inquiry, which "befits a being of dim faculties and bounded knowledge."[2]

In attempting further to show that a scientific education cannot, as a rule, give one the rich training afforded by the classics, Arnold argues that a scientist is the exception if he can derive from science alone that which the average person has to get from humane letters:

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[1]Arnold, "Literature and Science," Discourses in America, pp. 99-100.

[2]Ibid., p. 100.

> Let us therefore, all of us, avoid indeed as much as possible any invidious comparison between the merits of humane letters, as means of education, and the merits of the natural sciences. But when some President of a Section for Mechanical Science insists on making the comparison, and tells us that "he who in his training has substituted literature and history for natural science has chosen the less useful alternative," let us make the answer to him that the student of humane letters only, will, at least, know also the great general conceptions brought in by modern physical science; for science, as Professor Huxley says, forces them upon us all. But the student of natural science only, will, by our very hypothesis, know nothing of humane letters; not to mention that in setting himself to be perpetually accumulating natural knowledge,he sets himself to do what only specialists have in general the gift for doing genially. And so he will probably be unsatisfied, or at any rate incomplete, and even more incomplete than the student of humane letters only.[1]

Here Arnold again shows clearly his conviction that if there must be a choice between science and humane letters, it would behoove one to choose the latter; and that in spite of the fact that science is growing in prominence, there will always be a need for humane letters.

Undoubtedly this friendly controversy worked more for the good of education in England than otherwise. For one thing, it brought to the attention of many the inefficiency of the teaching of the classics--and of science also, for that matter; and for another it revealed that there were basically no irreconcilable differences between the advocates of science and the advocates of the classics, that, indeed they agreed that there was a place for both science and the

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[1] Ibid., pp. 125-26.

classics in the well-planned English school. One of Arnold's biographers sums up the controversy thus:

> [Arnold] draws his rapier in behalf of the humanists, and exchanges a few courteous thrusts with . . . Huxley . . . . With Huxley, who asked large concessions from the humanists, Arnold could come to an understanding, if not to a perfect agreement.[1]

Both agreed that there must be a more equitable emphasis upon subjects in the curriculum, and that science, long neglected, must be given due recognition. But it is quite obvious that neither Huxley nor Arnold would relinquish the claim of priority for his field of educational interest, science for the former and the classics for the latter.

Thus do we leave this genteel Huxley-Arnold dispute concerning the relative importance of science and belles lettres in the curriculum.

6. Need for Coordination of Curriculum from Elementary to University Level

Huxley was not only interested in winning curricular prestige for science but he was also concerned about some general phases of the curriculum. The course of study, to

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[1]Stuart P. Sherman, Matthew Arnold: How to Know Him (New York, 1932), p. 205. Dr. Walcott, like Sherman, believes that basically Huxley and Arnold are in accord, and that perhaps the differences between the two men were really the result of misunderstanding: "If Huxley had misapprehended Arnold's broad concept, he (Arnold) had only to correct that misapprehension in order to bring the two into general harmony" (Fred G. Walcott, Matthew Arnold and the Growth of Democratic Education in England (University of Michigan Dissertation, 1945), p. 235).

be effective, thought Huxley, must be planned so that the work done in the elementary schools would bear a direct relationship to that pursued in the university. In an "Address on University Education" (1876) he tells his Johns Hopkins University listeners that the elementary school should lay the foundation for the university, the latter being able to add nothing new, but merely to specialize and intensify the study of courses taken earlier. He believes that if secondary "schools are established, . . . they should be true intermediaries between the primary school and the university,"[1] thus assisting in the coordination of the curricula of all levels. Huxley explains how this plan should work. For example:

> Physical science will have its great divisions of physical geography, with geology and astronomy; physics; chemistry and biology; represented not merely by professors and their lectures, but by laboratories, in which the students, under guidance of demonstrators, will work out facts for themselves and come into that direct contact with reality which constitutes the fundamental distinction of scientific education.[2]

The universities toward which the elementary curriculum pointed, however, were guilty of being unprepared to improve a student's elementary education very much because they had been neglectful of their academic obligations. Colleges had become advanced elementary schools, teaching the classics and ignoring science, especially in research. The universities had become "clerical seminaries" and "boarding schools

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[1] Essays, III, 241.

[2] Ibid., p. 240.

for youths."[1] To remedy this situation, Huxley suggests that science--and other needed subjects--be placed in the university curriculum. In 1868-69 he and Tyndall, the eminent physicist, drew up a model scheme for science teaching at International College, on the council of which they both served. Their plan was as follows:

> Seven yearly grades were arranged in this scheme, proceeding from the simplest account of the phenomena of nature taught chiefly by object lessons, largely through the elements of Physics and Botany, Chemistry and Human Physiology--all illustrated with practical demonstrations--to more advanced work in these subjects, as well as in Social Science, which embraced not only the theory of commerce and government but the Natural History of Man up to the point at which Ethnology and Archaeology touch history.
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> . . . . . .
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> In the three later stages the boys might follow alternative lines of study according to their tastes and capacities; but of the earlier part, which was to be obligatory upon all, the report says:--These four years study, if properly employed by the teachers, will constitute a complete preparatory scientific course. . . . (A) wise teacher . . . will be able . . . to give the scholar a notion of the methods and of the ideas which he will meet with in his further progress in all branches of physical science.[2]

Such ideas took hold. By the beginning of the last quarter of the century, science had made notable progress in the universities, especially Oxford and Cambridge. In "Universities: Actual and Ideal" (1874), Huxley states that within the last twenty years Oxford has spent more than a hundred and twenty thousand pounds on physical, chemical,

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[1] Ibid., pp. 101-7.

[2] Letters, I, 331-32.

and physiological laboratories, and a museum; and Cambridge is following the same course. He adds that "in a few years it will be for no lack of the means and appliances of sound teaching, if the mass of English university men remain in their present state of barbarous ignorance of even the rudiments of scientific culture."[1] He warns, however, that science should have a faculty just as do theology, law, medicine and other departments, and that its members should teach advanced courses in science, so that students who planned to go into medicine and other special fields of science could complete courses that they would otherwise have to take after beginning to specialize.

In 1881 Huxley writes to a friend, Professor William Fowler, vowing to make Oxford recognize the importance of biology, declaring: "I mean to give biological science a status in the eyes of the Dons, and to force them to acknowledge it as a part of general education."[2] Still concerned about the status of science at Oxford, Huxley writes to a fellow scientist, Professor Lankester, asserting that the science student should be taught more biology, especially in the line of morphology; and, that the future medical

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[1] Essays, III, 214-15. Huxley praised the Scottish universities for their emphasis on science in the curriculum (ibid., p. 212).

[2] Letters, II, 33.

student should be given more elementary anatomy and physiology.[1] Thus did Huxley continue his attempts to improve the status of science in the universities.

Although he was fairly successful in his efforts to rouse the colleges and universities out of their lethargy in regard to science, Huxley admits that sectarian colleges cannot be relied upon to assist in this particular. In a letter to his friend, Professor Roscoe (1887), Huxley denounces this situation which he had seen at first hand as a member of the school board:

> Ever since I was on the London School Board I have seen that the key of the position is in the Sectarian Training Colleges and that wretched imposture, the pupil teacher system. As to the former Delendae sunt no truce or pact to be made with them, either Church or Dissenting. Half the time of their students is occupied with grinding into their minds their tweedle-dum and tweedle-dee theological idiocies, and the other half in cramming them with boluses of other things to be duly spat out on examination day. Whatever is done do not let us be deluded by any promises of theirs to hook on science or technical teaching to their present work.[2]

Huxley's wrath is evident here, and the reasons for his anger are obvious: dogmatic theology is twice villain in that it is false, difficult, and useless in itself; and it acts as a block to science, a subject based on truth and utility. In a letter to Professor Foster several years later (1892) asking him to come to London and set up a course in physiology at

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[1] Ibid., p. 300.

[2] Ibid., p. 166.

the Royal College of Science, Huxley writes that at this institution neither theologians nor classicists cause him worry because "It is the only place in Great Britain in which scientific teaching is tramelled neither by parsons nor by litterateurs,"[1] undoubtedly referring to Wilberforce, Arnold and others of theology and the humanities. This sarcastic thrust at theology and the classics reminds us that, even three years before his death, Huxley was still aware of the retardation of the growth of science in the schools caused by these two hostile forces.

7. The Medical Curriculum

Huxley further extended his interest in curriculum to the medical school. The medical curriculum proposed by Huxley was based upon studies offered in the curricula of the elementary school and the university.[2] The medical program was of interest to Huxley because he was a doctor by profession, and because it embraced the study of science, his favorite subject. The conclusion that Huxley reached after constant examination of the medical curriculum was that it needed to be revised. For one thing, the student was expected to master too many subjects, some of which he should have had before coming to medical school, others of which were not even needed, and should be discarded. He maintains that the medical

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[1] Ibid., p. 331.

[2] "Address on University Education" (1876), Essays, III, 251.

student should not be expected to know something about everything; instead, he should take foundation courses during the first two years, then specialize for the rest of his time in school. In "Universities: Actual and Ideal" (1874), he expresses his ideas about the curriculum:

> If I had the power to remodel Medical Education, the first two years of the medical curriculum should be devoted to nothing but such thorough study of Anatomy and Physiology, with Physiological Chemistry and Physics; the student should then pass a real, practical examination in these subjects; and, having gone through that ordeal satisfactorily, he should be troubled no more with them. His whole mind should then be given with equal intentness to therapeutics, in its broadest sense, to Practical Medicine and to Surgery, with instruction in Hygiene and Medical Jurisprudence; and of these subjects only . . . should he be required to show a knowledge in his final examination.[1]

Huxley emphasizes the importance of pathology and therapeutics, and their dependence for effectiveness upon a sound foundation of biology, his favorite subject.

Huxley further suggests that a candidate for the degree in medicine should not be required to pass an examination in botany and zoology as a part of the professional examination, but instead, he should be tested in these subjects before he has begun his medical studies. He also advocates that candidates be no longer required to pass an examination in Greek, but should substitute German or French, leaving Greek as one of the optional subjects.[2]

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[1] Ibid., p. 218. See also: Ibid., p. 252.

[2] "On the Medical Curriculum," Essays, IX, 21.

A regular medical subject to which Huxley objects is materia medica as it relates to drugs. In "On Medical Education" (1870) he recalls his own experience with the subject, asserting that he studied night and day, mastered the material, then forgot it all within a week, with no trace of a knowledge of drugs remaining in his memory. He states that he "cannot understand the arguments for obliging a medical man to know all about drugs and where they come from."[1] The subjects remaining for the four years of medicine as listed by Huxley are: (1) physics applied to physiology, (2) chemistry applied to physiology, (3) physiology, (4) anatomy, (5) surgery, (6) medicine (including therapeutics), (7) obstetrics, (8) hygiene, (9) and medical jurisprudence. We notice that he did not include materia medica in the subjects recommended.[2]

Huxley's main ideas about the medical curriculum were, therefore, as follows: he would have the prospective student finish all of his preparatory courses in the elementary schools or colleges, and then come to medical school, with only the regular courses to negotiate; he would discard materia medica; and he would replace Greek with German or French because much scientific research written in these languages would thereby be made accessible to the future doctor. These recommendations, and others made by him in the capacity

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[1] Essays, III, 320.

[2] Ibid., p. 321.

of Lord Rector of Aberdeen University, were accepted and put into use at the medical college there by March, 1874, about four months after Huxley had passed in the resolutions.[1]

Huxley's concept of the plan and function of the curriculum of all schools was to have sufficient science at all levels--along with other necessary subjects--to enable one to become a skilled worker if he must leave regular school early; to give the future man of science and the doctor sufficient basic science to insure their steady progress; and to make everybody realize the importance of the relationship existing between science and everyday life. He endeavored to drive home the point that all levels and phases of the curriculum belonged to an articulate whole, and that this whole must be achieved by equitable apportionment of place and time in the curriculum to all worthy subjects, and the proper coordination of the curriculum from the lowest to the highest level.[2]

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[1] Letters, I, 439.

[2] As soon as Huxley became a member of the School Board (1870) he began to work harder to secure science a regular place in the curriculum. In the New Code of 1871 science was placed in the curriculum as an "extra subject" (Royal Commission, I, xv). In the New Education Code for 1885-86 schools that wanted to qualify for grants, offered, in addition to the three R's: (1) optional subjects open to all, which included drawing and elementary science; (2) specific subjects which included mechanics, chemistry, physics, animal physiology, botany, agriculture, and domestic economy, to be taken by children in the upper classes of the school (John Russell, ed., New Education Code for 1885-6 (London, n.d.), pp. 11-12). Later, the Day School Code of 1900 offered drawing, physiography, geography, elementary science, mechanics, animal physiology, botany, horticulture, agriculture, chemistry; sound, light, and heat; magnetism and electricity; physics and chemistry. These subjects were to be taught so that they increased in difficulty from the lower standards through the upper standards (Code of Regulations for Day Schools (London, 1900), pp. 33-45).

CHAPTER V

TECHNICAL EDUCATION

1. Huxley's General Relation to Technical Training

In his advocacy of science in English education Huxley put great emphasis upon technical training. Always keenly observant, he saw that mass-production methods were being rapidly introduced into industry and that industrial and commercial competition from Germany and other continental countries was growing stronger.[1] By 1876 he was convinced that such a situation required technical education of a different nature from, and of a broader scope than, anything yet available in England.

Huxley's interest in promoting technical education was sharpened by the relative apathy on the part of the state and local authorities and of private organizations.

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[1] In nearly every country on the continent there were technical high schools that served as a source of instruction for future directors and foremen of industrial establishments. Student fees were practically nothing and teachers received excellent salaries. Both management and labor knew a great deal about the theory and practice of industry. Germany--along with other countries on the continent--was making serious inroads upon England's industry and commerce. (Second Report of the Royal Commissioners on Technical Education, 5 vols. (London, 1884), I, 508-10).

Something was being done, but certainly not enough.[1] Youth of the proper age for technical instruction were being neglected by the government. The system of apprenticeship had broken down, and many inventions had made mass production the order of the day, a development which made systematic technical training mandatory.[2] Huxley, convinced that science and industry were inseparable, deplored the fact that England had neglected to train the artisan in the modern techniques and skills.

Even as early as 1854, when Huxley was given his first position as a teacher at the Royal School of Mines, he showed a marked interest in technical education, an interest that was destined to grow to major importance. It was largely because of his insistence upon curricular changes that this school later that same year enlarged its course of instruction in order to meet the increasing demand for technical training. To help meet this exigency, Huxley proposed four divisions of instruction: (1) The General Division for those desiring a general knowledge of applied science; (2) Mining and Metallurgy Division for students interested in those fields; (3) a Technical Division for arts and manufacturers

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[1]The Royal Commission on Technical Instruction was appointed in 1881 to gather information in England and on the continent on the subjects of technical, scientific, and artistic education, and the effect of such training upon manufactures and commerce (ibid., pp. 536-40).

[2]Thomas H. Huxley, "The Struggle for Existence in Human Society," Collected Essays, 9 vols. (New York, 1894-1897), IX, 223-24.

depending mainly on chemical or mechanical principles; and (4) a Working Men's Division designed for men who could attend only evening lectures.[1] This comprehensive, yet thorough plan of technical instruction, worked with untold success.

It was about twenty years, however, before Huxley began an active campaign to bring such programs to the attention of the public. In 1877 he launched a campaign for technical education. Delivering an address that year to the Working Men's Club and Institute he expressed clearly his profound interest in technical training as well as education in general:

> . . . in the course of the last ten years, to go back no farther, I am afraid to say how often I have ventured to speak of education, from that given in the primary schools to that which is to be had in the universities and medical colleges; indeed, the only part of this wide region into which, as yet, I have not ventured is that /technical education/ into which I propose to intrude today.[2]

In this same address Huxley reminds his audience that when he was a member of the London School Board he advocated providing "a ladder, reaching from the gutter to the university, along which every child in the three kingdoms should have the chance of climbing as far as he was fit to go," adding, "I know of no other /phrase/ which so fully expresses my belief,

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[1] Calendar, History, and General Summary of Regulations of the Department of Science and Art, 1883 (London, 1893), p. 26.

[2] "Technical Education," Essays, III, 404.

not only about education in general, but about technical education in particular."[1]

Although there was much to criticize relative to the inadequacy of technical training, Huxley goes on to explain, there was, on the other hand, something to praise. He lauds the work that is being done under the direction of the Science and Art Department, whose classes, for the most part, were held in the evenings in order that the working men could attend them. Its program was modern and grew out of the actual need for such a plan of endeavor.[2]

2. Huxley's Relation to Science and Art Department

In brief, Huxley's association with the Department began in 1859 when he was appointed to give examinations in animal physiology and zoology.[3] In 1871 he served on the Commission

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[1] Ibid., p. 424.

[2] Huxley's proposed program for the technical education work of the Science and Art Department (1888) was as follows: (1) instruction in the principles of those branches of science and art which are peculiarly applicable to industrial pursuits, which may be called preliminary scientific education; (2) instruction in the special branches of such applied science and art, as technical education proper; (3) training of teachers in both these branches; and (4) selection of promising students who are to be given state aid for extended training. Huxley believed that such assistance would save for science many brilliant minds that would otherwise be lost to it ("The Struggle for Existence in Human Society," Essays, IX, 222).

[3] Life and Letters of Thomas Henry Huxley, 2 vols., ed. Leonard Huxley (New York, 1901), II, 43, 63.

of Scientific Instruction that drew up recommendations addressed to the Department concerning ways and means of improving and increasing scientific and technical instruction.[1] Later he delivered lectures for this body.[2] Because of the fact that he was directly connected with this great state-supported examining unit, Huxley was able to work very effectively for technical education.

The Science and Art Department was created in 1853 by the Government of Lord Aberdeen. The Department remained under the Board of Trade until the Education Department was constituted by an Order of Council of February 25, 1856. At this time the Science and Art Department, along with the newly created Privy Council Office, was placed under the Lord President of the Council, who was assisted by the Vice-President of the Committee of Council on Education. Several years later (1859), Parliament voted an annual sum of money to pay for instruction in science and art, with the stipulation that this sum would be administered by the Department.

The nature of the aid was in various forms. Some of it went as payments to the managers of Science and Art schools and classes and to training colleges, or as rewards to students such as certificates, prizes, medals, free studentships, scholarships and exhibitions. In Ireland, it took

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[1]Royal Commission on Scientific Instruction and the Advancement of Science (London, 1872), I, xxviii-xxx.

[2]Letters, I, 119.

the form of grants toward the purchase of apparatus, examples and fittings. Other sums were used for the maintenance and instruction of teachers and students attending the Royal College of Science and the Royal College of Art, South Kensington, the Royal College of Science, Dublin, and other approved centers; and still others went as loans and grants to local museums and to Science and Art schools.[1]

Examinations were given in subjects approved by the department, the papers being privately printed, sealed and distributed to the science schools throughout the country. After the examinations were administered, the papers were returned to the Department of Art and Science at South Kensington for grading and the granting of awards and prizes.[2]

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[1] Calendar, pp. 6-18. A free studentship entitled the holder to free admission to the lectures and laboratories, and to instruction during three years in the Royal College of Science in London, but not to any maintenance or travel allowance (Directory, Science and Art Schools and Classes (London, 1899), pp. 37-38).

[2] Royal Commission on Scientific Instruction, I, xix-xxv. The Society of Arts, founded in 1754, was the predecessor to the Science and Art Department. The Society gave examinations in science, drawing, and other subjects of the Science and Art Department to which it had to give way in 1859 when the latter took over examinations. The Society was supported entirely by private funds. (John William Adamson, English Education, 1789-1902 (Cambridge, 1930), pp. 387-88).

3. Huxley's Service to Technical Education through the Livery Companies

Huxley, however, gave the technical education movement what was perhaps its most effective assistance when he made his report to the Livery Companies of London in 1877, a report which clearly set forth the objects and methods of a scheme of technical education, and thus supplied these wealthy Companies with a program of endeavor in the field of technical training.

In this report to the Livery Companies Huxley states that a complete system of technical education should be directed toward the following objects: (1) the diffusion among artizans and others occupied in trades and manufactures, of sound instruction in those types of theoretical and practical knowledge which bear upon the different branches of industry, whether manufactures or arts; (2) adequate provision for the training and supply of teachers qualified to give such instruction; and for the establishment of schools or isolated classes, to which the industrial population may have access; and, further, for a proper system of examinations whereby the work done in the schools and classes may be tested; (3) the organization and arrangements for effecting the apprenticeships of scholars of merit in the branches of industry for which they show aptitude; for enabling such scholars to continue their studies beyond the ordinary school age, by means of exhibitions; and for opening to the rest of

them a career as teachers or as original workers in applied science. Huxley adds that his report aims at the organization in England of a scheme of technical education that was already being used successfully in Switzerland and Germany.[1] It was upon the principles laid down in this report that the City and Guilds Institute was established and its program planned.

The City and Guilds of London Institute, a body established as a result of this report, encouraged education adapted to the needs of all classes of persons engaged, or preparing to engage, in manufacturing and other industries. With this objective in view the Institute subsidized existing educational establishments which were providing sound technical instruction, and which needed assistance.

The Institute also promoted the formation of evening classes in the principal industrial centers so that workmen and foremen, employed by day, might be able to receive special instruction in the principles of science in their practical application to the processes with which they were already familiar.

It proposed to--and did--establish in London model technical schools to serve as types for other schools to be

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[1] City of London Livery Companies' Commission Report and Appendix (London, 1884), I, 67.

founded later, and supported largely by local efforts in counties and boroughs.[1]

The powers behind the founding of these technical schools--the Livery Companies--were organizations that were traceable to medieval times. Ordinarily a guild came into existence as such by an Ordinance of the Mayor and Alderman of the City of London incorporating the men of a craft and granting them powers to control their trade. In most cases the Ordinance was followed by a Royal Charter or by an Act of Parliament. Each guild was given approval for a distinctive livery or dress of its own.

The Mercers, Grocers, Drapers, Fishmongers, Goldsmiths, Merchant-Taylors, Skinners, Salters, Ironmongers, Vintners, Clothworkers, Leathersellers, Cutlers, Armourers and Brasiers, Carpenters, and Cordwainers were the main founders and supporters of the City of London Guilds. All gave lump sums to the Guilds Institute, and also awarded individual scholarships. Other schools giving instruction in technical subjects directly related to the work of a special group, e.g., carpentry, would get special help from the Carpenter's Guild. Each Guild showed great interest in the school specializing in that Guild's industry.[2]

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[1]The work done in these classes was supervised by the Institute, and this same body gave the examinations, the examinees increasing from 202 in 1879 in 23 centers, to 2,397 in 1883 in 154 centers (Second Report, I, 401-4).

[2]Bryan Pontifex, The City of London Livery Companies (London, 1939), pp. 3-12, 64-84.

Huxley, however, believed that although the companies were aiding technical education to some extent, they still were giving too little. Hence he was not too subtle in his criticism of the inadequacy of the Livery Companies' financial assistance to technical education, criticism which helped to bring on the state inquiry into the affairs of these companies. Huxley testily wrote a letter to the editor of the Times concerning the seeming invulnerability of these organizations:

> Nobody outside the Companies knows what their property may amount to. The inmost financial secrets of the Church and of the colleges of Oxford and Cambridge have been laid bare by those universal solvents, Royal Commissions; but no government which has existed in this country for the last century has been strong enough to apply aqua regia to the strong boxes of the City Guilds. Their possessions are a mystery.[1]

The following year (1880) a commission was appointed to inquire into the business of the companies.

Directly related, then, to this much-discussed matter of financing technical education was the Inquiry of the Livery Companies by the London Livery Companies' Commission. This group was appointed by the Crown in 1880 for the purpose of ascertaining the facts about the origin, organization, legal status, sources of income, and functions of the companies.

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[1]The Times (London), December 15, 1879, p. 8.

One of the members of this commission, Joseph Firth, was a bitter critic of the companies, charging them with failing to use their resources in behalf of the public.[1] He had argued that (1) London Livery Companies were an integral part of the corporation of the City of London, (2) the property was public trust property, and much of it was available for municipal purposes, (3) the companies were trustees of vast estates of which London tradesmen and artizans ought to be the beneficiaries, but such trusts are disregarded, (4) the companies were also trustees of estates applicable to charitable uses but failed to apply to such uses the funds applicable to them, (5) the companies were subject to the control of the Crown, and their lands and monopolistic privileges were only granted on condition that they perform certain duties but they had ceased to perform these duties, and (6) the continuance of a large amount of land in the heart of the City and in the North of Ireland in the hands of corporate and unproductive bodies was a hindrance to commerce and a loss to the public revenue.[2]

The fact that Firth was appointed to the Livery Companies' Inquiry Commission seemingly gave him an opportunity to deliver the coup de grace to the companies which he so bitterly criticized, but such was not the case. After all

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[1]Firth's charges appeared in print prior to his appointment to the Commission.

[2]Livery Companies' Commission, pp. 76-78.

of the companies had submitted accounts and other pertinent information, and after lengthy hearings had been held, the companies were completely exonerated from blame and no case of misuse of trusts could be found.

The Commission, however, made recommendations with respect to the improvement of the constitution of the Companies of London and the better application of their revenues:

> We recommend the appointment by such Act of Parliament of a Commission, which shall undertake, pursuant to the terms of such Act, (1) the allocation of a portion of the corporate incomes of the Companies respectively to objects of acknowledged utility, (2) the better application of the trust incomes of the Companies, (3) should it prove practicable, the reorganization of the constitution of the Companies.[1]

"Objects of acknowledged utility" in the first recommendation includes such things as technical education, scientific research, museums, and public libraries.[2] We see, then, that although the companies were cleared of Firth's charges, the state became aware of the need for exercising some sort of control over these affluent organizations. And this control proved to be satisfactory to nearly all parties concerned except to Mr. Firth.

Huxley's efforts to induce the Guilds to launch a full-scale program of technical training would have been less effective if it had not been for a very helpful medium, the London Times. This widely-read newspaper served as a sounding board for the issues concerning technical education. And

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[1] Ibid., pp. 42-43.

[2] Ibid., pp. 43-44.

even though Huxley and the editor were for the most part in disagreement, the public was enabled to become familiar with the pros and cons of technical education largely because of the articles and editorials which served to air the topic. Excellent testimony of Huxley's efforts to secure technical training facilities for the English is found in the exchange of views and opinions appearing in the Times of December, 1879.

In the initial article the editor reports Huxley's criticism of the Guilds' reluctance to finance technical education. The criticism was made at a meeting of the Society of Arts just after a Professor Thompson had read a paper on apprenticeships in technical education. In proposing a vote of thanks to Professor Thompson, Huxley asserted that since the Guilds possessed great wealth which had been left to them for the financing of such training, it would be a grave injustice if even the smallest sum were asked for out of the general revenues of the country for technical education. And he concluded by stating that if the people did not insist on this wealth being applied as prescribed by the benefactors, they deserved to be taxed heavily. The editor makes the following report of Huxley's critical remarks:

> . . . Professor Huxley expressed his belief that it would be a scandal and a robbery if a single shilling were asked for out of the general revenues of the country for technical education. The City of London Guilds possessed enormous wealth, which had been left to them for the very purpose now under discussion. If the people did not insist on the wealth being applied to its proper purpose, they deserved to

> be taxed down to their shoes. It would be well [continued Huxley] if those who had charge of these matters in the City of London would understand that they [the Guilds] were morally bound to do this work, and he hoped that if they continued to neglect it they would be legally bound to do this work for the country.[1]

A few days later Huxley was criticized by the editor of the Times (December 11, 1879) when the latter wrote that Huxley was attempting to move too quickly for real effectiveness in his undertaking. He also seems surprised that Huxley had advocated the utilization of guild property for technical education purposes, although he, too, believed that the Companies were obligated to technical education:

> A few years ago the very expression technical education was unknown; and now Professor Huxley and his friends are demanding a technical university. . . .
>
> Such a crown to the edifice of technical education is a very noble vision. But its translation into brick and mortar and professorial chairs may well wait . . . . In the meantime, it is a little hard to see why Professor Huxley should have generously appropriated for the purpose the estates of the City of London guilds . . . . There lies, indeed, upon the London companies an obligation, to which they are at last awake, to use their means for the elevation of trade.[2]

In replying to this criticism from the Times' editor, Huxley frankly states his position in the matter of the Livery Companies and their responsibility to technical education:

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[1]The Times (London), December 4, 1879, p. 6. See also Journal of the Society of Arts, XXVIII (November 12, 1879; November 12, 1880), p. 47.

[2]The Times (London), December 11, 1879, p. 9.

> . . . allow me to state that I have not proposed to appropriate the estates of the Livery Companies in order to provide the funds required to carry out such a scheme of technical education as I and others have suggested. . . .
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> I am no advocate of confiscation [of guild funds], nor am I one of the large number of persons who imagine that the whole revenues of the Livery Companies are either grossly squandered or corruptly misapplied. On the contrary, I have reason to know that they devote large sums, more or less wisely, to educational and benevolent purposes. . . .[1]

But Huxley adds that he still does not know whether the guilds intend to carry out his basic recommendations, namely, the establishment of (1) local technical schools accessible to the artisans and (2) a central institution chiefly for the training of teachers and scholars of exceptional capacity. He maintains that the offensive phrase "Technical University" had not been used by him, that he had only emphasized the importance of small schools.[2]

In this same letter Huxley explains that since the State-aided Science and Art Department did not cover all technical subjects, he deemsit necessary to request financial assistance from the Livery Companies. He reasserts his belief that the Companies are able and morally bound to subsidize a school of advanced technical education, pointing out that some Guild members--especially those who appointed him to bring in a report on technical education in 1877--had already contributed their share.

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[1] The Times (London), December 15, 1879, p. 8.

[2] Ibid.

Huxley agrees with the editor on the importance of building up the size of the classes and improving the lower technical schools, but he is convinced that the advanced school should be ready to receive students, even though the initial numbers may be small, and he wants all of the Livery Companies to support the project. He politely ends his letter to the editor by urging that the position of the companies in the matter be ascertained:

> Permit me, in conclusion, to thank you for the great service you have rendered to the cause of technical education by calling attention to its importance, and to promulgate urbi et orbi, in the hope of getting an authoritative answer, this simple inquiry,--Do the Livery Companies of London intend to carry out any general scheme of technical education such as that adopted by their own Committee, or do they not?[1]

Huxley's question was partly answered by Owen Roberts, Honorary Secretary to the City and Guilds of London Institute. In a letter to the Times directed to Huxley, Roberts chidingly asserts:

> Huxley must realize that negotiations have been going on for nearly a year for grant of a site at S. Kensington. Meanwhile there is ample work for local schools which should be established. The Livery Companies are far from being irresponsible relative to their obligations to Professor Huxley for his valuable advice and assistance.[2]

This reply by Roberts was not entirely satisfactory to Huxley because it was neither direct nor complete. Huxley gave able

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[1] Ibid.

[2] The Times (London), December 26, 1879, p. 8.

expression to his dissatisfaction with Roberts' answer by writing to the editor concerning the matter. In an ironic vein Huxley addresses the editor:

> . . . I am glad to read in The Times of today (December 26, 1879) an authoritative reply to the question which I ventured to put in your columns a fortnight ago. It will be extremely satisfactory to every one interested in technical education to have the official assurance of the honorary secretary to the "City and Guilds of London Institute for the Advancement of Technical Education" that the intentions of the Livery Companies are as good as ever, and that any delay in carrying these good intentions into effect on the part of the "ancient institutions" which he represents is the result of that "free spirit" which is probably as common among the moderns as among the ancients, and not unfrequently leads us all to prefer doing nothing, if we cannot have exactly our own way in doing something.[1]

Huxley continues by referring to the liverymen's fear that the state wanted to get control of their technical education program. This fear grew out of the fact that the Commissioners of the 1851 Exhibition[2] wanted to appoint three members of the Guilds' Technical Education Committee--educational experts--to see that the Exhibition funds were wisely administered for the proposed technical university.

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[1] The Times (London), December 29, 1879, p. 7.

[2] The Exhibition ("Great Exhibition," London, 1851) referred to above was an international display of the art and industries of Europe. A surplus profit of £186,000 which was realized from this exhibition was placed in the hands of a Royal Commission. This body purchased land in South Kensington with the intention of erecting there a central institution for technical science. In the end, however, this land was made the site of the South Kensington Museum and the headquarters of the Science and Art Department (Adamson, op. cit., pp. 291-92).

But it was brought out that these greatly-feared commissioners were not really a state body but an autonomous group appointed by the state, interested solely in cooperating with the guilds and not in dictating to them.

Huxley "learns" from the editor of the Times that the real responsibility for financing a central institute for teachers and exceptionally able scholars rests with the Commissioners of the Exhibition of 1851. He also learns that the proceeds of the Exhibition of 1851 were earmarked for such projects and that it was the bounden duty of the trustee of the profits of the 1851 Exhibition to domicile the proposed central institute on their premises at South Kensington.[1]

4. Livery Companies' Use of Huxley's Suggested Plan for Technical Education

When the guilds made their decision to initiate a program, they followed Huxley's plan almost to the letter. All of them realized that technical instruction was a requisite for the welfare of England's great industries, and were finally willing to assume responsibility for a large scale undertaking to make such instruction more widely available.

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[1] The Times (London), December 27, 1879, p. 7. Note that the above letters were written during 1879, the year prior to the appointing of London Livery Companies' Commission of Inquiry and hence helped to crystallize opinion relative to the need of such an inquiry.

Putting words into action, then, the City and Guilds Institute opened Finsbury Technical College (1881) for the purpose of giving evening instruction to artisans and for training boys for the supervisory jobs in industry.

In this same year the Royal Commission on Technical Instruction was appointed to investigate and report on the procedure followed in technical instruction on the Continent, in the United States and Canada, and in the United Kingdom. This body gave its first report in 1882 and its second two years later, making specific recommendations. These were to the effect that steps be taken to speed up the use of old endowments; that some provision be made by the Charity Commissioners for the establishment of schools or departments of schools in which the student could study natural science, drawing, mathematics, and modern languages; and that local authorities be empowered to establish, maintain, and contribute to the support of secondary and technical schools and colleges, including those founded for the study of agriculture.[1]

Three years, then, after the opening of Finsbury Technical College, the Central Institution was opened by the City and Guilds of London Institute. Begun in 1881 and completed in 1884, the Central Institution set out (1) to train teachers for provincial schools; (2) to train managers and

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[1]Second Report, I, 539.

supervisors of industry; and (3) to obviate the necessity of managers, foremen, industrial chemists and other key personnel to go to the continent where such schools were already established. The Central Institution was built near the science schools and the museum at South Kensington in order that there would be little time lost by students and teachers in going to and from the buildings. This new school served as a focal point for the various technical schools, and a center for the dissemination of advanced technical knowledge.[1]

After the founding of the Central Institution, the Guilds established technical classes in connection with the Middle Class Schools, Cowper Street, Finsbury; a department of applied fine arts at the Lambeth School of Art; and took over the examinations formerly given by the Society of Arts. They subscribed to the British Horological Institute, Clerkenwell; the London School of Wood Carving; the Mining Association of Devon and Cornwall; the Nottingham Trade and Science schools, the Artisans' Institutes Technical Education Fund; supplemented the salaries of the professors of mechanical and chemical technology at University College, London; and founded a professorship of applied art and one of metallurgy at King's College, London. These and many other

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[1] Ibid., p. 401.

projects, including teacher-training, constituted the educational program of the Guilds.[1]

In fact, the growing demand for technical training caused Huxley to come out in favor of the founding of an Imperial Institute as a keystone in the whole system of technical education and as a center with the express purpose of advancing industrial knowledge. He would have this school serve as a center of industrial exchange; a meeting place for capital and labor, where they might disucss problems and reach solutions; a storehouse of industrial knowledge accessible to the public; and a place where all technical education in the country might find its center and crown.[2] Finally, however, Huxley withdrew his support from the Imperial Institute proposal because he believed that, if carried through, it would alienate powerful and wealthy bodies interested in the previously established Central Institution at South Kensington, and it would antagonize city people because they were planning to build an institute of their own in London. This meant that the Institute would be unwelcome in both South Kensington and London. Writing to Foster (February, 1887), Huxley asserts that the Royal Society should not back the project because "it is in disfavor" with both the Guilds

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[1] Livery Companies' Commission, I, 67.

[2] T. H. Huxley, "On the Imperial Institute," The Times (London), January 20, 1887, p. 8.

and the city people. In a few years, however, the Imperial Institute was founded, despite Huxley's misgivings.[1]

5. Huxley's Part in Influencing the Guilds in Financial Matters

In addition to being effective in persuading the Guilds to establish individual schools, Huxley, as a member of the City and Guilds Institute Council, enlisted the enormous resources of these organizations in behalf of technical education as a whole.[2] The task of securing this financial assistance was facilitated greatly by the fact that the Livery Companies felt a responsibility to help finance any program that would help the state. They were finally convinced that some of the income from their vast holdings of inherited property should be used to promote English industries:

> . . . during the three years prior to the incorporation of the City and Guilds of London Institute, there was considerable unrest among some of the Livery Companies, who felt very strongly that, having regard to the terms of their charters, it was their duty to

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[1] Letters, II, 162-65. Huxley's apprehensions proved to be without grounds because the museum, which was formally opened by Queen Victoria in 1893, had the character that he had prescribed earlier. The object of the Institute was to promote the commercial resources of the Empire by arranging exhibitions of materials and products, especially from India and the colonies, and by providing for the "collection and dissemination of scientific, technical and commercial information relating to them" (Bulletin of the Imperial Institute, I (London, 1903), iii).

[2] James D. Teller, "Social Responsibility of a Scientist," Education, LXIII (1942), 3-10.

> apply some part, at least, of their large funds in furtherance of a cause that might prove of the greatest possible benefit to the State, and for which at that time no "Development Fund" was available. It was a voluntary undertaking on the part of the City Guilds, but they were no doubt actuated by the conviction that part of their inherited property was held as a kind of trust to be used for the benefit of the industries of the country.[1]

Even in the year that the City and Guilds of London Institute was established (1878),[2] the Mercers, Drapers, Fishmongers, Ironmongers, Clothworkers, Armourers, Cordwainers, Coopers, Plaisterers, and Needlemakers agreed to provide approximately £12,000 annually from their private funds for the purpose of financing the following program proposed by Huxley to the Companies: (1) the founding of a central institute in London for technical education; (2) the establishing or assisting of trade schools in London; (3) conducting of technological examinations; (4) and the giving of

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[1]Philip Magnus, Educational Aims and Efforts, 1880-1910 (London, 1910), p. 85.

[2]The aims of the City and Guilds of London Institute, as outlined by Huxley and other authorities, were to provide and encourage education for persons engaged or preparing to engage in manufacturing and other industries; subsidize existing establishments of technical education needing help; encourage in great industrial centers formation of evening classes for workmen and foremen giving theory to supplement their practical knowledge; give technological examinations; establish and maintain model technical schools in London, as types for local schools supported by local funds; erect a central institution like the great polytechnic schools of Germany, Switzerland, France, and Italy. Thus the Guilds planned to assist in the instruction of all classes engaged in industrial operations: artizans, apprentices, foremen, managers of works, manufacturers, and technical teachers (Second Report, I, 401-2).

grants in aid to existing technical institutions.[1] In the following year (according to Owen Roberts, Guilds' Secretary), these companies contributed an aggregate sum of nearly £14,000. And in addition to this, four of the companies voted a total of £30,500 toward the purchase of a site and erection or adaptation of necessary buildings for the proposed central institution. For this same purpose there was the £20,000 of accumulated income, making a total of £51,000 available for a building and site fund.[2]

It was largely because of Huxley's persuasiveness that the Guilds, between 1881 and 1884, contributed about £120,000 to technical training alone. In addition, the Clothworkers' Company promoted the establishment of Yorkshire College at Leeds, for instruction in the manufacture of woolen goods, and established similar institutions elsewhere.[3] This type of venture worked no financial hardship upon the Guilds because the estimated trust and corporate income of the companies for the year of 1879-80, for example, was between £750,000 and £800,000, a sum exceeding the income of both Oxford and Cambridge and their colleges at that time. This

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[1]W. Carew Hazlitt, The Livery Companies of the City of London (New York, 1892), pp. 88-89.

[2]The Times (London), December 30, 1879, p. 9.

[3]Hazlitt, op. cit., p. 89.

money represented the income of twelve great companies and sixty-two minor ones.[1]

In 1883 Huxley's presence at the Fisheries Exhibition in London brought him into close contact with several of the powerful city companies whose enormous resources he had been gradually enlisting on behalf of technical and scientific education. Leonard Huxley states it thus:

> Among these may be noted the Fishmongers, the Mercers, who had already interested themselves in technical education, and gave their hall for the meetings of the City and Guilds Council, of which Huxley was an active member; the Clothworkers, in whose schools he distributed the prizes this year; and not least, the Salters, who presented him with their freedom on November 13.[2]

The Fishmongers, for example, with the aid of several other companies, financed the erection and maintenance of a marine biological laboratory for research on food fishes.[3]

Despite the fact that the Livery Companies were giving considerable financial assistance to the technical education program from their private funds, Huxley was convinced that

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[1] Ibid., p. 84.

[2] T. H. Huxley, Letters, II, 54. Huxley's ability to enlist the financial aid of the companies is attested to by J. W. Clark, master of the Salters. Writing to Huxley (August, 1883) he says: "I think you must admit that the City Companies have yielded liberally to the gentle compression you have exercised on them. So . . . we propose to legitimise your claim for /technical/ education, which several of us shall be willing to unite with you in promoting." (ibid., p. 54).

[3] E. Ray Lankester, The Advancement of Science (London, 1890), pp. 219-20.

the program would soon outgrow the means of its existence and find itself in need of a larger operating fund, preferably a permanent subvention. Huxley now realized that convincing the authorities of the need for technical instruction was only the beginning of a job entailing the formulation of a sound plan for financing the program. He appreciated the support received from the Livery Companies and the Guilds, individuals, local sources, and the Science and Art Department, but he felt that more must be done. Speaking before the Royal Society in 1885, he points out that although the Central Institute was the outcome of the recognition of necessity for technical education by the wealthiest guilds in the world, its chief obstacle to the proper development of the important schools which it had founded was poverty. He asserts that this center of instruction required at least £15,000 annually but received only £9,000, adding that, "In Germany, a similar institution would demand and receive £20,000 a year as a matter of course."[1] What he really wanted was public financial support of the technical education program.

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[1]T. H. Huxley, "Address of the President of the Royal Society," Nature, XXXIII (December, 1885), 113.

6. Huxley's Part in Securing Government Support for Technical Education

Unceasingly Huxley urged the state to assume the responsibility for advanced scientific education on the ground that the good that various institutions did was not local but national, and beneficial to the economy of the nation as a whole. Citing several advanced schools of science, Huxley asserts that despite the fact that their service is national and not local, the state refuses to admit its obligation to them:

> The Midland Institute, Owens College in Manchester, the newly-instituted Science College in Newcastle, are all noble products of local energy and munificence. But the good they are doing is not local--the commonwealth, to its uttermost limits, shares in the benefits they confer; and I am at a loss to understand upon what principle of equity the State, which admits the principle of payment on results, refuses to give a fair equivalent for these benefits; or on what principle of justice the State, which admits the obligation of sharing the duty of primary education with a locality, denies the existence of that obligation when higher education is in question.[1]

Although we may easily observe that results were neither immediate nor in reasonable proportion to Huxley's demands for financial assistance for technical education, partly, at least, as a result of his efforts a limited program for financing such training, a program which had become operative under the Department of Science and Art as early as

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[1]"Administrative Nihilism," Essays, II, 288.

1859, expanded rapidly. In fact, the principle of granting aid to science schools and classes was established on a small scale in 1853, but no general system of making grants applicable to the entire country was inaugurated until 1859. In this year the first general Science Minute was passed which enabled authorities in any place to establish science classes and to secure state aid according to rules laid down.[1] But the most comprehensive legislation, and that which furnished most aid to the technical education program in which Huxley was now interested, was the Technical Instruction Act of 1889 and the Local Taxation Act of 1890.

The task of financing technical education, then, was made less difficult by the Technical Instruction Act of 1889 that allowed any county, borough, or urban authority in England, Wales, and Ireland to levy an annual rate of not more than a penny in the pound to finance technical or manual instruction. And in addition to this, the Local Taxation Act of 1890 placed at the disposal of authorities in England, Wales, and Scotland large sums of surplus money for the support of science and art and technical education.[2]

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[1] Calendar, pp. 9-10.

[2] Ibid., p. 7. Technical Instruction is defined in the Act of 1889: "The expression 'technical instruction' shall mean instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments. It shall not include teaching the practice of any trade or industry or employment, but, save as aforesaid, shall include instruction in the branches of science and art

Huxley, however, deplored the fact that ever since the state began giving financial assistance to science and art classes, the payments depended largely upon results of examinations conducted in the various classes and schools. He contended that this plan worked a hardship on both the teacher and pupil because of the uncertainty about income by the former and the undue pressure of examinations on the latter. By 1893, however, this picture had improved somewhat. The government assistance, which was granted through the Department of Science and Art, was in the form of (1) annual examinations, in which Queen's prizes and medals were awarded; (2) payments on the results of examinations and, to a limited extent, on attendance; (3) scholarships and exhibitions; (4) building grants, and in Ireland grants towards the purchase of apparatus; (5) supplementary grants in certain subjects; and (6) aid to teachers in training while attending the Royal College of Science and the National Art Training School, South Kensington, the Royal College of

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with respect to which grants are for the time being made by the Department of Science and Art, and any other form of instruction (including modern languages and commercial and agricultural subjects), which may for the time being be sanctioned by that Department by a minute laid before Parliament and made on the representation of a local authority that such a form of instruction is required by the circumstances of its district.

The expression 'manual instruction' shall mean instruction in the use of tools, processes of agriculture, and modelling in clay, wood, or other material" (Hugh Owen, The Elementary Education Acts, 1870-1891 (London, 1891), p. 713.

Science, Dublin, and other centers on the approved list.[1] This improved plan of state assistance made for fuller realization of government support of scientific training for technical fields; it made more evident the fact that the importance of technical training was gradually being recognized.

The amount of money assigned to technical education by English local authorities rose from £472,560 in 1892-93 to £654,463 in 1895-96.[2] In 1890 Parliament gave local authorities approximately £709,000 in England, and £34,000 in Wales derived from taxes on beer and whiskey.[3] These sources of income for the support of scientific and technical training, though increasing, were still inadequate for the

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[1] Ibid., p. 13-14. In 1884 the Royal Commission on Technical Education had complained of the method of paying teachers: "The remuneration of teachers should not depend to so great an extent as at present on the grants from headquarters" (Second Report, I, 522).

[2] Graham Balfour, The Educational Systems of Great Britain and Ireland (Oxford, 1903), p. 167.

[3] Record of Technical and Secondary Education, I (1891-92), 280. This is the official publication of a very active organization that aided the program of technical training: the "National Association for the Promotion of Technical and Secondary Education." This group worked for educational reforms related to (1) increasing general dexterity of hand and eye among the young who most likely will have to support themselves; (2) bringing about a more widespread and thorough knowledge of those principles of science and art that are related to industry; and (3) encouraging better secondary instruction generally, which would include instruction in foreign languages and science for those directing commerce and industry. This training, designed for both sexes, would be organized and promoted in accordance with the needs of various districts (ibid., p. 2).

program. Some of the deficiencies were made up, however, from private sources, with various organizations contributing considerable sums, and awarding prizes and scholarships in an effort to assure the success of this work.

7. Summary of Gains

It becomes more evident, then, that despite national lethargy, Huxley's fight for technical instruction made appreciable gains. The Science and Art Department and the Livery Companies had established more day classes for regular science pupils and more night classes for workingmen. A teacher-training program had been initiated, teachers and promising students were given public and private financial assistance, and apprenticeship instruction was embodied in a comprehensive plan of technical instruction. The Companies launched a building program that came to fruition in the form of numerous modern structures especially designed and equipped for the teaching of technical science and for research.[1] Further, the enactment of the Technical Instruction Act of 1889 and the Local Taxation Act of 1890 proved beyond the shadow of a doubt that there had been a general awakening of public interest in practical science training. Huxley's continual prodding had prompted many public-spirited men to help secure these solid gains for technical education.[2]

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[1] "The Struggle for Existence in Human Society," Essays, IX, 224.

[2] Ibid., pp. 234-35.

Evidence of the spread of the interest in technical education[1] and acceptance of the general principle for which Huxley was contending is to be found in letters to his friends. He wrote Professor Foster (December 1, 1887), informing him of the excellent reception accorded the main ideas of a speech he had just delivered in Manchester. He assures Foster that Manchester is solidly behind technical education:

> Manchester has gone solid for technical education, and if the idiotic London papers, instead of giving half a dozen lines of my speech, had mentioned the solid contributions to the work announced at the meeting, they would have enabled you to understand its importance.[2]

A few days later (December 4, 1887), Huxley apprises another friend, Sir. J. D. Hooker, of the fact that Manchester, Liverpool, and Newcastle have become actively interested in technical education:

> I . . . made a speech of fifty minutes in a hot, crowded room, . . . and was none the worse. Manchester, Liverpool, and Newcastle have now gone in for technical education on a grand scale, and the work is practically done. Nunc Dimittis.[3]

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[1]Huxley shows a strong faith in the future of science education when, for example, he tells an audience at the Josiah Mason Science College in Birmingham (1880) that this school will render inestimable service to those whose livelihood is to be gained by the practice of the arts and manufactures of the district. ("Science and Culture," Essays, III, 139).

[2]Letters, II, 193.

[3]Ibid.

Huxley was reassured by these developments because they indicated that technical education was on the march and that the populace was becoming aware of the importance of such training.

In the meantime Huxley's program for technical education was given a new impetus when A. D. Acland and Henry Roscoe, both of the House of Commons, began to help Huxley in his campaign for calling general attention to the subject. Public meetings were held in the great industrial and commercial centers with the result of greatly increased interest. This movement developed into the National Association for the Promotion of Technical Education, an organization in which Huxley was active for a number of years.[1]

Still another aspect of the evidence showing the growth of interest and activity relative to technical education is reflected in the rise in the number of students enrolled in technical courses. It was undoubtedly because of the increasing availability of technical training and the ever increasing national conviction that such training was indispensable to the industrial and commercial future of England, the enrollment in technical schools nearly tripled in one year's time. The number of students attending technical

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[1]Adamson, op. cit., p. 408. "The Association was founded in 1886, mainly on the initiative of Sir Henry Roscoe (scientist), for promoting legislation in favour of technical education, and for supplying information on the subject to local authorities." (Philip Magnus, op. cit., p. 111).

classes, including those under the Science and Art Department, was 16,698 for 1890-91 and 41,596 for 1891-92.[1] And the marked increase in state funds for the Department gave Huxley no little satisfaction. The state alone had given the Department £64,675 for 1856-67 and by 1892-93 had increased the amount to £605,954.[2] Individual students were given financial assistance by a provision of the Technical Instruction Act of 1891 which stipulated that a local authority may "Provide or assist in providing scholarships for or pay or assist in paying the fees of students ordinarily resident in the district of the local authority at schools or institutions within or outside that district."[3] In this development we see the growing opportunity for the capable student without funds to become more and more skilled in his field of endeavor; we see the gradual emergence of what Huxley often refers to as "capacity-catching" machinery.

Huxley was justly proud, then, that many technical schools had to be established in order to make it possible for the increasing number of students to receive training. The Manchester schools were considered outstanding for their work in technical instruction, offering, in addition to those mentioned earlier in the chapter, such courses as commercial

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[1] Record, I, 289-90.

[2] Calendar, p. 7.

[3] Hugh Owen, op. cit., p. 713.

arithmetic, shorthand, bookkeeping, commercial geography, typing and modern languages; dyeing, printing, spinning, weaving, cookery, millinery, laundry work and manual instruction. The fact that seventy courses were listed gives one a good idea of just how comprehensive the program of study was in these schools, and indicates how determined an assault was being made upon technical backwardness in England.[1]

The Liverpool schools also were offering numerous courses in technical education. Here the city council granted over £4,000 just for the purchase of much-needed technical apparatus. Such subjects as needlework, dressmaking, laundry-work, domestic economy, cookery, smith's work, sheet metal-work, carpentry and joinery, modern languages, bookkeeping, shorthand, typewriting, lithography, typography, brickwork and masonry, surveying, plumbing, bread-making, ambulance and nursing, photography, singing and musical notation, instrumental music, commercial geography, and mechanical and electrical engineering were given.[2] In this array of courses is evidenced the idea of putting theory into practice. Technical skill was sharpened for those who mastered these subjects and used them in their everyday work. Huxley visualized the concomitant improvement in the status of industry and labor resulting from such a program of technical education; hence,

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[1] Record, I, 281-83.

[2] Ibid., p. 76.

he continued to work for larger and better facilities for this type of training. Summing up his ideas about the matter, he names the basic requirements:

> It appears to me that if every person who is engaged in an industry had access to instruction in the scientific principles on which that industry is based; in the mode of applying these principles to practice; in the actual use of the means and appliances employed; in the language of the people who know as much about the matter as we do ourselves; and lastly, in the art of keeping accounts, Technical Education would have done all that can be required of it.1

He believes that industrial workers should be able to attend technical schools and there receive practical instruction; that in addition to the industrial courses, modern languages and commercial subjects should be offered. Indeed, Huxley was convinced that such a combination was needed for well-rounded technical training. And, surely enough, such training became more and more in evidence in urban and rural centers.

The results of the increase in state and local financial assistance are reflected further in the appreciable growth in the work of the Science and Art Department. We find that in 1870, in industrial art approximately 254,000 persons received direct instruction as students, an increase of 67,000 over the previous year.[2] As early as 1870 new schools

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[1] Letters, I, 508.

[2] Eighteenth Report of the Science and Art Department (London, 1871), pp. xxxi-xxxii.

of industrial art had been established at Belfast, Derby, Dover, Kendal, Leamington, Leicester, Portsmouth, Ryde and Winchester, making a total of 117 with 20,290 students in attendance. Of this number 9,452 submitted 56,857 drawings or models; the number in 1869 having been 7,683 students who sent in 50,060 works. All but a few of these students were enrolled in the industrial classes.[1]

Progress relative to the increase in the number of technical science pupils and technical science classes under the Department is indicated below:

Year	Schools	Pupils	Classes
1862	70	2,543	140
1872	948	36,783	2,803
1882	1,403	68,581	4,881
1892	2,553	180,410	10,352[2]

Here we see how instruction in technical science grew from 1862 to 1892; and its growth implies definite progress in technical education.

Huxley was proud of this growth in the work done by the Science and Art Department, asserting that this organization did more for the teching of elementary sciences among the masses from 1863 to 1888 than any group in England or elsewhere, and that it had become a veritable people's university,

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[1] Ibid., p. xv.

[2] Calendar, p. 10.

with classes spread all over the country and open to all. He is thankful for the Department because he realizes that the school board, for obvious reasons, is not qualified to serve as a proper guide for scientific or technical training, since "The influences under which the members of these bodies are elected do not tend to secure fitness for dealing with scientific or technical education."[1]

Further, the technical subjects that were first aided by state funds in 1859 were: (1) practical plane and solid geometry, with mechanical and machine drawing, (2) mechanical physics, (3) experimental physics, (4) chemistry, (5) geology and mineralogy, and (6) natural history, including zoology and botany.[2] By 1893, however, the state was giving grants for not six, but twenty-five subjects. They were: (1) practical, plane, and solid geometry, (2) machine construction and drawing, (3) building construction, (4) naval architecture, (5) mathematics, (6) theoretical mechanics, (7) applied mechanics, (8) sound, light, and heat, (9) magnetism and electricity, (10) inorganic chemistry, theoretical and practical, (11) organic chemistry, theoretical and practical, (12) geology, (13) mineralogy, (14) animal physiology, (15) botany, (16-17) biology, including animal and vegetable morphology and physiology, (18) principles of mining, (19)

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[1]"The Struggle for Existence in Human Society," Essays, IX, 223.

[2]Calendar, p. 10.

metallurgy, theoretical and practical, (20) navigation, (21) nautical astronomy, (22) steam, (23) physiography, (24) hygiene, and (25) principles of agriculture.[1] Such a growth in courses from 1859 to 1893, largely made possible by an increase in state financial responsibility, shows that technical science instruction was becoming more firmly entrenched in the English educational system.[2]

8. Agriculture and Huxley's Part in this Phase of Technical Education

Ironically, indeed, it is apparent that one of the last major industries to receive the benefits of technical education was agriculture. But it would seem that in a nation whose people consumed more food than the country produced, the situation would be just the reverse. Be this as it may, a program of technical instruction for agriculturalists slowly came into being.

Despite the fact that Huxley's role in the agricultural phase of technical education was limited, it is, nevertheless, deserving of our brief attention. True it is that Huxley was not a farmer, but he recognized the value of technical training in agriculture. Inasmuch as he knew the basic facts about the science of the industry, he ventured to outline a course in elementary agriculture. In a letter to a Mr. Harrison

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[1] Ibid., p. 13.

[2] Ibid., pp. 18-19.

(1891) Huxley gives what he considers an application of technical education to agriculture. He states that he would not attempt to teach chemistry, botany, physiology, or geology as such because this method entails the spending of too much time on abstraction and theories instead of concrete things of a practical nature. He asserts that the history of a bean, of a grain of wheat, of a turnip, of a sheep, of a pig, or of a cow presented in its proper relation to the elements of chemistry, physiology and other subjects would give one enough elementary science for the comprehension of the fundamental processes of agriculture. This, he concludes, is enough for the beginner to assimilate before trying more advanced studies in the field.[1] There is no doubt that Huxley's plan is more thorough than it perhaps appears to be at first glance; hence, its importance should not be overlooked. And perhaps the strongest point in the plan is the idea of combining theory and practice in agriculture.

Much of Huxley's influence concerning agricultural education is evident in the growth of this technical field. Such training was given in the various farm districts, and practical and theoretical courses were offered. In Aberdeenshire well organized courses, covering a period of from five to six weeks, were given in the four sections of the county,

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[1] Letters, II, 301. Huxley was a member of the National Association for the Promotion of Technical and Secondary Education, a body that helped to promote education in agriculture, as well as in other industries.

each being served by one teacher who conducted classes in various places within the county.[1] Attendance was usually good because the students were interested in improving their knowledge and economic status. Such points as treatment of soil, choice and purchase of fertilizer and seeds were discussed; methods of planting crops, and crop diseases were explained; and facts about harvesting and marketing were presented. The young farmers and farm workers profited greatly from these much-needed courses.[2]

Keeping in step with developments in Aberdeenshire, the authorities in Durham County provided instruction in agriculture by arranging for the presentation of lectures and holding of classes at convenient points for the farmers; and by the introduction of such subject matter into grammar and secondary schools, experimentation with soil and plants, and the creation of scholarships to enable students of promise to go through a complete agricultural course in college. This could be done right at the Durham College of Science that had a department of agriculture, with experimental stations devoted to research and advanced methods. The universities of Edinburgh and Aberdeen had plans similar to this one.[3]

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[1]For this type of work there were expert itinerant teachers who helped things out admirably. Paid by the state and community, they taught in small towns and remote areas that had few or no technical schools. They were especially useful in the instruction of home industries in the districts that could not afford a resident teacher (Record, I, 31-32).

[2]Ibid., pp. 453-55.

[3]Ibid., pp. 451-52.

9. Huxley and the Problem of Teachers

Although instruction in agriculture was becoming better organized and more scientific, Huxley realized that there must be especially trained personnel to carry on such a program. In short, someone must assume the task of carrying to the people the wealth of technical knowledge that was so necessary to agriculture and other industries as well. This job belonged to the technical science teachers who were few in number. In fact, the demand for them far exceeded the supply. Huxley's role in the matter of effecting a balance between demand and supply was quietly effective.

Because of the shortage, Huxley helped find ways and means of securing the retaining competent instructors. This scarcity of teachers, which was perhaps as great as it had been in the case of non-technical science instructors, offered a real challenge to the technical leaders of the day. Huxley believed that such personnel could not be produced by ordinary training, but must have special schooling, largely in practical work, in order to measure up. Potential teachers should be helped to acquire practical technical training in order that they might eventually become instructors. Such persons, contended Huxley, should be nominated by the authorities of the various science colleges and schools of the country and given teaching fellowships. He would not select such prospects by the means of competitive examinations because many desirable teacher qualifications would not be discernible in

the results.[1] Both the former and the latter methods were employed, however, to increase the supply of technical teachers. Centers for their training were organized in the urban and rural districts so that they would be accessible to as many as possible.

The first of these centers advocated by Huxley was set up at the Central Institute (1886); and, subsequently, the Institute's department of technology formed training classes in different parts of the country and organized an extended plan for the certification of teachers.[2]

Huxley's plea for the training of technical teachers helped to stimulate the various counties in organizing such programs. In Durham, by 1892, Saturday classes for teachers of technical subjects were being held summer and winter. Those attending had to pass an examination at the end of the course in order to attend the following term. In order to enroll, they must be needed as instructors in their districts, be prepared to teach the course they wished to take, and show an aptitude therein.[3]

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[1] "Technical Education," Essays, III, 444-45.

[2] Magnus, op. cit., p. 102. The fact that Huxley was a member of the Guilds' Institute Council enabled him to help put into effect some of his own suggestions. Besides, Huxley was a member of the Technical Instruction Committee of the Guilds from 1883 to 1885. In this position he worked particularly for more substantial aid for teacher-training in technical science (Adamson, op. cit., p. 402; Letters, I, 509).

[3] Record, I, 451.

In Derbyshire teachers were instructed in agriculture, and schoolmasters in agriculture and coal mining; in Dorsetshire teachers were given courses in cookery, laundry, and domestic economy; and in Essex, instruction in manual training and cookery. In Hampshire, cookery, mechanics, and domestic economy were taught. And a well-worked out program in Surrey offered classes with practical work in botany, horticulture, chemistry, animal physiology and mechanics to elementary and pupil teachers. At the end of the course, any student-teachers reported upon favorably by the lecturers or examiners were given a month's practical work at the City and Guilds Technical Institute, the Royal College of Science, or other places of higher education. Often most--and sometimes, all-- of the expenses of these teachers were paid by local committees and by the various Livery Companies in recognition of the fact that in most cases teachers could not afford such training.[1]

Finally, then, the teachers, for whom Huxley was the spokesman, began to receive financial assistance from local committees. In 1892 Bedfordshire granted £2 scholarships to teachers studying agriculture; Dorsetshire gave a grant of £500 to be expended for travelling expenses of elementary teachers to study centers for science and art classes, cookery, laundry, and domestic economy; Hampshire announced that the

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[1] Ibid., pp. 504-7.

county council had set aside £2,000 for teachers' classes in cookery, mechanics, domestic economy, and drawing; and Flintshire allocated money for travelling expenses and tuition for those instructors enrolled in agricultural classes. And there were many more counties with similar programs.[1] Huxley points out that the Livery Companies had done something similar. For example, the Clothworkers, following his advice, had given financial assistance to teachers (1872); and around 1877 other Livery Companies also began giving financial assistance for the improvement of the teaching of handicrafts.[2]

Throughout his discussions of technical instruction Huxley emphasizes the necessity of practical experience with the subject that is being taught. An instructor of manufactures, for example, in addition to acquiring the theory of the subject, should also know how to put this theory into practice. He should be able to operate machines, dye goods, plant and harvest crops, run a dairy, make clothes, build a structure, or do anything that the subject he teaches has to deal with. If a young prospective teacher showed sufficient promise, Huxley would have him serve an apprenticeship in his

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[1] Ibid.

[2] "Technical Education," Essays, III, 425-26. Huxley observes that "quite recently others of the livery companies have determined upon giving their powerful, and indeed, almost boundless, aid to the improvement of the teaching of the handicrafts" (ibid.).

special field of interest; then he would help the apprentice take advanced studies before finally assuming the duties of a teacher. In this manner the instructor would become equipped with both the theory and practice of his subject.[1]

Members of the Royal Commission on Technical Instruction (1884) were of the same opinion as Huxley in this matter, and pointed out that instructors with practical experience in the trades they taught were very desirable for such work, asserting:

> . . . we are of the opinion that whenever it is possible persons engaged in the trade taught and having scientific knowledge should give instruction to workmen. . . . We visited /some excellent/ classes of this character at the Polytechnic Institution in Regent Street, /and/ at the Manchester Technical School. . . .[2]

It was the consensus that the teacher must be able to demonstrate the practical application of technical theory in order to get good results from his instruction.

Huxley, however, states that after the teacher has been trained to a point of efficiency, there always arises the problem of retaining him, a problem due mainly to low salaries for teachers. Further, Huxley points out that it is necessary not only to get teachers, but to keep them after you have them. By personal experience as a teacher and by experience gained while a member of the London School Board, he was well acquainted with the inadequate financial reward for teaching.

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[1] Ibid., pp. 435-38.

[2] Second Report, I, 253.

As a remedy, he suggests that some special means be provided whereby good technical teachers may be kept on the faculty, because the profession of teacher is not a very lucrative or otherwise tempting one, and it may be advisable to offer special inducements to good men to remain in it.[1] A man who has been trained to become a technical instructor, asserts Huxley, will be tempted to carry his knowledge and his skill to a better market, in which case all of the trouble and expense of training the teacher will have been lost; hence, such an eventuality must be avoided by paying the teachers better salaries. This, in turn, would tend to raise their status and dignity, thereby making the profession more attractive to them; and the nemesis of future economic security would assume harmless proportions.[2]

It would be indeed difficult to overestimate the value of Huxley's contribution to the development of technical education in England. In his proposed curricular changes while he was teaching at the Royal School of Mines (1854) Huxley made his first move in this direction. Five years later he became an examiner for the Science and Art Department. But it was in 1877 that he really came to the fore for technical education. It was in this year that Huxley made his memorable report to the Livery Companies, a report whose

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[1]"The Struggle for Existence in Human Society," Essays, IX, 234.

[2]"Technical Education," Essays, III, 444.

proposals later became the framework of the guilds' technical education program. His work with the guilds was given much-needed stimulus by the inquiry into the affairs of the Livery Companies who, as a result, were ordered by the Royal Commission of Inquiry to publish their incomes and to increase their financial support to technical education and other stipulated fields. As a result of this campaigning by Huxley and pressure by the Crown, the Livery Companies founded many technical schools and gave financial aid to deserving students and teachers.

Then, too, Huxley succeeded in securing state and local assistance for technical training, aid which was materially increased by the Technical Instruction Act of 1899 and the Local Taxation Act of 1890. In addition to the above accomplishments, Huxley helped to establish a program of scientific agricultural training, one that stressed the relation of theory to practice. And finally, in order to insure having an ample supply of trained technical teachers, Huxley successfully urged the establishment of teacher-training centers and advised the paying of more equitable salaries, especially for trained instructors. It is evident, then, that the ultimate recognition of the values of technical education was largely the result of Huxley's forceful and persistent efforts to give due place to such education in English schools.

CHAPTER VI

CONCLUSION

1. End of Huxley's Career

Huxley's influence upon the progress of science in English education was insistent and widespread, although its results cannot be mechanically labelled with subsequent pieces of educational legislation. It was like a swelling stream that never abated and never changed its course. Expressing his opinion concerning his own contribution, Huxley asserts--in a letter to the Bishop of Ripon (1887)--that he has "played the part of something between maid-of-all-work and gladiator-general for Science,"[1] a role that included research, writing, public lecturing, and classroom teaching. After years of hard work Huxley was ready to hand over to his younger contemporaries the task of promoting scientific education. At the age of sixty-two, then, he assumes an air of optimistic resignation to time and the physical forces about which he had spoken so often.

But he had earned rest and relaxation. His services to English education in the thirty-odd years since he had first assumed an active role in this field had been notable.

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[1] Life and Letters of Thomas Henry Huxley, 2 vols., ed. by Leonard Huxley (New York, 1901), II, 173.

These services were chiefly in the Department of Science and Art as an examiner, in the Royal School of Mines, the Royal College of Surgeons and the Royal Institution as a teacher, on the Royal Commission on Scientific Instruction as an adviser, and on the Guilds Committee as a counsellor on technical education. Huxley had also played an important part in shaping the general curriculum from the elementary grades to the advanced classes. For this reason Huxley tells a group at Manchester (1887) that he had been instrumental to some extent in the organization of primary education in London:

> You are aware . . . that, within the last seventeen years, a vast system of primary education has been created and extended over the whole country. I had some part in the original organisation of this system in London, and I am glad to think that, after all these years, I can look back upon that period of my life as perhaps the part of it least wasted.[1]

Huxley had made his recommendations for the revision of the curriculum so that it would include science. And the primary schools, he believed, constituted the foundation for all advanced training in science; therefore, he had contended that a well-organized course of primary training was necessary for the successful promotion of over-all science education. By this plan there truly could be a "ladder reaching from the gutter to the university," with the lower rungs

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[1]Thomas H. Huxley, "Address on Behalf of the National Association for the Promotion of Technical Education," Collected Essays, 9 vols. (New York, 1894-1897), III, 430-31.

strong enough to support the aspiring student of science in his climb to greater academic heights. It was to this phase of his work in education that he is referring in the Manchester address.

Now, after busy and fruitful years of service, Huxley feels that the time has come to give over his work to younger men. In "Science and Pseudo-Science" (1887), he refers to the past and speaks of the future:

> "My career is at an end. I have warmed both hands before the fire of life"; and nothing is left me, before I depart, but to help, or at any rate to abstain from hindering, the younger generation of men of science in doing better service to the cause we have at heart than I have been able to render.[1]

Thus does Huxley modestly withdraw from the scene of action near the end of a century that was characterized by the rapid growth of the scientific spirit, the application of scientific methods to problems of everyday life, and the rejection of traditional beliefs that could not bear investigation.[2]

2. Huxley: the Fruits of His Labor

Huxley had pointed out repeatedly the need for a combination of the scientific spirit and of applied scientific methods to solve life's problems until he finally helped to awaken the English to the importance of scientific and

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[1] "Science and Pseudo-Science," Essays, V, 125.

[2] Letters, II, 396.

practical instruction. One great stimulus to this awakening was his vigorous and continuous preaching concerning the neglect of the study of natural science. A factor that aided his cause was the ever-increasing fear of the scientific and industrial rivalry of Germany and other continental nations, a fear that tended to make the arguments of the scientists doubly effective.[1] And science teaching progressed, despite apathy toward and protests against such instruction.

Science, step by step, gained a footing in the strongholds of the older learning and entrenched herself there. Opposition within the schools and universities gradually diminished, and science took a place among the subjects in their curricula. Further, the teaching of this subject became more practical, and new colleges were founded in the more important centers of population in order to enable the community to secure thorough training in modern science.

One writer (1898) contends that the introduction of the teaching of science had become general, and refers to the programs of the public schools, the universities and the intermediate schools in support of his contention. Writing three years after Huxley's death, he asserts that for the most part science has become accepted in the curriculum:

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[1]Isaac Sharpless, English Education in the Elementary and Secondary Schools (New York, 1907), pp. 151-52.

> The public elementary schools have mostly introduced science into their scheme of instruction and it occupies a more and more worthy place in their timetables. All the great public schools include some amount of science in their curriculum. The universities of course have professorships of various sciences, and these are better attended by students than formerly. The intermediate schools . . . are following suit. . . .[1]

Undoubtedly it was largely through Huxley's efforts that the English people had been convinced that the older learning had been made inadequate by the changed conditions of the times. It was he more than any other single man or group of men who showed them that new fields of knowledge--scientific fields--should be included in any scheme of instruction intended to equip men for modern life, and that in this newer knowledge much might be found to minister to the highest ends of education.

It must be admitted that the utilitarian aspects of science were often in the foreground. Science brought into existence new trades and professions, and modified many of the older ones. It came into the affairs of everyday life. It aided industry immeasurably. Further, Huxley had warned the English of the importance of science in industry until they finally established technical schools in many towns for the purpose of teaching the theory and practice of various arts and industries, and of making artisans understand the

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[1]J. H. Gladstone, "Signs of Progress in Science Teaching," Nature, LIX (January, 1899), 298.

nature of the processes with which their trades were concerned. In the end this work in behalf of science in industry proved beneficial to the country at large.

In addition to the material gains, there had been a broadening of the range and method of teaching; the old subjects were better received because they were more scientifically taught, and the new subjects held the interest of large classes of pupils because they were replete with interesting new material. Indeed, science in education had become a familiar refrain by the beginning of the eighteen-nineties.

At the end of the century it was no longer a question as to whether science would be taught in the schools or not. Around 1870 that point had been hotly contested, but thirty years later the fight was practically won; and science has been growing in importance in education ever since. By 1900 the champions of the old established subjects became reconciled to the fact that science had come into the educational picture to stay.[1]

On the economic front the English people were gradually winning the struggle for existence, partly because Huxley had made them see that science education was necessary to economic survival. Such training was well underway by the end of the century, and may be thought of as a symbol of scientific and industrial progress.

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[1]Archibald Geike, "Science in Education," Nature, LIX (December, 1898), 108-9.

Indicative of the Huxley-inspired progress of science education is the manner in which the number of science students increased during years of strong opposition to such training. The following figures illustrate this rise in the number of science students: in 1865 there were 5,479 students, in 1870, 34,283;[1] in 1881 there were 61,177, in 1885, 78,810; in 1890 there were 133,821,[2] in 1895, 146,305; and in 1898 there were 363,378.[3]

The evening or continuation schools, so often advocated by Huxley, were holding their own during this period also. The aggregate number of scholars enrolled for 1896-97 was 107,042; for 1897-98, 126,740; for 1898-99, 106,665; and for 1899-1900 the number was 108,228.[4] It was by these evening schools, that the masses were more readily served; workers who were employed during the day could continue their scientific training at night and thus improve themselves. The trend toward more and varied science education was unmistakable. An occasional slowing down occurred, but the effect on the future growth was negligible.

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[1] Eighteenth Report of the Science and Art Department of the Committee of Council on Education (London, 1871), pp. vii-viii.

[2] Thirty-eighth Report of the Department of Science and Art of the Committee of Council on Education (London, 1891), p. viii.

[3] Report of the Seventieth Meeting of the British Association for the Advancement of Science (London, 1900), p. 189.

[4] Ibid., p. 460.

In addition to the increase in the number of science schools and in the enrollment, we have other evidence of the effectiveness of Huxley's efforts to promote a program of science education. Perhaps the most important was the Education Act of 1870 that was sponsored by W. E. Forster, minister of education and friend of Huxley. This Act accorded recognition to science in the curriculum; then there was the Technical Instruction Act of 1889 that guaranteed financial assistance to technical education; and the Code of 1890 that marked the beginning of the last stand of "Payment by Results," the practice that Huxley had always criticized. This code based the grant upon attendance, examinations being confined to sample groups of not more than one-third of the school. In 1895 this plan was abandoned and examinations--which Huxley considered necessary evils--were replaced by inspection. In 1897 payment for individual passes ceased, and in 1900 nearly all traces of "Results" disappeared when a block grant was substituted for special grants for particular studies, but such payments remained for cookery, gardening, dairy work, and manual instruction.[1]

These changes reveal that after much prodding by Huxley--and others--the state was assuming increasing responsibility for science education, realizing, no doubt, that the task of making such training available was truly that of the government,

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[1]John William Adamson, English Education 1789-1902 (Cambridge, 1930), p. 374.

either local or national. But financial assistance without organizational changes would have made needed improvements in curricular coordination nearly impossible. Two years after the turn of the century the obstacles to these changes were removed.

The Act of 1902, which provided for technical education in the programs of schools from the lowest to the highest, and for giving financial assistance to students especially interested in science, came as a belated answer to Huxley's earlier agitation for such a system of education. The School Boards, long a block to proper curricular articulation, were abolished. Being concerned with elementary instruction only, they cared little--and did less--for the sequential relation of this level to advanced work, thereby making it possible for students to finish the first part of their training without having their courses directed toward the following years of study. In place of the boards, local authorities were appointed, having the power to deal with all branches of education, and to assist all types of schools, from the kindergarten to the technical school and the university. The Act also enabled them to use local taxes for the provision of scholarships and exhibitions, by means of which promising pupils might climb from the lowest to the highest rungs of the educational ladder.

The passing of this Act fulfilled the aspirations of the educators of the day and--except for religious grievances

registered against it by non-conformists--it may be regarded as a landmark in the history of English education, "only equalled in importance and far-reaching consequences by the Act of 1870."[1]

Huxley's influence was increasingly in evidence as the new century began (twentieth) and the results of the Act of 1902 became clear. Science and art were still growing in importance; and the improvements called for by the Act were accomplished without too much expense. In the various centers of science and art, one could see signs of the growing extension of science and art instruction, and of the infusion of scientific and artistic ideas into the minds of the people. In relation to the cost involved, the excellent products of science classes and of science schools were ample compensation for the moderate outlay.[2]

These milestones in the progress of science education were not the result of the efforts of any one person; instead, they represent the sum total results of work done by many advocates of such training. From this group we selected Huxley for our study, and have found that he devoted much time and energy to bringing science to the masses and into the schools. He knew what needed to be done and he set about the task with optimistic resolution.

[1]Philip Magnus, Educational Aims and Efforts, 1880-1910 (New York, 1910), p. 33.

[2]Sharpless, op. cit., pp. 159-60.

It is true, we repeat, that it is practically impossible to attribute various education acts and codes to Huxley's efforts alone, but we know that--along with other scientists and educators--he helped to set forces in motion that made such eventualities inevitable. In one instance, however, Huxley claims that he actually managed to persuade the London School Board to approve resolutions, based on the Act of 1870, assuring the future of elementary science in the schools;[1] and apropos of technical education, Leonard Huxley describes his father as the "engineer" of the City and Guilds Institute for their program of technical instruction.[2] We may refer to his tilts with Wilberforce and Gladstone and reason that his able support and lucid explanation of the theory of evolution gave science added momentum; and that his mild dispute with Arnold tended to help science obtain equal curricular rank with the previously dominant humanities. At all times he took into consideration the science training of the masses as well as of the students, a practice that likewise helped to awaken the English to the importance of science.

Also contributing to Huxley's effectiveness was the fact that he was a member of seventy-five societies, national and foreign, and of ten important commissions, eight of which

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[1] Letters, I, 387-88.

[2] Ibid., p. 508.

were royal. In such a strategic position he was in close touch with men high in scientific, educational, and political circles, and had ample opportunity to seek their support for his proposals on science education.

The scope and vision evidenced in the work of one of the many commissions[1] on which Huxley served is well illustrated by its recommendations which served as guides for future legislation relative to science education. This commission, made up of such distinguished men as The Duke of Devonshire, J. P. Kay-Shuttleworth, John Lubbock, The Marquis of Lansdowne, J. Norman Lockyer, and Huxley, embodied in their proposals a broad plan for science instruction. The objectives of this plan were these: the proper teaching of younger children with lessons planned to prepare the pupils for advanced courses; and the modifying of the type of instruction for pupil teachers, the conditions of admission to training colleges, the duration of the courses, and the syllabus of subjects taught, so as to provide for the instruction of students in the elements of physical science.

The proposed means for securing these objectives were: that the instruction in elementary science classes under the Science and Art Department be arranged so that it might work in harmony with the general system of education; (2) that there be more efficient inspection of science classes; (3) that

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[1]Royal Commission on Scientific Instruction and the Advancement of Science.

teachers be given science instruction and allowed to take examinations for Elementary Science-Teacher, Second Grade Science Master, with corresponding payment differences; (4) that provision be made in recognized science schools for the practical instruction of assistant teachers; (5) that grants made by the Science and Art Department for buildings be extended to embrace institutions for scientific instruction; (6) that grants be given for laboratory and museum fittings; (7) that a complete and efficient institution be recognized as a science school, and be organized to become a center for elementary science classes, and to provide the assistance to First Grade Science Masters, the loan of apparatus and specimens, and the means of instruction in the laboratories and museums to the more advanced students of the group; (8) and that when laboratories are attached to second grade grammar schools in the schemes issued by the Endowed Schools Commissioners, the trustees of such schools be encouraged and enabled to invite the formation and teaching of elementary science classes in their schools.[1]

These recommendations indicate how well directed were the efforts to place science in its rightful position in English education. Huxley realized the importance of these proposals of the Royal Commission on Scientific Instruction,

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[1]Royal Commission on Scientific Instruction and the Advancement of Science, I (London, 1872), xix, xxviii-xxx.

and much of their pointedness may be attributed to his influence upon the other members of this investigating body.

In his overall efforts to effectuate a program of science education, Huxley launched out against a sea of apathy and essayed to arouse in both the public and the authorities an intelligent interest favorable to making this type of training available to everybody. He lectured, gave formal classroom instruction, advocated the use of the museum for science instruction, helped to train science teachers and wrote textbooks. Although his attack was centered on the regular curriculum, he sought to bring this training within the reach of the artisan because of the dependence of commerce and industry upon skilled and semi-skilled workers.

Huxley is remembered for devoting a life of service to a worthy cause: for having served as a spokesman for science in the schools and for the masses. He worked diligently to make clear the role of science in the pageant of progress. With his aid, science gradually forged to the front; the state, so long dilatory about its responsibilities to education, gave greater financial and legislative assistance; normal schools and other teacher-training centers were established; and science was finally given its long-deserved parity with established subjects in the curriculum. Huxley's name stands out uniquely because of his insistence upon relating science to everyday life, and because of his conviction of the inutility of scientific theory without its practical

application. His faith in the laboratory method echoed his belief in proof, and his abhorrence of blind faith in authority. He advocated science instruction for children and adults alike, coordinated from the lowest to the highest level and made available in day schools, evening schools and special classes.

Although during the course of Huxley's career many science and technical schools were established in England, and many colleges and universities gave science courses recognition, he did not live to see the full fruits of his labor. Yet, he did have the reward of knowing that science had reached a more satisfactory stage of progress, and was giving no indication of faltering in its course. Only a few years after his passing, the pressure of events connected with World War I catapulted science into a place of lasting prominence. Today we live in a period that is referred to as the atomic age; and as we consider how important science is in the present scheme of things, we wonder why Huxley's self-imposed task of convincing the English of the necessity of science education was so difficult. His Collected Essays, Letters, Autobiography, Memoirs, committee testimony, articles, and textbooks will always stand as evidence of the breadth, depth and farsightedness of his ideas relative to the dissemination of scientific knowledge; the effectiveness of these ideas is shown by the active acceptance, by both the state and the populace, of the responsibility of providing an adequate science education program for the English people.

APPENDICES

APPENDIX I

HUXLEY'S TESTIMONY TO THE ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION - JUNE 15, 1870[1]

His Grace the Duke of Devonshire, K.G., in the Chair

The Most Hon. the Marquis of Lansdowne.

Sir John Lubbock, Bart., M.P., F.R.S.

Sir James Phillips Kay-Shuttleworth, Bart.

Bernhard Samuelson, Esq., M.P.

William Sharpey, Esq., M.D., Sec. R.S.

Thomas Henry Huxley, Esq., LL.D., F.R.S.

William Allen Miller, Esq., M.D., LL.D., Treas. R.S.

George Gabriel Stokes, Esq., M.A., LL.D., Sec. R.S.

Thomas Henry Huxley, Esq., LL.D., F.R.S., a Member of the Commission, examined.

251. (Chairman.) (1) I believe you have acted as examiner under the Science Department of the Committee of Privy Council on Education? (2)--Yes, I have since the commencement of the system.

252. (1) Will you be so good as to state the manner in which the examinations are conducted? (2)--A letter is addressed

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[1]Royal Commission on Scientific Instruction and the Advancement of Science, I (London, 1872), 19-26. See also Huxley's testimony in Second Report of the Royal Commissioners on Technical Instruction, III (London, 1884), 317-42.

Note: (1) will indicate the question and (2) the answer.

to the examiner early in the year, requesting him to undertake the office and to prepare examination papers. When the time comes those papers are sent to the secretary of the Department of Science and Art, enclosed in a special envelope, and directed to the science inspector. The proof is returned to the examiner in a similar envelope, and is sent back again in the same way, so that great care is taken to prevent any improper inspection of the questions. Then as I understand, the papers are sent to all the schools which apply to be examined on the same day; that is to say, every school receives its papers on the same day, and the answers are written, under the inspection of the Committee, upon paper prepared with a proper heading, and furnished by the department. The numbered answers are returned to the examiner, who, without knowing anything about the schools from which they come, or the names of the candidates, affixes to them such marks as he thinks fit, and returns them to the department. There is a certain scale of marks which determines whether the candidate should be put in the first class or the second class, or should be rejected. There is a document which I asked Captain Donnelly to put in yesterday, giving the instructions of the department to the examiner, telling him what is the purpose of the examination, and giving him a sort of general direction as to the principles which should govern him in assigning marks, so as to get something like uniformity of action among the different examiners. Where the examination is a small one, the number

of candidates not being very great, the examiner does the work himself. But where the examination is a very large one, as in the case of my own subject (for example, this year I had over 3,000 papers), according to the number of the papers, the examiner is empowered to nominate, for the sanction of the department, one or more assistant examiners. A meeting takes place between the examiner and his assistants, after the papers have come back to the department, and the examiner-in-chief takes some of the papers and points out what he considers should be the style of marking, what should constitute rejection, and what first-class, and so on, so as to secure something like uniformity. Then the assistant examiners take the papers away, each having his own batch allotted to him, and as fast as they are read they are sent back to the department. The examiner-in-chief then appoints another meeting with the assistant examiners, goes over a certain portion of the papers with them, and satisfies himself that they are doing their work fairly and tolerably uniformly. Generally three meetings of that kind are found to be sufficient, and the work is done in about three weeks from the time at which the papers are sent out. The schoolmaster is paid upon those who pass; he gets nothing for those who are rejected, and he is paid a certain sum upon those who pass in the second class, a certain sum upon those who pass in the first class, and if any take honours, which they rarely do, because the examination is a separate and rather a stiff one, he gets a still larger sum.

253. (1) Do you examine in more than one branch? (2)--I examine in two branches, in physiology and zoology.
254. (Dr. Miller) (1) The results of one examination are not summed up with the results of the other examination; they are entirely independent, are they not? (2)--Yes.
255. (Chairman.) (1) By the method of employing assistant examiners you consider that a sufficient degree of uniformity is insured to secure justice to the students? (2)--Yes, I think so in my own case. I have been exceedingly fortunate, because the assistant examiners have been able and distinguished men. It is necessary that a very great amount of discrimination should be exercised; for although the questions are very simple, yet it needs men who know a great deal about the matter to form an accurate judgment upon them quickly.
256. (1) The examination papers are entirely elementary, are they not? (2)--There are three divisions. I ought to have stated before that the questions are set in three groups. There is an elementary stage, an advanced stage, and an honour division; the questions in each of those stages are separate, and the candidate must make choice of one of those three divisions. We endeavor to enforce the rule (it has been rather difficult in practice to carry it out, but gradually it is becoming enforced) that the candidate shall not go up for the advanced stage, unless upon some previous occasion he has passed through the elementary stage. That has been found necessary in order to prevent, as far as possible, mere

cramming, and it is a very useful precaution.

257. (1) Are the examinations held more than once a year? (2)--The examinations are only held once a year, in May.

258. (1) Those that go in for the advanced stage must have passed through the elementary examination in the previous year, must they not, or on some previous occasion? (2)--We endeavor to secure that as much as possible. There are some practical difficulties which prevent the rule from being always enforced, but I have always tried for my own subjects to have it enforced as far as possible. I ought to state that by way of making the examination still more fair to the schoolmasters and to the candidates, a very elaborate statement is prepared of the precise subjects in which the candidates will be examined. There is one syllabus in animal physiology, and there is another in zoology, and the subjects in which the candidates in the elementary stage and the advanced stage will be examined, are laid down with considerable minuteness. The honours examination is left perfectly open.

259. (Sir J. Kay-Shuttleworth.) (1) That, I apprehend, is given before people begin to study? (2)--It is published every year in the Science and Art Directory.

260. (Chairman.) (1) Those directions are permanent? They do not vary from year to year, do they? (2)--No, they do not.

261. (1) Does the same rule apply to the honours division; must they have passed through the two preliminary examinations?

(2)--I think as far as possible. I am not quite sure what the rule of the department is about it, but I think that is the case; but the fact is that it is exceedingly rare for anybody to get honours.

262. (1) Is the number that pass the elementary examination much in excess of those that go in for the more advanced examination? (2)--I am not quite sure about the number; but I believe it is so. I have nothing to do with the returns; they are made up by the department, and I cannot say much about them. I have here a return of the results of the examination of science schools and classes in May 1869, which is the last return. In my own two subjects for that year, to begin with animal physiology, in honours 11 failed; there was nobody successful. In the advanced examination there is a statement here of the number for the year 1869, which gives 2,227 in animal physiology, and 303 in zoology; but that is of all classes put together.

263. (1) Does the more advanced examination require a considerable further knowledge of the subject than the elementary examination? (2)--Yes, considerably further.

264. (Sir J. Kay-Shuttleworth. (1) At page 50, Appendix B, 17th Report of your department, there is a table showing the percentages of successes and failures in each stage in each subject, and also a table of the detail of successes and failures in each subject? (2)--Yes, taking it together with the previous statement, that will give the whole. For

example, in 1869 there were 2,227 papers sent in animal physiology. Out of that number, taking the elementary stage, there were 63 who passed in the first class, there were 291 in the second, there were 618 in the third, and there were 811 failures. I should say that last year, in 1869, there were three classes, but this year there are only two. In the advanced stage there were 42 who passed in the first class, 193 in the second, and 198 failures, making a total of 433, a small number as compared with the elementary. They got very much weeded in the elementary examination. In zoology in the same year there were 303 papers sent up, and of those in the advanced stage nobody passed in the first-class; there were 13 in the second, and 31 failures, making a total of 44 of the advanced stage. In the elementary stage there was one passed in the first class, 25 in the second, and there were 108 in the third, and 119 failures, making a total of 253.

265. (Chairman.) (1) Have you formed any opinion as to the amount of good you are doing by those examinations? Can you say whether a considerable number of the candidates show such attainments in science as are likely to be of use to them in future life? (2)--I have watched that very carefully during the 10 years that I have been connected with this system of examination, and I am fully of opinion that a great amount of good is being done by the system; and I think that the good will be immensely increased, with one proviso, that the examiners do their work with care and conscientiousness; that is

at the bottom of the whole thing. When we began the system 10 years ago, it was of course necessary to be very easy with it, because people did not know how to teach physical science; and it was necessary to get the schoolmasters to understand that the thing was worth exertion; but as time has gone on I think that the examiners have seen the necessity of gradually raising the standard. As the schoolmasters became accustomed to the system, and as the method of teaching became thoroughly developed, so the standard has been gradually raised; and, so far as my own subject is concerned, I see a steady improvement from year to year. As in all other examinations there are a great many who pass with a very superficial knowledge; but I must confess that however superficial that knowledge may be, I think if it is honest, so far as it goes, it is all to the good. There is a wonderful difference in the state of mind between a person who has never heard of a subject, and one who has forgotten what he has heard. Those two states of mind are almost infinitely different. Although I do not know but that if you were to put a very large proportion of those scholars through their paces a year after they had passed, they would cut a very bad figure indeed, yet I think that is the case in all examinations whatsoever, and does not militate against the conclusion that a very considerable amount of good, in opening people's minds and rendering them able to think, has been done by those examinations. At the same time I

should say that there is a per-centage of candidates, and quite as large a per-centage as in any other examinations, who have really acquired a fairly respectable amount of thorough information upon the subject. I have been quite surprised, and so have my colleagues, the assistant examiners, at the character of some of the papers. I should think perhaps we might say 10 per cent. of the papers would come under the head of papers which would do credit to any teaching and to any examination of the same character; and so far as my experience goes, that is about as much as is to be hoped for from any sort of examination, and I have seen a great deal of examinations in my time. There is one great evil which we have had to contend with from the very commencement. The teachers see that it is possible to make a good deal of money out of it, and there are some of them who seem to have set their minds entirely upon trying to get money out of the system by simply cramming young children, and by putting them up, so to speak,to be shot at, upon the chance that they would get something out of it. The remedy for that is entirely in the hands of the examiners. If the examiners are lax, that system will increase, and the evils of it will increase until the whole system will do harm instead of good. I have not the slightest hesitation in saying that I believe that it is in the power of the examiners to stop it at once. It is perfectly easy for any person of experience to see whether a teacher is acting in this fashion, or whether he is not; and if he is,

plucking 90 per cent., or more, of those he sends up, prevents his attempting, or at least discourages him a good deal from attempting, it again. Last year we had a considerable number of teachers in physiology up to London, for the purpose of giving them some instruction in practical methods of teaching, and with a view of improving the teaching in general. I took advantage of the opportunity to make an address to them upon that very subject, and to explain to them what I thought was my duty, and what was theirs; and what I proposed to do when I observed that anyone was teaching for the mere purpose of getting money without regard to the goodness of the teaching itself. I have reason to know that I gave some of my auditors great offence, but I thought it was proper that they should understand quite clearly what our relative duties were, and what I proposed to do, and this year I think there is considerable improvement in that respect.

266. (1) Can you explain how there is such a much larger number in animal physiology than in zoology? Is it from the subject being more attractive, or do the candidates think that it would be more valuable to them in a pecuniary point of view? (2)--No, there are two reasons for it. In the first place, I have had charge of these subjects from the beginning. I am quite convinced that as matters are at present, it is exceedingly difficult to teach zoology properly, and I set my face altogether against the sort of superficial teaching which was attempted. On the other hand, I have taken very great pains

to organise a system for the teaching of human physiology, a subject with the elements of which I think everyone ought to be, and may be, acquainted.

267. (1) After the examinations are concluded are you brought in any way into communication with the teachers; have you the means of forming an opinion as to which of the schools are really doing good work, and which are not coming up to the mark? (2)--If I like to inquire I can always find out. For example, on the present occasion there are one or two schools to which I mean to call attention in my report to the department, where it is quite obvious that things are not going satisfactorily. In one school, for example, from which about 80 or 90 papers were sent up (I knew they came from the same school by the style of teaching, and by their being consecutive numbers), I found it my duty to reject between 70 and 80, or nearly the whole, and I shall make a special report upon that school.

268. (1) As far as they are concerned there is no waste of public money, because most of their pupils are rejected, but there is a great deal of unnecessary work cast upon the examiners in looking over the papers? (2)--To a certain extent there is a waste of public money. I meantioned in one of my reports in a former year, that I thought something should be done with those teachers who send up candidates in such condition, because the assistant examiners are paid by the numbers of papers which they have to examine, and

consequently every paper which is sent up in an obviously unfit state, is so much money taken from the State without justification. It is not very much it is true, but still it is too much.

269. (Mr. Samuelson.) (1) Can you give the Commission an analysis of the document for the guidance of the examiners that is issued by the department? (2)--I am afriad that I could not trust my memory for that as it did not occur to me to bring it; but it will be very easily put in by-and-by. It is strictly speaking a private document sent by the department to the examiners, but I presume that there could not be the slightest objection to publishing it. (See Appendix.)

270. (1) Do you on the whole approve of the course laid down for examiners by the department? (2)--Yes. It is the result in fact of a great deal of communication between the department and the examiners.

271. (1) The assistant examiners, I think you said, are appointed by the examiner-in-chief? (2)--They are recommended by him. The appointment rests with the Lord President.

272. (1) But is the recommendation ordinarily followed? (2)--Yes. The examiner-in-chief is held responsible for the whole examination, and all that the department does is to sanction the appointment of those persons upon his responsibility.

273. (1) What, in your opinion, has been the effect of the change with respect to the mode of ascertaining the qualification

of teachers, which took place about two years ago, on which Mr. Cole gave some evidence yesterday? (2)--I think it has been unfortunate, and I should very much like to see that examination of teachers revived. In spite of all that may be said, I think that the former plan was a very great check upon the system of cramming. I should like to see all the teachers put through a special examination.

274. (1) In spite of the great increase of the number of teachers which has taken place lately, you think there would be no difficulty in devising a system of examination which should not be very expensive to the State, and which should be effectual in securing a sufficient standard of qualification on the part of the teachers? (2)--I think so. I do not see why there should be any great expense connected with it, and I think that upon the whole you would save by the diminution in the number of bad papers sent up.

275. (1) Would you require the teachers to come up to London for examination, or to certain centres to be defined beforehand? (2)--I think it would be very difficult to manage it otherwise. I should like to make the examination practical. I should like to set a teacher to work (in physiology, for example), to show me how he would teach the circulation of the blood, or how he would demonstrate the structure of a sheep's heart, or something of that kind. It would be very awkward to get materials and appliances in every locality in which the teachers might be; therefore I think it would be

desirable, I will not say essential, that they should come to London.

276. (1) To London or to some point where they would come into personal contact with the examiners? (2)--Yes.

277. (1) Even if there should be some increase of expense, you think that such a course would be so decidedly superior that it ought scarcely to weigh in the balance? (2)--I confess that I do not think that the question of expense of that kind ought to weigh in the balance at all, because, if this system goes on, you will be expending 100,000l. a year before long, and it will be money very well spent, if the examinations are well managed. The per-centage upon such a sum as that of the expense of examining skilled masters would not be worth speaking about.

278. (1) Have you paid any attention to the papers which have come up from the few science schools in which science is taught systematically during the day? (2)--I have no knowledge of the schools. Unless anybody were to tell me what the numbers meant, I should not know from whence the paper came; and unless some special circumstance called my attention to a series of numbers, I should not inquire. It is rather better upon the whole that the examiner should not know anything about it. It gives a complete answer to people who are angry at not getting what they think they deserve.

279. (1) Formerly you came into contact personally with the teachers, did you not, under the old system? (2)--Only at

the time that they were examined. I saw nothing of them at any other time.

280. (1) At that time was there a large per-centage of those teachers whom you considered to be fully qualified for teaching elementary science? (2)--They were not passed unless they were so qualified.

281. (1) Are you aware what is the present standard for qualifying a person to become a teacher of elementary science? (2)--I am not sure; but I think that a teacher has to pass in the advanced stage.

282. (1) But not in honours? (2)--No.

283. (1) So that in point of fact a man may be a pupil one year and a teacher the next? (2)--Yes, so far as I know anything about the working of that part of the system; practically there is no guarantee for the fitness of the teacher. Perhaps I had better read the 32nd article of the Directory upon that point:--"Payments are made on the results of instruction where it has been given by teachers who have qualified in either of the categories mentioned below. And no payments are made on account of instruction given in subjects in which the teacher is not so qualified. The qualification consists in having (a.) obtained a teacher's certificate in any of the before-mentioned sciences, according to the rule in force previous to January 1867," (those are the old rules,) "or (b.) obtained a first or second class in the advanced stage at the May class examinations since that date,

or (c.) taken honours at the May examination." They say further; "In mathematics a first class in each stage will, from and after May 1870, qualify the holder to earn payments on the results of instruction in that stage, and a first class or honours in stages 3, 5, and 7, on the results of instruction in the preceding stages. Teachers already qualified to earn payments in 'elementary mathematics' are qualified in stages 1, 2, and 3, and teachers already qualified in 'higher mathematics' are qualified in all the stages of pure mathematics." The next article is this:--"The examination for qualification to earn payments on results of instruction will be dispensed with in the case of a candidate who has taken a degree at any university of the United Kingdom, or who has obtained the associateship of the Royal School of Mines, London, or the Royal College of Science, Ireland."

284. (1) As I understand it, a man can only obtain payment on results in the subject in which he has taken a certificate? (2)--That is so.

285. (1) I believe that under the former system, when there were special examinations, that was not the case. A man, for instance, having taken a certificate upon an examination in chemistry, was qualified to teach electricity or physiology, or any other subject within the programme of the department? (2)--I cannot answer for certain, but I do not think that is the case.

286. (1) At any rate you would not approve of it if it were

so? (2)--No, certainly not. I think they are obliged to take a separate examination.

287. (Dr. Miller.) (1) It says, "Obtained a teacher's certificate in any of the before-mentioned sciences, according to the rules in force," that is the first qualification? (2) --Yes, those are the rules now existing.

288. (Mr. Samuelson.) (1) But the old rule was as I have stated, but you would not approve of it? (2)--No, I do not see what the use of it would be; but the present rule limits it very definitely indeed.

289. (1) With respect to the teacher's qualification, would you simply return to the old rules which were in force before 1867, or have you considered what would be the best rules to enforce with respect to teachers' examinations? (2)--If I were to propose an ideal system (I do not know how far it may be practicable), but I should like to have all those teachers passed through a normal school in London, through a proper training school for teachers. That is what one would strive to have, and that the teachers should all take their qualification in the normal or training school. You will never get thorough scientific training in the country till that is the case.

290. (1) Do you think it would be desirable to require that, even in the case of persons who are only to teach elementary science in night classes to adults? (2)--I think it would be very desirable.

291. (1) That in point of fact is a very strong argument in favour of the proposed school of which Mr. Cole spoke yesterday? (2)--I do not quite know what may be Mr. Cole's views upon that subject, but it is, and always has been, a very distinct notion of my own. I do not see how you are to secure thorough value for the money which the State pays unless you have something of that kind.

292. (1) Are you of the opinion that such a school might also afford instruction to persons whose intention is to devote themselves to industrial pursuits, in fact that the proposed training school might at the same time be a school of mines, or a school of practical chemistry? (2)--So far as the instruction in general science is good for all, I think that might be so, but undoubtedly the special instruction in mining or mineralogy might interfere with the instruction of teachers in the method of teaching. The two things are quite distinct. I do not mean to say that that difficulty could not be overcome, but the two lines of operation are two distinct lines.

293. (1) But you do not see any difficulty in combining them in the same institution? (2)--No, I do not see any difficulty in that.

294. (1) In fact the cost of giving instruction to your teachers would be in some degree diminished by the admission of other students? (2)--I think it might be, but still I confess that I should be very sorry to have the course of

instruction requisite for teaching teachers how to teach, modified by the requirements of some other kind of teaching.

295. (1) You would not sacrifice the one to the other? (2)--No, I think the one is of far more importance than the other. I think that if you get a body of trained teachers all over the country, they will do your technical work for you very much better than you can do it in any other way.

296. (1) Have you considered the question of how far the present staff of teachers in the School of Mines and in the School of Chemistry, and in the School of Naval Architecture could do the work of such a training school as has been shadowed forth? (2)--There is no doubt that there is a foundation for a school of the kind. I know the organisation of the School of Mines best, and it is very defective in some respects. There is no mathematical teaching, for example, which is a lamentable defect. Then there is an entire want in the School of Mines, as it now exists, of any means of teaching several of the subjects practically. For example, I am set there to teach natural history without a biological laboratory, and without the means of showing a single dissection. I am in the position of a chemist who should be set to teach chemistry without a laboratory.

297. (1) And even for your preparations, that place is quite inadequate? (2)--There is no provision whatever. I cannot teach in the proper sense of the word, so that I should think one could not say in the School of Mines more, at present,

than that there is a nucleus of an efficient body.

298. (1) As far as laboratories are concerned, is it the case or not, that the same laboratories would be available for the two classes of students; that is to say, the students who are to become teachers, and those who are now receiving instruction in the three institutions which I have mentioned? (2)--That is a question of space, because students in a laboratory take up so much room, and of course while they are being instructed others cannot occupy the same space.

299. (1) But the kind of laboratories is the same? (2)--I presume so; but I should not like to go beyond my tether in that matter.

300. (1) You say that there is no mathematical teaching whatever in the School of Mines. I believe that in teaching applied mechanics no reference whatever is made to mathematics, and there are no mathematical demonstrations possible? (2)--I can give no opinion upon that subject.

301. (1) Are you acquainted with the building which is now being erected at South Kensington? (2)--No; that is to say, I have been in it, but I do not know it in detail.

302. (Dr. Sharpey.) (1) With regard to examinations, have you ever considered that it would be practicable to check that tendency to send up unqualified candidates, by making some ratio in the payment between those that passed and those that were rejected; for example, supposing that 70 per cent. are rejected, and 30 per cent. pass, that the payment upon the

passed should not be at the same rate as it would have been had the rejections been fewer. Until you get that better arrangement for training teachers which you are now referring to, might not some means of that sort be devised for checking the evil? (2)--I think something of the kind might be done, and I have made representations to the department about it; I think that where the rejections are very bad, some notice should be taken of it. I think that the plan you suggest might not be a bad one.

303. (1) It seems obvious from what you have stated, that they send them up with the mere hope or chance that they may draw prizes? (2)--Yes. I should be glad to be understood that this is not the general case, but in every examination there will be a certain, and sometimes a considerable, number of candidates sent up upon that principle, or rather want of principle.

304. (1) Probably if it is not checked it may go on increasing until you have the better means of training teachers? (2)--Yes. It is a point which will always require the utmost vigilance in the examiner. If the examiner is an easy-going man he will always have his subject made a prey by the people who find it out.

305. (Sir J. Kay-Shuttleworth.) (1) Yesterday you will have observed that in answer to a question put to Mr. Cole, it appeared that the great majority of the teachers in those local science schools were certificated teachers of primary schools? (2)--Yes.

306. (1) Also it was stated that those teachers are for the most part engaged in teaching in the morning and in the afternoon, during 2½ hours at each period, and that they have likewise to teach for an hour and a half their pupil teachers, and several of them have charge likewise of evening schools, and that it is after they have discharged those duties for the most part that they teach the science school; is that at all the ideal system which you have formed of the mode of supplying elementary scientific instruction to the country? (2)--No, I was not aware of the fact before; if the teachers work in the manner you describe, the fact may account for the very large per-centage of rejections.

307. (1) Are you aware likewise that the Committee of Council on Education a few years ago rescinded a minute which previously restrained elementary teachers from instructing any evening schools whatever, after the instruction in the day school? (2)--I have understood that to be the case.

308. (1) You are probably aware also that the per-centage of the money which can be earned in the elementary day schools, has from recent Acts of the Privy Council been somewhat reduced? (2)--I have understood so.

309. (1) Is it not therefore apparent that there is a great temptation to the teachers of the elementary schools to increase the amount of their annual income by teaching evening schools, and also science schools? (2)--Clearly so.

310. (1) You have already in answer to questions put to you by Mr. Samuelson, expressed your great preference for the system which preceded that recently adopted, of requiring a special examination in each of the subjects which the teachers selected for instruction in evening science schools? (2)--Yes.

311. (1) Taking into account all the circumstances which I have related, the great previous occupation during the day of the teacher, the exhaustion of his energies, and the temptation which he has to earn money by teaching, are you not of opinion that some portion of the instruction given during the 12 hours of the day, must suffer by such a constant occupation of his mind and energies? (2)--Your statement conveys a correct impression of the daily work of the teacher. I should imagine that the whole of his instruction must suffer. I cannot conceive of a man giving thorough and good instruction under those circumstances.

312. (1) You will observe that upon this matter being brought under Mr. Cole's attention yesterday, he admitted that the system must be regarded as transient and temporary? (2)--Quite so.

313. (1) I have observed this morning that you are of opinion yourself that no course could be adopted which would give any clear and satisfactory elementary scientific instruction to the artizans of the kingdom, unless the teachers generally passed through a normal school in London? (2)--I think that

that is the ideal to be aimed at. I think that a great deal may be done in an imperfect sort of way without it, but I think one must look to that.

314. (1) Are you not also of opinion that the teachers, in giving this elementary instruction in science, ought not to be engaged in day-school instruction? (2)--My own feeling is that I should rather put it in another way; that is to say, that scientific teaching ought to be made a fundamental part of all primary teaching in the kingdom, and be made a part of the day's work. Unless I am greatly misinformed, the scientific instruction which is now current in the kingdom was the result, so to speak, of a battle between two official departments. I do not know whether I am rightly or wrongly informed, that it was in the teeth of the Educational Department that this scientific instruction was introduced; but, if such be the case, the fact accounts, I think, for the nocturnal, and somewhat surreptitious, position which science at present occupies. Sir James Shuttleworth can tell much better than anybody else whether such was the case or not. I think that is the way that we have dealt with science, not only in primary education, but in the larger educational bodies in the country; and my hopes to see science made an integral part of the elementary teaching everywhere in the country, and not to have it merely forced upon one department by another, as it seems to have been the case formerly.

315. (1) You are aware that so far as positive legislation

yet has extended, the school age has been defined by the revised code as 11 years of age, and by the Factories' Act as 13 years of age, for half time. Have you much hope that any elementary scientific instruction which deserves the name could be given to a child before the age of 11? (2)--Considering the difficult matters with which elementary education is now made to deal, such as the exceedingly difficult problems connected with dogmatic theology and the like, I think science might be taught quite as well. I think that the time which is devoted to the one might with equal success be devoted to the other.

316. (1) Have you ascertained what degree of success attends instruction in dogmatic theology in elementary schools? (2) --I can only presume from its being so strongly insisted upon, and made the subject of such a great battle at present, that it must have a great value.

317. (1) I mean, do you know what degree of success it has attained? (2)--I do not know.

318. (1) Have you also observed in what standards the scholars ordinarily pass in the very best elementary schools, and under the largest and most efficient staff of educational machinery yet employed, up to the highest school age, in respect of ordinary elementary instruction, such as reading, writing, arithmetic, and geography? (2)--I am not aware, I have not paid attention to that; but I may say in relation to this matter, that I have no doubt whatever that a certain amount of

scientific teaching of a very valuable kind might be given to children of the ages now specified. I think that the nature of your scientific teaching must be very carefully determined, but I think a great deal of what may be fairly called elementary science, with respect to the ordinary phenomena of nature, is information which might be made very complete in its way, although, of course, it would be very elementary; indeed, I am quite sure, from my own knowledge of children, that that may be given to children under 12 years of age, with extreme benefit.

319. (1) That, of course, would be of a very different character from that which at present comes under the review of the examiners of the Science Department? (2)--I do not think necessarily so. I think, for example, that children of that age may be taught elementary physical geography. I think it might be made a most important and most valuable subject of instruction, and not only of instruction, but of training, under that age. The elementary facts of physics (I am now using physics, of course, in its most elementary sense), I imagine may be taught with perfect ease.

320. (1) You are probably well aware of the expedients which are adopted in some of the Swiss and Prussian schools with the object of teaching the simplest elements of the subjects to which you advert, such as in physical geography and geology, raised maps, and in the elements of mechanical science, small models of various descriptions, which are explained familiarly

to the children, and so forth? (2)--Yes.

321. (1) Those are, I suppose, the forms of instruction to which, on the whole, you are now alluding? (2)--Certainly, that is the main characteristic of any sound elementary scientific teaching. The great blunder that our people make, I think, is attempting to teach from books; our school-masters have largely been taught from books and nothing but books, and a great many of them understand nothing but book teaching, as far as I can see. The consequence is, that when they attempt to deal with scientific teaching, they make nothing of it. If you are setting to work to teach a child science you must teach it through its eyes, and its hands, and its senses.

322. (1) You are aware of the suggestion of Dr. N. Arnott, the author of the Elements of Physics, for the instruction of the youngest children by means of objects of the kind which are called scientific toys? (2)--I have heard of his propositions.

323. (1) But, looking to any success in instruction in elementary science, in connexion with the manufactures of this country, I suppose that you would expect that the form of instruction which you would advise should be adopted in primary schools, should be developed in some secondary form in more advanced schools? (2)--I think so.

324. (1) And for that purpose a suggestion fell from Mr. Cole yesterday, that where practicable, secondary day schools, or secondary evening schools, should be established? (2)--Certainly.

325. (1) It was to these secondary day schools, or secondary evening schools, that my previous question had reference, when I asked whether you would not conceive it desirable that the teachers prepared for them should not have charge of elementary day schools? (2)--Certainly not.

326. (1) With regard to centres of examination to which Mr. Samuelson adverted, you are aware that for the examination for certificates under the Committee of the Privy Council for the teachers of elementary schools, training colleges throughout the country are employed? (2)--Yes.

327. (1) There would be, as you are well aware, in connexion with training colleges, and in future it may be so to a greater extent, a collection of models and apparatus and means of instruction in physical and experimental science, -might not those centres afford an opportunity of conducting the examination of teachers in various parts of the country? (2)--I think they might, if you could get the examiners. The difficulty is to manage your examiners, if you have your examination centres scattered over the country; because the more you multiply your examiners the less is the chance of uniformity in the examination, and the more difficulty there is in dealing justly with the candidates; so that I think there is considerable importance in having a homogeneous body of examiners, men who will work together, and who in course of time may organise a continuous system to which the candidates may look.

328. (1) Are you aware that the system adopted by the Committee

of Privy Council consists of two forms, one the inspection of the fairness with which the examination is conducted at the local centre, together with any viva voce examination, or it might be in this case an examination in manipulation, which it may be necessary to conduct locally, and then the transmission of the examination papers to the centre to be distributed to the examiners: would not some such form as that greatly diminish the difficulties which you anticipate? (2)--No, I think that that is putting the cart before the horse. As far as my own experience as an examiner goes, I think that the only thoroughly valuable form of viva voce examination is that which comes after the written examination, when you have read a man's paper and you want to know whether he really knows what he is talking about, or merely is writing very cleverly from memory. Such viva voce examination is invaluable, because it furnishes a commentary upon the written paper.

329. (1) Viva voce examination, in the case of elementary teachers, is upon subjects different from that of the papers; for example, it is an examination in the power of instructing a class, or in some subject which could be better tested by viva voce examination, such as recitation or some other matters of that kind; and I was contemplating rather that the same method of individual examination might be applied to manipulation? (2)--Just so. I misunderstood your question.

330. (1) With respect to a training or normal school, without in the slightest degree anticipating whether it is desirable

or not to depend for the establishment of a connexion between theoretic science and its practical application upon the action of the teachers in the country, or to make it form part of a normal school, would you propose that the following subjects should be mixed or separate, viz., first, pure theoretic science, then theoretic science in its application to some special object, such as mining or naval architecture, and then, thirdly, the method of instructing in theoretic science and its application, for example, to elementary or secondary instruction. By a greater occupation of the teacher's time, might those be grasped by any thoroughly competent man; as, for example, the application of mathematics to several subjects, or of chemistry? (2)--Putting it into a practical shape, and taking chemistry as an example, you would propose that the same person should teach theoretical chemistry; in addition to metallurgy and other applications of chemistry; what the Germans would call "pedagogics," or the method of teaching chemistry. I merely take that illustration and apply it in my own mind to the subjects which I am acquainted with, and I should say that it would not be a good method, for I think that anyone of those three things is quite enough to occupy a man's entire attention.

331. (1) What you would prefer as I understand, is that the normal school should be entirely for teaching pure science, and the method of applying it to second-rate schools? (2)--So far as it is a school for teachers, certainly. What I should

like to see taught is science itself to begin with, and secondly, the method of teaching science.

332. (1) May we not call it method in its application to secondary and elementary schools? (2)--Yes, just so.

333. (1) And you would be inclined to depend upon the exertions of a teacher instructed sufficiently in pure science and in method for the application of science? (2)--Yes, I think that there is a great deal of misunderstanding as to the utility of the spread of technical education over the country. I do not think that much good is to be done by attempting to deal with the trades directly. In the scientific education of the masses of the people, the great object appears to me to be, to construct such a scheme as should enable you to sift out, and to get hold of the men who have really scientific ability. If you can pick out the men of intellect from the men who are only fit to carry water, and hew wood, and give them a fair scientific training, you may trust to the arts getting all that they want out of them.

334. (1) Allow me to take an illustration from northeast Lancashire, the place where I live, surrounded by the following trades needing the application of pure science to the practical arts and industry of the country. We have mining, we have calico printing and dyeing, we have machine making to a very great extent, and we have the constant operation of the inventive faculty of the artizans, which is the real source of almost all the inventions by which the textile manufacture has

been advanced. What I intended by my previous question, was to ask you whether your conception was that the establishment of a secondary school in such a region, in which the teachers who had been prepared in the normal school to teach certain departments of pure science, and who had an opportunity, either in the day or in the evening, of receiving into the schools the men who were practically engaged in those various forms of industry, was the most favourable opportunity for attempting the combination of scientific instruction with the practical arts of industry, rather than in the normal school? (2)--That is to say, you would make your technical schools local.
335. (1) Your idea is that the secondary school in which scientific instruction would be given would be local, and would be attended by artizans connected with the mining and printing and mechanical industry of the neighbourhood, and that those artizans would come to it for instruction in science connected with their several departments, and perhaps in other sciences, and my question was whether that combination was in your mind that which it is most expedient to establish? (2) --In replying to Mr. Samuelson previously, I did not mean to raise any objection against establishing technical schools in London. All that I mean to say was that I thought that there might be danger in combining the technical school with the normal school; that is to say, that if you tried to get the same set of men to do both duties, the one set of duties would most likely interfere with the other; but I did not mean to

express any opinion as to the utility of having technical schools in London or elsewhere.

336. (1) I am simply desirous of eliciting your opinion as to whether the provision of the class of secondary schools which I last described would diminish in your mind the importance of the creation of the other form of technical instruction by the Mining School or the School of Naval Architecture, or other technical schools in London? (2)--No, I do not think that they would interfere with one another at all, they might cooperate to any extent.

337. (Mr. Samuelson.) (1) You stated, did you not, that you thought some teaching of elementary science might, with great propriety and great benefit, be introduced into an elementary day school? (2)--Yes, certainly.

338. (1) Would you consider that the present system of examination by papers would be adapted to pupils of that class of school? (2)--I should not consider it so good a system for pupils of that class, for the quite young children that I am now referring to, as a <u>viva voce</u> examination.

339. (1) You would consider it desirable that the examination should be conducted by the school inspectors? (2)--Certainly.

340. (1) You would not approve, I suppose, of the suggestion contained in Captain Donnelly's paper of 12th of November, 1867, with reference to the teaching of science in elementary schools, that the Science and Art Department should make a return of the results to the Education Office, and that the

function of the Education Department should simply be to pay upon those results? (2)--If that proposition contemplate that education in science should be introduced into the ordinary day's work of the school, I think it would be exceedingly undesirable to have one person looking after three-fourths of the education, and somebody else looking after the other one-fourth. I think it important that whatever teaching in science there is, it should be put upon precisely the same footing as all other teaching.

341. (1) That would involve qualifications on the part of the inspectors of schools, which, under our present system, they do not necessarily possess? (2)--I do not see why you should not have scientific inspectors of schools as well as literary inspectors. There would be no difficulty whatever in sending round proper science inspectors to examine the schools qua science.

342. (1) But if the payments were to be made on results, the inspection should necessarily be local? (2)--I think so, I think that for young children (and we are talking about teaching science to young persons under 12 years of age) the means of judging whether the work is properly done by viva voce examination is very much superior to that by papers.

343. (1) In the papers which have been sent up to you and which have come under your notice as the result of the present system of examination, have you or have you not, detected a want of elementary instruction in what are familiarly called

the three R's on the part of those who stand for examination? (2)--Yes, it is a lamentable want, particularly in those cases to which I have just now referred, where the schoolmaster has evidently been sending up a lot of candidates simply crammed. I could almost pick out those papers by the handwriting and the spelling.

344. (1) You have stated that the first requisite of a normal school of science should be that it should, in the first place, qualify the teachers in pure science, and secondly in the art of teaching? (2)--Yes, certainly.

345. (1) But having reference to the destination of the majority of those teachers, namely, that they should hereafter teach in secondary schools, would it not be desirable that they should have a general acquaintance with the application of those sciences to industry? (2)--I am afraid that when you come to practical matters a mere general knowledge of the application of science is likely to do as much harm as good. I can understand very great value attaching to a specific knowledge of the applications of science to an art, but a mere general knowledge it strikes me may be just as likely to mislead as not. It is very much like medicine. A person would do very unwisely who should endeavor to doctor himself upon the strength of his knowing a little of physiology, or even knowing a good deal; he had much better leave it alone.

346. (1) Putting it more specifically, assume that a teacher comes up to the normal school to be trained; assume him to

come from a mining district, in which the management of mines is very much in arrear as compared with other districts, would you not consider it desirable that the teacher, knowing his destination to be such a district as I have described, should go through a course of instruction in a mining school, having special reference to mining? (2)--I quite think so. If I could deal with that man as I pleased, I should put him first through the normal school that we are talking about, and afterwards I should send him to the School of Mines to go through a third year of special instruction in mining. But the instruction in the School of Mines is not mere general knowledge of the mining processes, it is very specific and particular knowledge. It is like the technical instruction of a medical school, to refer to my previous illustration.

347. (1) Then so far as the classes could be held in the same building and in some manner connected, do you think that it would be rather an advantage than a disadvantage? (2)--So long as the one class of work did not interfere with the other, and I do not see why it necessarily should in this particular case of which we are now talking; in fact it does not in the School of Mines at present.

348. (Chairman.) (1) I suppose that the character of the examination papers that you draw up is hardly such as children at elementary schools under the age of 11 or 12 could be expected to be capable of answering? (2)--I do not see any reason why a child of average intelligence, of between 11 and 12 years of

age, might not be made to pass very well indeed in the elementary stage.

349. (1) Such papers as you are in the habit of giving now for examination? (2)--Yes, quite so. I think that a child between 11 and 12 might be very fairly and well taught sufficient physiology to be able to answer those questions.

350. (1) As a matter of fact, I believe they are all considerably older than that, are they not? (2)--The ages very from 11 to 45. I was rather surprised yesterday at Mr. Cole's statement as to the average age. I should have thought that had been on the whole rather younger, but no doubt he has better means of information than I have. I am bound to say that I was very much struck the other day, in looking over some of the results of the last examination, with the fact that, roughly speaking, the proportion of rejections is in the inverse ratio of the age; that is to say, of the older, upon the whole, the greater number pass, and of the younger the greater number are rejected. That, of course, is what you may expect from the present state of education.

351. (1) If such a normal school as has been suggested were established, do you think that teachers could be trained sufficiently to be able to give instruction in any considerable number of those different branches in which the science examinations are held, there being, I think, no less than 23 branches? (2)--I should say not any considerable number, but I do not see why they should not combine several. For

example, I do not see why teachers should not give elementary instruction in both physics and chemistry, or in physiology and zoology, or in physiology and botany, and other allied subjects.

352. (1) It would be only practicable, I presume, in very populous places, to have schools of such an extent that young men, wishing to obtain instruction in any of those branches, would be sure of being able to receive instruction? (2)--Only in large places.

353. (1) The greater part must be confined to a certain number of those branches? (2)--I should think so. Of course a great alteration will take place if education is made compulsory over the country; and if the number of schools is very greatly increased there will be in almost any place somebody who may be sufficiently instructed to teach in one or more of those subjects.

354. (1) If science teaching were introduced into elementary schools, would it not be desirable that there should be a more intimate connexion between the Education Department, and the Science and Art Department, than that arising simply out of both being under one chief? (2)--I must confess that I think the present state of affairs is an anomaly which could only exist in our own country. Separating the teaching of science from education, is like cutting education in half. It is a wonderful state of affairs, and the result is that practical antagonism, which I believe does not exist now, but which

for a number of years, I am told, did exist, when one half of the department of the state which had charge of education was opposed to that which the other half was doing.

355. (1) If scientific teaching were introduced into elementary schools, have you considered which of those branches would be the more important ones to introduce; it would be, I imagine, impossible to introduce all? (2)--I think it would be extremely undesirable to attempt too much. My great fear of what educational reformers are now doing is that they are going in for too much. I should myself like to see the teaching in elementary science diminished rather than increased in range. I should like to restrict it in the first place, at any rate, to mathematics, to physical geography, elementary physics and chemistry, and to botany and human physiology in elementary day schools. I think a great deal more good is to be done by restricting the teaching to a few subjects selected from very various regions of the whole ground of science.

356. (1) I believe those are the branches in which practically the greatest number of persons offer themselves for examination at present? (2)--I think they are. My reason for recommending them is obvious. Of course without mathematics it is impossible to go very far; in fact its importance as a matter of general training is immense; then, without a knowledge of elementary physics and chemistry, all further progress in sciences comes to an end; it is all loose and vague. Botany I recommend because it is the only branch of natural science

which can be taught at first hand conveniently; you cannot teach zoology conveniently, but flowers and plants are always to be had and you can teach botany properly. Human physiolgy I recommend the teaching of for its practical importance, and it may be taught thoroughly and well.

357. (1) At prcsent I imagine to a certain degree mathematics are taught in the better class of elementary schools in the larger towns? (2)--I imagine so.

358. (1) But no other branch of science whatever is taught in elementary schools except physical geography? (2)--I think not.

APPENDIX II

HUXLEY'S CURRICULUM COMMITTEE REPORT TO SCHOOL BOARD FOR LONDON[1]

The Report of Huxley's Committee on Curriculum, 14 June, 1871, was adopted in the following form:

In Infants' schools instruction shall be given in the following subjects:--

(a) The Bible and the Principles of Religion and Morality in accordance with the terms of the resolution of the Board passed March 8th, 1871.

(b) Reading, Writing, and Arithmetic.

(c) Object lessons of a simple character, with some such exercise of the hands and eyes, as is given in the Kindergarten system.

(d) Music and Drill.

In Junior and Senior schools certain kinds of instruction shall form the essential part of the teaching of every school; but others may or may not, be added to them at the discretion of the Managers of individual schools, or by the special direction of the Board. The instruction in the discretionary subjects shall not

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[1] Final Report of the School Board for London, 1870-1904, Second Edition: Revised (London, 1904), pp. 94-95.

interfere with the efficiency of the teaching of the essential subjects.

The following subjects shall be essential:--

(a) The Bible and the principles of religion and morality in accordance with the terms of the resolution of the Board passed March 8th, 1871.

(b) Reading, Writing, and Arithmetic; English, Grammar and Composition and the principles of Bookkeeping in the Senior schools; with Mensuration in Senior Boys' schools.

(c) Systematised Object Lessons, embracing in the six school years a course of elementary instruction in Physical Science and serving as an introduction to the science examinations which are conducted by the Science and Art Department.

(d) The History of England.

(e) Elementary Geography.

(f) Elementary Social Economy.

(g) Elementary Drawing.

(h) Music and Drill.

(i) (In Girls' schools). Plain needlework and Cutting Out.

The following subjects shall be discretionary:--

(a) Domestic Economy.

(b) Algebra.

(c) Geometry.

Subject to the approbation of the Board, any extra subjects recognized by the new Code, 1871, shall be considered to be discretionary subjects.

APPENDIX III

RECOMMENDATIONS OF THE ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE (1872)[1]

I. We recommend that the instruction in elementary science classes under the Science and Art Department, be so arranged as to work in complete harmony with the general system of public elementary education, but, at the same time, we consider it important that the Education Department and the Department charged with Instruction in Science shall continue to be coordinate.

II. We recommend that a more efficient inspection of Elementary Science Classes be organized, and that the Inspectors should advise the Local Committees and report on:--

(a) The apparatus of instruction.

(b) The state of the discipline and methods.

(c) The general efficiency of the arrangements.

III. We recommend that teachers who have already qualified by passing the May examination in either of the advanced classes shall continue to be recognised as qualified to conduct Elementary Science Classes, with the title of Elementary

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[1] Royal Commission on Scientific Instruction and the Advancement of Science, I (London, 1872), xxviii-xxx.

Science-Teacher, and to earn the grants awarded by the Department of Science and Art on the results of the examination of their scholars; but that this qualification and title shall in future only be attainable by passing in the first of the advanced classes.

IV. We recommend that should such arrangements as are herein-after set forth for conducting the practical instruction of teachers, and for providing for them practical examination at several centres, be adopted, all elementary science teachers shall, after such practical instruction, be admissible to a further examination, which, in all suitable subjects, shall be practical. We recommend that success in this examination shall entitle a teacher to a certificate of Second Grade Science Master.

V. We recommend that, as an inducement to teachers to prepare for and pass this further examination, payment for results in the case of a Second Grade Science Master be made at a somewhat higher rate than in that of the Elementary Science Teacher.

VI. We recommend that an examination, both by papers and by practical tests, in any group of allied subjects defined by the Department which the candidate may select, shall be open to all those teachers who have passed in the advanced classes, or who have been otherwise admitted as Science Teachers; and that success in this examination shall entitle

the candidate to receive a certificate of First Grade Science Master in that group.

VII. We recommend that a greater capitation grant be payable in respect of the scholars of a First Grade Science Master teaching in any group of allied subjects with or without assistance, than in respect of the scholars of a Second Grade Science Master, provided that the Inspector report that the apparatus is sufficient, and that practical instruction has been given in each suitable subject.

VIII. We recommend that, with a view of maintaining uniformity of standard in these examinations, they shall be conducted at the several local centres by the staff of Examiners acting under the Science and Art Department.

IX. We recommend that the more systematic training of teachers of science referred to, be provided for--

(a) By the adoption of special arrangements for this purpose in the Science School which has been referred to in our First Report; and by the recognition by the Department of similar arrangements for the instruction of this class of students in any University or College, and in Science Schools as herein-after described.

(b) By giving to the students of Training Colleges the opportunity of remaining a third year, during which scientific instruction may either form a principal part of the curriculum of such Colleges

or be accessible in some adjacent College or School of Science approved as efficient for that purpose.

X. We recommend that the Science and Art Department be at liberty to dispense with the preceding examinations and to accord the privilege of First and Second Grade Science Masters in consideration of University Examinations in Science, or of a satisfactory course of study in Colleges in which Science is taught, as well as in other cases of obvious scientific qualification.

XI. We recommend that in schools recognised as Science Schools, as herein-after set forth, facilities for the employment of Assistant Teachers be afforded as an experiment on a limited scale, some addition being made to the emoluments of the teacher in consideration of the instruction afforded; provided the Department be satisfied, on the report of an Inspector, that such assistant teacher has received practical instruction in subjects in which it is prescribed, and that he has been actively engaged in teaching.

To encourage the more advanced scholars to become assistant teachers under first grade masters in such schools, a small stipend, rising in successive years, might be granted on condition that a like sum was raised locally, subject to such conditions as the Department might deem expedient. The proportion of assistant teachers should not exceed one for every 15 successful scholars in any science school, and no scholar should be recognized as an assistant teacher until he

has passed in the first division of the elementary class in the May examination.

XII. We recommend that, with a view of training First Grade Science Teachers, exhibitions of sufficient value and in sufficient numbers be offered to elementary science teachers and to assistant teachers who have served three years, and passed in the first division of the advanced class in the May examinations; and that such exhibitions should be tenable in any University, College, or Science School recognised in Recommendation IX.

XIII. We recommend that the grants made by the Science and Art Department for buildings be extended, under sufficient guarantees, so as to embrace institutions for scientific instruction, although they may not be built under the Public Libraries Act, or be in connexion with a School of Art.

XIV. We recommend that grants similar to those now made for apparatus be given for laboratory and museum fittings under proper guarantees.

XV. We recommend that whenever the arrangements for scientific teaching in any institution shall have attained a considerable degree of completeness and efficiency, such institution be recognized as a Science School, and be so organized as to become the centre of a group of elementary science classes; and to provide the assistance of First Grade Science Masters, the loan of apparatus and specimens, and the means of instruction in the laboratories and museums to the

more advanced students of the group.

XVI. We recommend that assistance be given for the formation and maintenance of such Science Schools by special grants, the conditions of which shall be determined by regulations to be framed by the Science and Art Department.

XVII. We recommend that when laboratories are attached to second grade grammar schools in the schemes issued by the Endowed Schools' Commissioners, the Trustees of such schools be encouraged and enabled to invite the formation of elementary science classes, to be taught therein.

All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.
LANSDOWNE.
JOHN LUBBOCK
J. P. KAY-SHUTTLEWORTH.
BERNHARD SAMUELSON.
W. SHARPEY.
G. G. STOKES
HENRY J. S. SMITH
T. H. HUXLEY

J. Norman Lockyer,
Secretary.

March 22nd, 1872.

APPENDIX IV

HUXLEY'S REPORT TO THE GUILDS' INSTITUTE COMMITTEE

Huxley's Report to the Guilds' Institute Committee in the fall of 1878 stated that a complete system of technical education should be directed towards the following objects:

1. The Diffusion, among artizans and others occupied in trades and manufactures, of sound instruction in those kinds of theoretical and practical knowledge which bear upon the different branches of industry, whether manufactures or arts.

2. Adequate provision for the training and supply of teachers qualified to give such instruction; and for the establishment of schools or isolated classes, to which the industrial population may have ready access; and further, for a proper system of examinations whereby the work done in the schools and classes may be tested.

3. The organization of arrangements for effecting the apprenticeship of scholars of merit in the branches of industry for which they show aptitude; for enabling such scholars to continue their studies beyond the ordinary school age, by means of exhibitions; and for opening to the rest of them a career as teachers or as original workers in applied science.[1]

Huxley adds:

> Those who are acquainted with the systems of technical education which have been developed in Belgium, Germany, Switzerland, Austria, and other continental countries during the last fifty years, and which are at present carried out on a very large scale, with the aid of state or municipal funds, in all those countries,

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[1] City of London Livery Companies Commission Report and Appendix, I (London, 1884), 66-67.

will perceive that the project which I have submitted to the Committee, aims at the organization in this country, of a scheme of technical education essentially similar in principle to that carried out in the "Gewerbe Schulen" but more especially the "Gewerbliche Fortbildungs Schulen," of which numbers exist in every German state (even the smallest) but modified in practical working so that it may adapt itself to the social conditions and the existing educational arrangements of our people . . . . Switzerland, with about two-thirds the population of London and comparatively less wealth, supports a multitude of such schools, with the magnificent "Polytechnicon" of Zurich as their crown. The condition of England in these matters is simply scandalous.[1]

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[1] Ibid., p67 (Footnote #1).

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