In university teaching in France, the subject of probability is stressed. Even where statistics is taught as ancillary to another subject, the theoretical arguments on which the methods are based are given considerable importance. To quote Professor E. Morice, director of the School of Instruction at the National Institute of Statistics on the value of theoretical training: 'Rather than training users who are immediately able to manipulate many and diverse statistical techniques there is a preoccupation to make them understand the underlying meaning and theoretical bases of statistics; this will enable them later to master the techniques and adapt them to particular problems which rarely involve an immediate and crude application of a set technique.'

In technical high schools which train large technical staff required by the State the students have superior mathematical knowledge and the teaching generally includes a great deal of theory beginning with lessons on probability theory. Technical problems particular to the field of application are considered from the general point of view, in conjunction with the theoretical problems to which they correspond.

The courses in statistics given in the various institutes and schools devoted to industry, engineering, agriculture, commerce, arts and trade are briefly indicated in Appendix A.

Methods of Teaching

Lectures and seminars are the chief methods of teaching. Since the number of students in the faculties of law taking statistics is small, the teaching approximates to the tutorial system. Close association of students and teachers in seminars is a common feature in all university faculties.

Practical training through laboratory exercises is given sufficient importance in the courses given to economists and in most of the other courses. The time devoted to practical work as compared to lectures can be seen in the listing of the different courses in the previous section. These given by the Institute of Statistics, Paris, and the School of Instruction of the National Institute of Sciences, place particular stress on practical training and computational experience. No information is available on field training.

TRAINING

In France there are good facilities for training technical and business personnel. The various schools and institutes referred to in the first section impart statistical knowledge relevant to different fields. Training, however, is regarded as one of culture rather than of

technical apprenticeship. As far as possible, the teaching of routine techniques is avoided whenever it is not possible to make the students understand, at least by intuitive means, the hypotheses and restrictions implied in their use.

Statistical training is given at a much more practical level in the Conservatoire des Arts et Métiers (Art and Trade School). Statistical training here is entrusted, together with industrial economics, to the professor of industrial and statistical economics. Far from making it a mere explanation of methods, deprived of its contents by ignoring concrete objectives, statistics is taught through numerous applications during lectures, as well as through practical work.

The public courses of the Conservatoire are intended for a varied audience of practitioners of all levels and specialities, and the training is not conditional on any required standard of previous education. The professor tries to put before his audience all the knowledge, even advanced, which he deems useful. To quote the report for France: 'Practical statistical training aims at preparing the upper grades and research workers exercising their activities in the most diverse fields to put into practice statistical procedures of representation or the treatment of certain statistics for administrative purposes or for industrial or commercial operations, and to study profoundly the scientific or practical problems justifying those procedures. With regard to statistical representations and treatments they first consider their pertinence, through actual examples pursued to the very end, the correct interpretation is taught and the choice in each case of the most suitable manner of representation, and the recognition of all that can be drawn from them.'

The diploma and the assistants' courses given by the School of Instruction of the National Institute of Statistics are of a professional kind and are designed to give the trainees a thorough understanding of the theory of statistics and experience of the important applications in economics, business and sociology. These courses seem to come nearer the definition of training than those given in the institutes and schools mentioned above.

The Institute of Statistics, University of Paris, in addition to its longer courses, arranges special courses for engineers and industrialists. The Training Centre of the Institute gives the following accelerated courses:

Primary course (quality control, two weeks' duration) having as its objective the initiation of practical men to the ideas and fundamental techniques of statistical control. The method of teaching is very practical and is based on a process of exposition which is essentially applied. A large place is given to the handling of numerical tables with the object of enabling the students to carry out simple practical applications when they return to their own work.

Particular care has been taken in the presentation of the demonstration material and the course provides accelerated and complete instruction for the mastering of this subject. Engineers will benefit by attending this course as an introduction to the course of instruction in industrial technical statistics.

Secondary course (statistical techniques for engineers, three weeks' duration). Deals with all the statistical techniques which are useful in industry. The method of exposition consists of beginning, whenever possible, with concrete examples, and much time is allotted to the performance of calculations by the students.

Economic management of an enterprise. This course is in preparation. It will be devoted to the applications of statistics to the economic management of an undertaking. In contrast to the previous courses, this one will be spread over several months, and will be held in the late afternoon.

The general syllabus will include: the establishment and the keeping up to date of records (both internal and external) required by the manager of an undertaking; the setting up of complex indicators and models; the use of raw data, complex indicators and models for economic purposes (analysis of changes of stock, production and sales, analysis of costs of production, etc.); economic analysis of trade cycles; the study of markets.

RESEARCH

Universities and institutes in France are actively engaged in statistical research, the main lines being probability and theoretical statistics. The approach is more mathematical than in other countries and therefore research students should be well equipped mathematically.

Information is not available on the organization of research courses in universities and institutes. It appears that after the completion of certain diplomas, a thesis on a statistical subject is required for the doctorate. The appropriate doctoral degree will depend on the faculty in which the student works. As already mentioned, the doctorate in economic science requires the completion of the diploma of political economy and diploma of economic sciences (which includes a study of statistics) and the presentation of a thesis. Usually the thesis has to be defended in public.

CONCLUSIONS

One of the most striking features of statistical education in France is the mathematical emphasis surrounding it. The traditional

association with mathematics and mathematicians has perhaps been the reason for it. Statistics is treated more as a branch of mathematics than as a social science.

It is not clear to what extent the university-trained graduate is competent to perform the usual tasks of a professional statistician, as for example conducting socio-economic surveys, collecting data and analysing and interpreting them. More study of special techniques relevant to particular fields of application and more practical and field training seem to be necessary for the student of statistics. Although it is desirable to try to teach how a statistical tool works, it may be necessary to teach many, who lack the ability to understand its working, at least how the tool can be used. Some professional orientation appears to be called for in most of the courses given at present.

Statistics has not attained its due status in any university. There is no faculty of statistics and, except in a few special institutes, work in statistics is not independently organized nor is separate staff appointed for teaching statistics. Courses are given widely, but only when the subject attains a higher position can it develop along more practical lines and receive collaboration and stimulus from other subject fields.

APPENDIX A

Courses in specialized schools in France

SCHOOLS ENTRUSTED WITH THE TRAINING OF THE LARGE TECHNICAL STAFF OF THE STATE

École Polytechnique (Polytechnic). Lectures on probability theory as part of the applied mathematics course.

École Nationale Supérieure des Mines (National School of Mines). Course of statistics (theoretical statistics with industrial applications), 14 lectures.

École Nationale des Ponts et Chaussées (National School of Roads and Bridges). Probability theory (four lectures, course being extended in the direction of the technical application of statistics).

École d'Application du Service d'Exploitation Industrielle des Tabacs et Allumettes (Training School for the Tobacco and Match Industry). Course of statistical methods (20 lectures and 10 practical classes).

École Nationale Supérieure du Génie Maritime (National Maritime School). Lectures on industrial applications of statistics.

École Nationale Supérieure des Télécommunications (National School of Telecommunications). Lectures on probability theory and mathematical statistics (six meetings).

École Nationale Supérieure de l'Aéronautique (National Aeronautical School). Course on probability theory and mathematical statistics (12 lectures).

École d'Application des Fabrications d'Armement (Training School for Armament Manufacture). Course on probability theory and mathematical statistics.

École d'Application de la Météorologie Nationale (National School for Meteorology). Course on probability theory and mathematical statistics.

École Nationale de l'Aviation Civile (National School of Civil Aviation). Course on probability theory and mathematical statistics.

École Nationale de la France d'Outre-Mer (National School for Overseas France). Course of statistical methods overseas; statistical observations and analysis; economics and demography (25 lectures).

ENGINEERING SCHOOLS

Conservatoire National des Arts et Métiers (Academy of Arts and Crafts). Course on industrial economics and statistics with practical work in statistics (15 lectures) and in economics (15 lectures).

École Nationale Supérieure de Chimie de Strasbourg (National School of Chemistry of Strasbourg). Statistical methods applied to experiments (10 lectures).

Institut Technique de Normandie (Normandy Technical Institute). Elements of probability theory in the course of applied mathematics.

École Centrale des Arts et Manufactures de Paris (Paris Central School of Arts and Industry). Course of applied statistics.

École Spéciale des Travaux Publics (School of Public Works). Lectures on probability theory and statistical theory as part of the course on mathematics.

École Nationale Supérieure de la Métallurgie et des Mines de Nancy (National School of Metallurgy and Mines, Nancy). Course of statistics (statistical methods and technical applications—12 lectures and practical work).

École Nationale des Arts et Métiers de Paris (National School of Arts and Crafts of Paris). Course on probability theory and statistics (16 lectures).

École Supérieure d'Électricité de Paris (Paris Electrical School). Lectures on probability theory as part of the finishing course on mathematics (four lectures) and a course of theory of the transmission of information (six lectures).

Statistical Education: France

Institut National Agronomique (National Institute of Agronomy). Theory of probability and statistical methods applied to genetics and agricultural experiments (27 lectures and practical work). Application of statistics to economic investigations (six lectures).

École Supérieure d'Application d'Agriculture Tropicale (Training School for Tropical Agriculture). Course on statistical methods applied to research and experiments in agriculture (25 lectures and 15 practical classes). Special lectures as part of teaching on agricultural statistics in tropical regions and on genetics.

Institut de Chronométrie et de Micromécanique de Besançon (Besançon Institute of Chronometry and Micromechanics). Lectures on statistical control.

École Nationale Supérieure d'Agronomie de Toulouse (National School of Agronomy of Toulouse). Course of statistical methods in agriculture (25 lectures) and of mathematical genetics (25 lectures).

ECONOMIC AND SOCIAL SCIENCES, BUSINESS, MISCELLANEOUS

Institut d'Études Politiques de Paris (Paris Institute of Political Studies). Elementary course on statistics.

Institut d'Études Politiques d'Alger (Algiers Institute of Political Studies). Elementary course of statistics applied to economics (12 lectures).

École des Hautes Études Commerciales de Paris (Paris School of Advanced Commercial Studies). Course of statistics applied to business (15 lectures).

École Supérieure de Commerce de Montpellier (Montpellier School of Commerce). Lectures in statistics.

Institut Commercial de l'Université de Nancy (The University of Nancy Institute of Commerce). Course on statistics applied to business (30 lectures).

Institut de Sciences Financières et d'Assurance de Lyon (Lyons Institute of Finance and Insurance). Course on probability theory (one hour a week), mathematical theory of insurance (two hours per week), econometrics (one hour per week), and probability theory and statistics (three hours per week).

Institut des Finances et des Assurances, Paris (Institute of Finance and Insurance). Course on probability theory, mathematical statistics (preparation for examinations of the French Institute of Actuaries).

École Nouvelle d'Organisation Économique et Sociale, Paris (School of Economic and Social Organization). Course on statistics and trade cycles.

Institut de Technique Comptable, Paris (Institute of Accounting Technique). Course on elementary statistical methods.

Institut National d'Études du Travail et d'Orientation Professionnelle (National Institute for the Study of Labour and Vocational Guidance) and Institut de Psychologie de l'Université de Paris (Institute of Psychology of the University of Paris). Course on statistics (40 lectures and practical work).

Statistical Education: France

École Nationale Supérieure de l'Enseignement Technique (National School for Technical Training). Theoretical statistics and statistics applied to the management of undertakings (18 lectures and nine classes of practical work).

Institut de Biométrie Humaine et d'Orientation Professionnelle de Marseille (Marseille Institute of Human Biometry and Vocational Guidance). Course of statistics (for candidates for the State diploma of vocational guidance consultant (30 lectures and practical work).

Le Centre de Perfectionnement de l'Administration des Affaires (Centre for the Improvement of Administration of Business) of the Paris Chamber of Commerce teaches the use of statistical methods and probability theory.

APPENDIX B

Syllabus of the course in statistical techniques for the diploma in economic sciences at the University of Lyons

Introduction: Place of statistical techniques in economic courses.

First part – statistical observation. I. The agency of observation; the Institute of Economic Studies. II. The methods of observation; the collection and scrutiny of documents. III. The presentation of statistical data; statistical series; charts, graphs, rectangular, polar, and triangular diagrams; chronological, cumulative, arithmetical and logarithmic curves.

Second Part —statistical analysis. I. Statistical consolidation: (a) the problem of means; means of units and of frequencies; (b) the problem of indices; simple, synthetic and principal economic indices. II. Statistical refinement: (a) the measurement of variation; dispersion and deviation; disparity, discordance, dissimilarity, distortion; (b) different types of variations; seasonal and cyclical variations and trends.

Third part —statistical laws. I. The problem of correlation: (a) the method of calculation of the correlation coefficient, adjustment, interpretation of the coefficient, its

values, its statistitutes; simple, partical, multiple and total correlation; cost of the operation; the regression; (b) the illusions and dangers of the coefficient with reference to the time factor; (c) correlation coefficient and the study of economic variables; the method of smoothing graphs (curves). II. The problem of forecasting: (a) automatic forecasts and its dangers; the working of Harward's barometers; (b) clear forecast and the difficulties of complex historical methods; (c) the working of prospective and restrospective models, actual and rational statistics.

GERMANY (FEDERAL REPUBLIC OF)[1]

FACILITIES FOR TEACHING

Teaching Centres: Degrees and Diplomas in Statistics

Statistics courses are held in the 16 universities in West Germany. The faculties or departments may be divided into three groups according to the type of courses given: (a) six faculties of economics, social science, or political economy, eight departments of political science in faculties of law and political science, and two departments of philosophical studies; (b) ten faculties of science, or mathematics and science, and one science department of a philsophical faculty; (c) six medical faculties. The majority of students in the country (roughly six-sevenths) taking statistics courses study in the above faculties or departments; more than nine-tenths of these belong to group (a), of which courses now usually extend over eight terms (four years).

There is no special diploma in statistics; the students are awarded the usual diplomas. Students of the faculties of group (a) are awarded the degree of *Diplom-Volkswirt, Diplom-Kaufmann* or *Diplom-Handelslehrer*. Graduates of group (b) receive the *Diplom-Mathematiker*.

In addition to the 16 universities considered above, there are eight *Technische Hochschulen* (technical universities) where the statistical instruction differs as to both aim and scope. At two technical universities, statistics is taught in the curriculum for economics during the first three terms; the student wishing to continue his economic studies then shifts to a university. At two other technical universities short courses in quality control, sampling and experimental design are given. There are also two universities where statistics is taught

almost to the same extent as in some of the university faculties of group (a); these award the *Diplom-Volkswirt*. At the Berlin Technische Universität (Technical University), statistics has a more important place and several courses are available to economic engineers and practical economists.

There are 10 other institutions or schools of university rank where statistics is taught. Among these the Mannheim School of Economics and the School of Economics and Social Sciences of Nuremberg are important as training centres for statisticians. At both the teaching follows the same lines as in the university faculties of group (a). The degree awarded by the Nuremberg School is *Diplom-Sozialwirt*.

Careers for Statisticians

Statistics-trained graduates find employment in the 11 ministries of economics and roughly 60 statistical offices (1 federal office, 10 State and about 50 municipal offices) or in about two dozen institutes of economic and opinion research, some of which are partly private and partly public. They may also join chambers of commerce and industry as well as private organizations and large firms. Mathematicians with statistical training are usually engaged by insurance companies.

Although it has not been possible to estimate the numerical demand for statistics-trained personnel, it is evident that the rapid economic recovery of the country has produced a large demand for university-trained economists. Those who have also received some instruction in statistics find ready employment, particularly in business.

ORGANIZATION OF TEACHING

Requirements for Admission

To be admitted to a university or an institution of university rank, the student must held the certificate of maturity awarded on passing the *Reifeprüfung* [final examination at a recognized *Gymnasium* or *Realgymnasium* (secondary school)].

Statistics Courses: Aims, Duration and Content

There is considerable uniformity in regard to the statistics courses and their aims in the university faculties and departments in group (a). Everywhere the so-called 'Resolutions of Heidelberg' are considered as specifying the minimum statistical knowledge to be expected of every graduate holding a diploma in economics or in the

science of commerce. These resolutions were accepted on 29 October 1953 at a meeting of professors of statistics held in connexion with a session of the German Statistical Society. They run as follows:

'Resolution concerning the minimum of statistical knowledge to be expected of every graduate holding a diploma in economics or in the science of commerce.

'A. Methodology. Technique of statistical enumeration or inquiry (including the designing of questionnaires, inquiry through interviews, and similar problems). Statistical processing. Technique of tabulation and graphic representation. Statistical calculation with figures affected by either systematical or random errors. Law of large numbers and chief theoretical distributions. Averages, measures of dispersion, ratios. Index numbers (index technique and its application illustrated by the most important index numbers). Analysis of time series (trend, cycle, season, random component). Essentials of the theory of correlation. 'Causal analysis by statistical means' including a general idea of the principal tests (criteria for the random, or essential character of a difference, the goodness of fit, etc.). Statistical estimation and the elements of the representative method.

'B. Material Statistics. Organization of German official statistics and the chief statistical sources of Germany and foreign countries. Population statistics, economic statistics (including national accounts, the statistical aspects of the basic econometric concepts, and market and opinion research).

'Note I. For students of practical economics less emphasis may be given to material statistics and more to statistics concerning business administration.

'Note II. Statistical exercises or laboratory work are indispensable to the success of the training.'

Professor O. Anderson (University of Munich) states that 'the relative brevity and incompleteness of the programme is explained by the necessity of taking into account the fact that the different faculties or departments of the 16 universities and the ministries of education of the federal states and West Berlin to which they are subordinate, lay quite different stress upon the instruction in statistical methodology within the curricula for economics and that for business administration'. Thus statistics is generally much more strongly represented at universities possessing large economic faculties.

Another difficulty in the way of teaching advanced statistical methods in the faculties of economics or business administration is the low mathematical standard of the students. Since only those who are weak in mathematics in the secondary school take to economics and law, it is found very difficult to introduce them to algebraic formulae or to the mathematical way of thinking.

A further consequence of this 'anti-mathematical' attitude is that a considerable number of professors of economics and business administration at the economic faculties, particularly of the older generation, show a marked disinclination for the study of modern statistical methods and 'mathematically infected' statistics.

The courses for students of economics and other social sciences at the universities and the technical universities, follow broadly the standards recommended by the Heidelberg resolutions. There are, of course, differences in the degree of elaboration of some of the topics. In some of the technical universities the syllabus appears to be limited to elementary statistical methods and the relevant applications like quality control or sampling.

At the 11 faculties of group (b), statistics is mostly taught as so-called 'mathematical statistics' only in connexion with the theory of probability. In the majority of cases, these lectures are destined for pure mathematicians and physicists. At three or at best four universities the requirements of actuaries are also taken into account at two others the instruction in mathematics and statistics is also meant for biologists, and only at one for psychologists.

At the six faculties of group (c) at which statistics is taught for medical students, it represents a relatively rarely chosen minor subject, and is not included in the examination.

It is reported that the graduates of the faculties of groups (a) and (b) in general cannot be considered as fully qualified statisticians since they have neither been trained in statistical technique (planning of an inquiry, design of questionnaires, organization of processing and tabulation, use of the source works, etc.) nor have they thoroughly studied economic and social sciences.

With regard to the courses needed for a diploma, it is stated that 'to a certain extent, the German student is still free to choose those lectures of his own and other faculties which he wishes to attend, but his admission to the diploma examination at the end of a prescribed number of terms (eight for students of economics) is made dependent on the proof of a 'regular study' of the special branch he wants to be examined in. As for statistics, when prescribed by the regulations or chosen by the candidate, this means that he must have subscribed at least to the basic, or chief lecture on it and submitted the required certificates of practicals and seminars taken, and of statistical examination papers written and passed'.

Methods of Teaching

Owing to the shortage of staff and material equipment (space, books and journals, calculating machines, etc.), the main method of teaching is through lectures. Even when a lecture is announced as being

accompanied by practical exercises, these exercises, as a rule, consist of the lecturer working some problems in the course of the lecture or giving the students minor exercises to be done at home. Laboratory practicals seem to exist at present only at the Faculty of Political Economy of the University of Munich, but even there, they are obligatory only for students of the economics department.

There does not appear to be any field work. The Anglo-Saxon tutorial system does not exist in German universities.

Statistical seminars as independent institutions exist at 4 of the 16 faculties of group (a) and 2 out of 11 of group (b), and also at one technical university and one school of economics. These seminars are responsible for advanced teaching and research. Their financial position which is dependant on grants from the university budgets is rather poor, and this restricts their staff and their usefulness.

Teachers

The position regarding the teaching staff in 1955 in the three categories of institutions is given below in some detail.

Universities. Faculties and departments belonging to group (a): only 4 full professors (i.e. 'ordinaries') of statistics; 7 full professors lecturing on statistics though their scientific interests concern quite different fields (most frequently the theory of economics); 1 regular assistant professor; 6 honorary professors (mostly officiating, or retired presidents of statistical offices); 3 supernumerary professors; only 10 lecturers, and not less than 14 specialists invited to lecture on statistics, whereas the number of assistants, i.e., the main source from which the future teaching staff is drawn, totals 8 persons only. Faculties belonging to group (b): 2 full professors of mathematical statistics; 5 full professors of applied mathematics, geophysics, etc., who lecture also on the calculus of probability and mathematical statistics as minor subjects; 1 supernumerary professor, and 3 assistants. Faculties belonging to group (c): 1 regular assistant professor; 2 supernumerary professors; and 2 invited specialists.

Technical universities. Two full professors of mathematical statistics; 2 full professors teaching statistics as minor subjects; 2 lecturers; 4 invited specialists; and 2 assistants.

Other institutions of university rank. Five full professors teaching statistics as minor subject; 2 regular assistant professors; 3 supernumerary professors; 2 lecturers; 10 invited specialists; and 3 assistants.

It is common in West German universities to invite specialists from outside to give lectures on particular subjects. They are usually pro-

fessional statisticians in business, in institutes or in public statistical offices. Invitation to visiting professors from abroad is to a certain extent handicapped by language difficulties. The number of visiting professors in different universities varies with the grants given by the state governments. In 1955, 10 foreign professors visited the country and lectured at the universities.

Co-ordination of Statistics Teaching

As a rule, there is no co-ordination between the different faculties since the tradition of the German universities implies far-reaching autonomy of the individual faculties. This is also true of the professors regarding their teaching activity, e.g., 'general statistics' for economists and 'mathematical statistics' for students of natural science are taught by different departments. Even within a faculty there is no co-ordination between the statistics courses for theoretical economists and for students of practical economics, unless the same persons is responsible for both.

Nor is there co-ordination between the teaching of statistics in a university department and the statistical work done in a government office or a professional institute except when the head of the office or the institute is also a lecturer in the university, as is not infrequently the case.

TRAINING

University-trained men in economics or commerce who are selected for superior posts in offices—scientific advisers, heads of departments, etc.—have to undergo practical training in the statistical offices as probationers working successively in all departments of these offices. The training usually lasts a year. It is now planned to train such higher personnel as *Wirtschaftsreferendare* (junior civil service candidates with economics) and the training is expected to take at least 9 months out of the $3\frac{1}{2}$ years probationary period.

At a lower level are the civil servants and employees who, not having completed their university training, form the technical personnel of the statistical offices. Special courses are instituted for them periodically in their own offices. The organization and programme are left to the president of each office.

A good example is a course given for employees of the Federal Statistical Office comprising 655 working hours spread over about 18 months. It was completed in the summer of 1954 with an examination which was recognized by the Ministry of the Interior. About 95 hours are devoted to the 'general part' of statistics and

75 to the 'special part'. The rest of the time was given to 'administration' and 'principles of social sciences'.

The university courses do not appear to have any practical or professional bias; in fact, this is considered against the tradition of the German universities. Professor Anderson states: 'Now the aim of university education is more and more menaced by the tendency to convert some faculties or faculty departments (and to no small degree the departments of practical economics) into *de facto* professional schools for the training of narrow specialists.'

'There are certain academies and associations which impart training in modern statistical techniques, for example, the Technische Akademie Bergish Land, the GAMM (Society for Applied Mathematics and Mechanics), and the sub-committee of Technical Statistics of the Board of Trustees of the Rationalization of the German Economy.'

RESEARCH

Faculties in universities which hold statistical seminars and certain sections of the German Statistical Society may be considered as the chief centres of research. Further information on organization of research studies is not available.

There is no doctoral degree exclusively in statistics. Candidates submitting statistical theses and passing a certain number of oral examinations (the *Rigorosum*) may be awarded a doctoral degree, according to the subject of the faculty, either Dr.rer.pol. *(Doctor rerum politicarum)*, Dr.phil. *(Doctor philosophiae)* or Dr.rer.nat. *(Doctor rerum naturalium)*.

In 1955 the total numbers of candidates for doctor's degrees with statistical theses were as follows: universities—group (a), 58; group (b), 10; group (c), 8; technical universities, 7; other institutions of university rank, 17. Some economic research institutes undertake studies in statistical methodology (e.g., the IFO Institute, Munich). Some applied research work is also being done in the statistical offices of the federal and state governments. Details are, however, not available.

CONCLUSIONS

It is a little surprising that statistics has not yet attained its due status amongst university subjects. There is as yet no full diploma or doctorate in statistics. Judging by the numbers taking the statistics course, the subject is apparently found useful by students of

the economics and commerce faculties. In 1953–54 the number giving 'economics and statistics' as their stated professional aim was 3,880, about one-fifth of all economics students. The number in mathematical faculties (group (b)) was 200–250.

The organization of research in statistics does not appear to have developed to the same extent as in other subjects. The inadequacy of funds and staff appears to be the main difficulty. The number of doctor's degrees awarded on the basis of statistical theses in 1954 and 1955 was 42 in universities, seven in institutions of university rank and none in technical universities.

Professor O. Anderson states regarding the position of statistics in universities and schools: 'The extremely small number of properly equipped chairs of statistics (professors) and the shortage of first-class young statisticians almost necessarily resulting are the chief drawbacks from which statistical instruction suffers at present in the Federal Republic of Germany.'

INDIA[1]

FACILITIES FOR TEACHING

Historical Review

The first university to introduce teaching in statistics in India was the Mysore University where, in 1924, pass and honours courses were opened in which statistics was taught along with other subjects, chiefly mathematics, mathematical economics and actuarial science. Statistics gradually came to be introduced into the undergraduate and post-graduate courses in mathematics in several other universities. The post-graduate degree in statistics was first instituted in 1941 in the Calcutta University. Mysore instituted the M.Sc. degree in 1942, Travancore in 1944 and Bombay in 1948. Since then, many universities have started giving courses at undergratuate and post-graduate levels, both as a major subject and a minor or ancillary

1. Based on an original report by P. B. Patnaik entitled 'Facilities for Training and Research in Statistics in India'.

subject. Research courses in statistics have also been developed in several universities in recent years.

There is increasing recognition of the importance of statistics as a university discipline. There are proposals for a further expansion of facilities for teaching and research by opening more university departments of statistics and strengthening the existing ones.

An important landmark in the history of statistics in India was the establishment of the Indian Statistical Institute at Calcutta in 1931. The objects were 'to promote the study of statistics, both pure and applied and allied subjects and to provide for research and instruction for the advancement of the study, and dissemination of knowledge of statistics and allied subjects'. The Institute has been responsible for training a large number of statisticians and teachers of statistics. In recent years it has organized its teaching and research on a regular basis and has also started giving systematic professional training in a variety of fields.

The Indian Council of Agricultural Research, New Delhi, is another institution which has been giving training in agricultural statistics since 1945. The Statistical Branch of the Council gives academic as well as professional types of courses and conducts research. In-service training of statistical personnel of government offices was introduced in the Central Statistical Organization in 1954.

Teaching Centres: Degrees and Diplomas in Statistics

Of the 32 Indian universities, nearly 20 offer undergraduate courses in some department or college. The teaching for degrees in statistics is usually done in the university department of statistics while courses for degrees in other subjects are given in a university department or in an affiliated college.

The universities which award the bachelor's degree in statistics are Agra, Aligarh, Annamalai, Benares, Baroda, Bihar, Calcutta, Gauhati, Lucknow, Madras, Mysore, Nagpur and Poona. The degree awarded is the B.A., or the B.Sc., for which two years' study after the intermediate is required. In India a student after matriculation does two years of intermediate study before entering on a degree course, whether in arts, science, engineering or medicine. In some universities, the bachelor's degree in statistics is either 'pass' or 'honours'. In two southern universities, the duration of the honours course is three years.

In all the universities mentioned above as also in Gujerat, Osmania, Rajputana, Sagar and Travancore, statistics is a special subject for undergraduate students in mathematics; it is rarely an obligatory subject.

In 16 universities, courses in statistics are given for bachelor of

commerce degrees and in seven of them it is obligatory. In contrast to this, only in four universities is statistics included in the under-graduate studies in economics; in Madras, statistics is compulsory for the course in economics while in Mysore it is a minor for students of honours economics. Statistics is a subject for the honours degree in psychology at Patna and Mysore. No other bachelor's degree has a separate paper in statistics in the final examination. Statistics is part of a paper for students in agriculture in three or four universities.

With regard to post-graduate courses, the following universities provide courses for the master's degree: Bombay, Calcutta, Gauhati, Karnatak, Lucknow, Mysore, Patna, Poona and Travancore. The M.A. or M.Sc. degree is awarded to bachelors after two years of study. In the Mysore University the period required is one year for holders of the three-year honours degree. The master's degree can be taken by written examination or by thesis; in the latter case, the M.Sc. is considered as a first research degree.

Statistics occurs fairly frequently in the curricula of post-graduate degrees in other subjects; it is more common there than in under-graduate curricula. In departments of mathematics, statistics is almost always taught as one of the special subjects. It is one of the subjects for the economics M.A. in 16 universities, but it is more often optional than compulsory. The courses for the master's degree in commerce almost always include statistics and it is obligatory in nearly half the universities. Work in other subject-fields, such as psychology, education, and sociology, is very limited. The Indian Institute of Technology, Kharagpur, provides some courses for students in engineering and technology at both undergraduate and post-graduate levels.

At Delhi and Madras Universities diplomas in statistics are avail-able to graduates after two years' study. The Indian Council of Agri-cultural Research (ICAR) awards a post-graduate diploma after two years' study. The Indian Statistical Institute (ISI) gives a three-year training course open to those with master's degrees, in which a wide range of academic and professional subjects are included.

Careers for Statisticians

There is a great demand for qualified statisticians in India—in government, teaching, research and, to a lesser extent, in business and industry. The profession of statistician is quite an attractive one and with the planned economic and industrial development of the country, the statistician will occupy a more important place and his value as a social scientist will be better realized.

A master's degree in statistics or in economics or mathematics (with some statistics), is required for posts of statisticians in public

service. But those with degrees in statistics are preferred for posts involving more technical work. Persons with master's degrees in economics or commerce who have taken courses in statistics generally find employment in trade, business, and banking. For junior statistical posts in government offices or in business, bachelors with the statistics major are in demand.

For the teaching profession, recruitment is from amongst those holding M.Sc. degrees in mathematical statistics and having some research experience. In the last few years there was considerable scope for employment in this capacity owing to a rapid increase in the number of departments of statistics, but these departments will absorb a smaller proportion in future.

The number of students taking the B.A./B.Sc. pass or honours degrees in statistics from Indian universities in 1953 was 148, and in 1954, 215. The numbers of post-graduates in statistics in these two years were 86 and 105. (The numbers are expected to be doubled in 1956.) The number of graduates and post-graduates in economics, commerce, mathematics and other subjects who have taken courses in statistics is not known, but is likely to be of the order of 5,000. From inquiries made, it appears that as many as 40 per cent of the post-graduates in statistics do not find employment in statistical posts. The situation will be worse when the present expansion of courses in statistics produces more trained men, unless industry and business realize the advantages of employing more statisticians. Engineering and technology can absorb a large number, but the value of statistical techniques and the benefits resulting from their adoption are yet to be recognized.

ORGANIZATION OF TEACHING

Requirements for Admission

The mathematical prerequisite for admission to the bachelor's degree course in statistics comprises algebra, analytical geometry and calculus of the intermediate standard. This is, however, found inadequate and courses in algebra, trigonometry, analytical geometry, calculus and elementary analysis are usually given again to all students of statistics.

The requirements for taking courses in statistics for degrees in economics, commerce and psychology are generally not higher than matriculation mathematics for undergraduates and intermediate mathematics for post-graduates. This weakness in the mathematical equipment of the students puts a serious limitation on the theoretical content of the courses in statistics given to them.

Admission to the M.Sc. course in statistics is open to bachelors in statistics or mathematics, preference being given to those who have honours degrees. In one or two universities, majors in physics are also eligible. The regulations completely bar graduates in economics, psychology, zoology, etc., from taking the advanced courses given for the M.Sc.

The minimum qualifications required of a student for joining the diploma in statistics of the Delhi University is a degree in mathematics, economics or commerce. Admission to the diploma of the ICAR is given to students who have taken a three-year honours or master's degree in mathematics.

The three-year statistician's training course of the ISI can be taken by those who have already taken a master's degree or its equivalent in mathematics, statistics or natural and social sciences with a knowledge of mathematics up to the B.A. standard. Persons with specialized research or professional experience may also be admitted. Those with the M.Sc. degree in statistics may be admitted directly into the second year on the basis of a special examination.

Courses in Statistics: Aims, Duration and Content

The curriculum for the B.Sc. combines statistics with mathematics and one other science subject (not including a language); statistics has usually the same importance as each of the other two subjects for the ordinary (pass), but it has nearly double the importance for the honours degree. For the B.A. in some universities, only mathematics is combined with statistics, each of the two subjects covering about half the number of papers in the examination.

There is great diversity in the syllabuses in statistics of the pass courses. The basic topics included are descriptive statistics, probability, interpolation, large sample theory and applications, index numbers, life tables, time series. Additional topics are usually tests of significance and analysis of variance and simple experimental designs. For the two-year honours course, the syllabus goes further to include estimation and tests, sample surveys, official statistics, economic statistics, vital statistics, psychological statistics and quality control. The three-year honours course at two universities treats the above topics at a slightly more mathematical level, as the students are given courses in matrix algebra, higher analysis and calculus of finite differences. In Mysore University, an economics minor has to be taken.

The mathematical preparation of a student admitted to the M.Sc. course in statistics appears to be inadequate and hence courses on vectors, matrix algebra, analysis (including infinite integrals and Fourier series), higher functions, and calculus of finite differences are

usually taken in the first year. In respect of the content of statistics, there is a high degree of uniformity amongst different universities in so far as theoretical courses are concerned. The core subjects are the following: probability, elementary statistical methods, large sample theory, correlation and regression, analysis of variance, estimation and tests of hypotheses, multivariate analysis. In addition to these, one of the following subjects—sequential analysis, non-parametric inference and theory of designs—may occur in the syllabus.

The M.Sc. syllabuses also include the following subjects although universities differ as to the number of these taught and the level of instruction: time series, experimental designs, economic statistics, vital statistics, educational and psychological statistics, sample surveys, statistical quality control and official statistics. Specimen syllabuses are given in Appendix A.

One criticism of the M.Sc. curriculum is that it over-emphasizes theory at the expense of applications, that the courses are too academic and not related to the actual requirements of the profession. Another criticism is that there is practically no scope for specialization in a theoretical or applied subject, and that this seriously affects the preparation of an able student for research. Since the teaching of statistics for students of economics, commerce, biology, medicine, agriculture, etc., even at the post-graduate level, is not sufficiently advanced, the technical work and research in these fields of application will have to be done by those who take the M.Sc. degrees in statistics. Therefore, their university training should include suitable specialization and field experience.

In courses for students majoring in other subjects, the curriculum in statistics amounts to one out of six papers for the B.A./B.Sc. examination, and one or two out of eight for the M.A./M.Sc. examinations. Statistics is taught in the final year for from 50 to 100 hours.

The content of the undergraduate courses is fairly elementary, mainly consisting of descriptive statistics and simple applications. For mathematics, however, elements of probability and tests are included.

The syllabus in statistics as a special subject for M.A. mathematics comprises finite differences, probability, estimation, tests of hypothesis, analysis of variance and simple designs. There is also some descriptive statistics including correlation, curve-fitting, etc.

In India it is admitted that some knowledge of statistical sources and methods is an indispensable requirement for every economist. The aim of teaching statistics to post-graduate students of economics is therefore to train them in employing statistical methods to study economic phenomena quantitatively. The courses for M.A. economics, in addition to general methods, deal with index numbers,

time series, sample surveys, national income, and statistics of trade, agriculture and population. Sources of Indian statistics is almost always included as a topic. Owing to the low mathematical equipment of the students, except in one or two centres, advanced courses on econometrics, analysis of time series, or demand analysis are not given.

The curriculum for the diploma in economic statistics of the Delhi University maintains a balance between theory and application. The courses given are the following: economics (for mathematics graduates); mathematics (for economics and commerce graduates); theoretical statistics—descriptive statistics, sampling theory, tests; applied statistics—economic and business statistics, vital statistics, sample surveys; Indian official statistics and economic intelligence, mathematical economics and econometrics, current economic problems.

The courses in statistics for M.Com. are quite elementary, dealing mainly with collection and presentation of data and descriptive statistics. Some importance is given to analysis of data (index numbers, time series); socio-economic surveys, financial statistics and official sources also figure in the programme. Post-graduate courses in psychology, education and other subjects are very limited in scope and are not yet properly organized.

The courses given at the ICAR and the ISI are described later in the section on Training.

Methods of Teaching

The teaching of statistics is done mainly through lectures and practical exercises. Whether the size of a lecture class is small or large, there is little discussion and the student is generally a passive listener. Particularly, economics and commerce classes in particular are so large that it is not possible for the lecturer to carry on any discussion or seminar work. In some places, post-graduates in statistics being small in number, occasional seminars are held in which the staff members also participate.

Individual teaching and tutorials are quite unknown in Indian universities owing to the shortage of staff and the heavily loaded curricula. Consultation and individual attention are possible only for research students. Some individual teaching by junior staff is done during practical work, but this serves only the immediate purpose of removing the difficulty encountered by a student in his practical exercise and not for general instruction.

There is considerable emphasis on practical work for the students taking major courses in statistics. Nearly four to six hours a week of practical work are given for undergraduates and six to nine

hours a week for post-graduates. The time devoted to practicals for the M.Sc. course in statistics ranges from a third to a half of the total time devoted to the entire subject. An adequate number of desk calculators are available in each statistical department and computational training as well as practical experience of applying statistical methods to numerical data can be given. Careful planning of practical exercises using live data is needed so that the student will have to think out and apply the proper techniques.

The practical training given to students of economics, psychology, etc., is quite unsatisfactory. Calculating machines are not available and numerical exercises are done haphazardly. The practical side of the teaching deserves greater attention.

Almost no field training is included in the curricula. Post-graduate students of statistics and economics have received some training in socio-economic sample surveys conducted by a few universities in the last two or three years. The diploma students of the Delhi School of Economics spend eight weeks on projects conducted by the school. Some training in statistical work in government departments is available through the Central Statistical Organization. Professional institutions like the ISI and ICAR offer to university students facilities to study their projects.

Methods of Testing Competence

There is no regular method of assessing the progress of a student studying statistics in a university as oral or written tests are not frequently held. The main reason for this is that in India the syllabus for a subject is not divided into courses given in a fixed number of lecture and practical classes so that a test can be held at the end of each course. Periodical examinations at the end of each term (about three months) are conducted, however, on portions of subjects covered. It is the experience of most teachers that the Indian student takes a test or an examination so seriously that frequent tests would interfere with his current work.

The final university examination is usually held at the end of the two-year or three-year period of study for a degree and this places a considerable strain on the student. In a few universities, the M.Sc. examination is divided into two parts, the first part being held after one year.

The B.Sc. and M.Sc. examinations in statistics comprise both written and practical papers and the competence of the candidate is judged separately in theory and practice. A *viva voce* examination is also held in some universities for the M.Sc. degree. The courses at ICAR and ISI have a final oral examination to supplement the written and practical examinations which are held frequently during the period of training.

The knowledge acquired in statistics by a student of mathematics, economics or other subject is tested by one or two written papers at the final university examination; there is usually no practical test.

A thesis has to be submitted for the research degree of M.Sc. or Ph.D., but there is generally no such requirement for other degrees. The ICAR diploma has a thesis requirement and the diploma of the Delhi School of Economics requires a report on field work.

Teachers

The staff of a statistics department in a university ordinarily consists of full-time teachers. In one or two universities, there are part-time teachers from outside the university. It is not common for persons from outside the teaching profession to give courses in applied or professional subjects.

The staff members responsible for major courses, particularly for post-graduates, possess high degrees in statistics from Indian, British or American universities. Many of them, however, lack experience owing to the fact that most of the departments were set up only in the last six or seven years, and they have very little contact with the statistical profession in the country. These factors influence the quality of teaching and expose it to the charge of being too academic. The situation, however, is improving as a result of greater association of the teachers with professional and research work.

The teachers responsible for courses on statistics given with mathematics, economics and commerce usually have their main qualifications in one of the latter subjects and not in statistics. This sometimes results in mechanical and uninspired teaching. To be able to teach statistics as ancillary to other subjects, a teacher should be qualified in both statistics and the particular subject field. With the expansion of teaching in statistics, particularly in professional institutions, it may become less difficult to find such persons.

The staff for statistics are over-worked; their heavy teaching load leaves little time for conducting research. Even the professors have so much teaching and administrative work that research supervision for more than one student becomes difficult. The conditions of service of statistics teachers are similar to those of other university teachers. Salaries being low compared with those in government service or business, capable young men do not stay long as teachers.

In view of the shortage of senior men in teaching, it appears desirable to pool the resources of universities, professional institutions and government statistical offices for exchange of teachers and specialists. This will benefit both teaching departments and the profession.

Professors from abroad have been visiting India in recent years at

the instance of the government and research institutions. They have lectured and held seminars at the ISI and several university centres.

Centralization of Teaching of Statistics and Co-ordination

The importance of statistics as a university subject of study in India is reflected in the constitution of separate departments of statistics in 10 universities. In two other universities there are combined departments of mathematics and statistics. Usually the university department conducts the teaching for the M.A./M.Sc. degree in statistics while the constituent and affiliated colleges teach for the B.A./B.Sc. degree in statistics (pass or honours).

The teaching of statistics for degrees in mathematics is almost always done by teachers from the mathematics departments, and the courses for students of economics, commerce and psychology are given by the respective departments. In very few universities (e.g., Bombay and Calcutta) the statistics department is responsible for teaching economists or psychologists at post-graduate level.

Centralization of teaching appears desirable in some of the universities with well-developed departments of statistics and with staff competent to teach mathematical statistics, economic statistics or psychological statistics. The facilities of a statistical laboratory and a well-stocked library should also be available for use by all students of statistics.

Co-ordination between the statistics and other departments is at present rather limited. Research workers in social and biological sciences should be able to get assistance from the statistics staff in designing experiments or surveys and analysing the results. The statistics staffs, in turn, will find applied problems to stimulate their own research.

TRAINING

Courses in Universities and Professional Institutions

Evening classes are not available for persons in employment who require some knowledge of the theory and working methods of statistics except in Madras and Calcutta. The University of Madras has a two-year diploma course open to graduates, the lectures being given after office hours. In addition to general theory, a few applications are covered, the standard being that of the B.Sc. degree in statistics. No other university has organized special training courses for persons in employment.

At Calcutta, the Indian Statistical Institute (ISI) gives a few

courses at various levels. The computers training courses (junior and senior), are each of six months' duration. The minimum requirement for admission is the intermediate examination, preference being given to persons in employment who would profit by computational training. The courses are held in the mornings and evenings outside office hours; lectures and practical work are combined in each session. A number of topics in descriptive and theoretical statistics are covered as well as processing and analysis of data. A large number of persons in employment in government statistical offices, banks and the institute itself attend these courses. They can appear for the computer's certificate examinations of the institute. Similar training courses are likely to be opened in Delhi.

The ISI introduced, in 1955, a six months' statistician's course intended to provide basic knowledge in statistical theory and its applications to various fields. The minimum qualification for admission is a university degree with some mathematics, a computer's certificate of the ISI, or more than three years' experience of statistical work in a statistical laboratory. The courses are conducted by means of lectures and practical work held in the evenings for the benefit of employed persons. The training is intensive and a large range of subjects is covered: ancillary mathematics; statistical methods, theory of probability; sampling theory; statistical inference, sample surveys, official statistics; economic and business statistics; design of experiments, vital statistics, genetics, educational psychological statistics, statistical quality control. The course promises to develop into a system for meeting the needs of junior statistical workers for basic theoretical knowledge and also for preparing candidates for the statistician's diploma examination of the ISI.

The aim of the three-year statistician's course of the ISI already mentioned in the section on degrees and diplomas, is to train statisticians who are qualified for professional work in a large variety of fields. Up to 1955 this was a two-year course. It was then converted into a three-year advanced theoretical-cum-professional course. About 30 students, the majority holding master's degrees in statistics, mathematics or economics are admitted each year, selected from all over the country.

The courses cover all important branches of statistics and emphasize theoretical knowledge at the same time equipping trainees with the necessary professional competence in special fields of application. The basic and specialized courses are designed to satisfy the requirements of persons who are to take up responsible statistical posts in government departments, financial, commercial or industrial organizations and scientific or educational institutions.

The training comprises lectures, laboratory work, tutorials, assisted reading, seminars, visits and demonstrations, in-service

training and participation in large-scale applied work. The curriculum of the course is briefly described in Appendix B.

The extensive facilities of the project division of the institute are available for training in socio-economic surveys, machine tabulation, crop estimation, statistical quality control, etc. The Research and Training School, which is mainly responsible for theoretical and laboratory courses, has a highly qualified staff which includes specialists in different branches of statistics. It receives a large number of visiting professors and guest lecturers from abroad as well as from other institutions in India. Excellent library and computational facilities are available to the trainees.

The Central Statistical Organization of the Government of India arranges to give the three-year students a three months' training in the statistical work of various ministries and departments. During the specialization period of four to six months some trainees may be placed as 'apprentices' in government statistical offices.

The Statistical Branch of the Indian Council of Agricultural Research, New Delhi, gives certificate courses (senior, one year's duration; junior, five month's duration) for workers in agriculture and biological sciences, having a working knowledge of statistical methods. Admission to the senior certificate course is open to graduates in mathematics, economics, agriculture or applied subjects, but preference is given to persons deputed by government or other institutions. The shorter junior certificate course is provided for persons who cannot be absent from their duties for a long period.

The senior course has the following content: descriptive statistics, statistical methods, design and analysis of experiments, sampling techniques and their application in agricultural surveys, miscellaneous statistical problems and agricultural statistics. The junior course covers elementary portions of the above. The students of the two courses have many combined lectures and practicals.

The ICAR gives a diploma course (duration two years) which is open to persons from government departments or research institutions with at least a bachelor's degree and with some knowledge of mathematics and some experience of statistical work, in addition to regular students with M.A./M.Sc. degrees in statistics or mathematics. The syllabus includes the following: descriptive statistics, statistical methods, experimental programmes, design, analysis and reporting; sampling techniques and their applications in agricultural surveys, statistical genetics, biometric methods, critical analysis of data. In addition to these, the students study advanced statistical theory relating to some of the above subjects.

The training programmes for the certificate and diploma courses consist of lectures and practical and field work. Students receive training in projects and in the organization of agricultural research

stations, in government offices responsible for collection and analysis of agricultural statistics, and by conducting sample surveys. Naturally, the work for the diploma is more intensive and practically the whole of the second year is devoted to this kind of training; each student has also to work on a research project in association with a senior member of the staff and must prepare a report. The diploma training produces statisticians who are strong in theory and competent to work in agricultural and allied fields.

The Indian Statistical Institute maintains an International Statistical Educational Centre in Calcutta in co-operation with the International Statistical Institute and under the auspices of the Government of India and Unesco. The course is designed to train officers deputed from countries of the Middle, South and Far East, who are likely to be engaged in statistical work on return to their countries. The duration of the course is nine months and the curriculum covers theory and several applied fields. Since the mathematical equipment of students is not high, advanced work does not appear to be possible in the near future.

The teaching is organized through lectures, practical classes, demonstration and field work. The teaching work is done by the staff of the ISI as also by visiting teachers from several countries and United Nations agencies. Training is also given in the Project Sections of the ISI as well as at the CSO in Delhi.

In-service Training

Faculties for training individual officers deputed by government departments, universities and recognized scientific or technical institutions in special lines of work have existed for some time at the Indian Statistical Institute. The training is whole-time and for periods of two to six months. The ICAR have facilities also for short-term individual training in specific topics of agricultural statistics.

The Central Statistical Organization (CSO), New Delhi, has recently instituted an annual in-service training course of six to seven weeks' duration for statisticians likely to be called upon to take up responsibility for organization and direction of statistical services in the states or in the centre. Training includes courses of lectures in methodology as well as seminars on subjects of current interest in addition to demonstration of applied work and provision of facilities for study of methods employed in tackling special problems in governmental work. A large number of specialists in different fields from Delhi and other cities participate in the training programme.

The CSO has also organized jointly with the ISI a training course for statisticians from the centre and from the statistical offices in the

states. They should be graduates with over two years' experience in a statistical office. The general training is for a period of six months during which general statistical theory and practical applications to several fields will be taught through lectures, seminars, practicals, visits and demonstrations. There is a further three-month period of specialization in one particular branch of special interest to the sponsoring office. The training is partly at the ISI in Calcutta and partly in Delhi where the facilities of the various statistical offices are utilized.

There are proposals for large-scale in-service training of such primary workers as field investigators and computers in several state statistical bureaux, in the wake of general expansion of statistical work under the Second Five-Year Plan. In-service training programmes for higher level staff also appear to be under consideration.

Training in statistics is also available in a number of institutes— the Forest Research Institute, Dehra Dun, gives a six-week course to forest officers and the All-India Institute of Hygiene and Public Health has a three-month course in biometry for doctors and public health workers.

Training in statistical quality control for technicians (period, 10 days to three months) is now systematically organized by several Indian Society for Quality Control (SQC) units in Calcutta, Bombay and Bangalore. The Ahmedabad Textile Industry's Research Association gives regular courses on quality control to technicians of its member mills. The SQC periodically arranges programmes of lectures for technicians from mills and factories.

RESEARCH

The research degrees in statistics awarded by Indian universities are M.Sc., Ph.D. or D.Phil. The higher degrees D.Sc. or D.Litt. are generally awarded on the basis of published work. A few universities offer the M.Sc. as a research degree for which a bachelor in mathematics or statistics can qualify after two years of study and research. The main requirement is the thesis; but in one or two centres, a short written examination on the field of study has also be taken. There is always a *viva voce* examination.

The regulations for the Ph.D. are fairly uniform in all the universities. An M.A./M.Sc. (or a three-year honours graduate) in mathematics or statistics can register and after a minimum of two years of work under a supervisor can submit his thesis for the degree. He is not required to complete any courses and, except in one centre, there is no written examination. After the thesis is adjudged by examiners, some of whom may be from outside India, an oral examination is held.

Few universities have developed facilities for guiding and supervising the work of Ph.D. students. During 1953–55, it is reported that six students were registered for the M.Sc. and 12 for the Ph.D. In addition to these, five from amongst the junior members of the staff of departments of statistics have also registered (M.Sc., one; Ph.D., four).

It is possible to work for the Ph.D. degree by conducting research in an institution outside a university, provided both the institution and the supervisor are recognized by it. Thus at the Indian Statistical Institute, some of the staff members and research scholars register for the D.Phil. of the Calcutta University.

The titles of the theses approved for the M.Sc. or Ph.D. degrees suggest that the main field of research in India is mathematical statistics. Only a few theses are written on the subject of applied statistics. The situation is likely to improve if the university departments are associated with applied work done in professional institutions and government agencies.

Outside the universities, a considerable volume of research work is done in the ISI, the ICAR and a few other institutions. The ISI has a wide range of research activities; research students and statisticians from outside receive adequate training in research in almost all branches of statistics.

CONCLUSIONS

During the last seven years a rapid expansion of statistical education has taken place and there is likely to be further expansion with more universities opening courses in the next three or four years. The major development has been the setting up of full-fledged statistics departments and the provision of major courses leading to degrees in statistics. Little progress has however been achieved in introducing statistics as an ancillary subject for students of the social or biological sciences. The exceptions seem to be economics and commerce, but even in these fields most of the courses are only elementary and descriptive and, even at the post-graduate level, do not include any of the advanced techniques.

There appears to be a real need for teaching statistical methods to students of psychology, education, sociology, zoology, agriculture, medicine and technology. Post-graduate and research workers in the social and biological sciences are handicapped for want of advanced applied courses. The few specialized institutions in the country are doing useful work in this direction. But universities will have to develop facilities for teaching statistics more extensively in their own departments.

The main difficulty is the scarcity of teachers in different departments, who are competent to teach statistical theory and applications in the respective fields. It may be possible to give in a centralized statistics department a general purpose introductory course to students of all the subjects followed by a course on special methods required for each subject. The special course can be given by a teacher from the department of statistics having sufficient knowledge of the field, or by one from the other departments having competence in statistics. There are few persons of such qualifications, but it is possible to get the additional training required at the Indian Statistical Institute or at some other suitable centre.

It is generally accepted that the education given in a university should be followed by professional training and that every graduate entering a profession should be suitably trained for it. In most professions, this requirement has been met by suitable arrangements between the universities and other bodies or within the universities themselves. Conditions in statistics are, however, not yet favourable for such organization. There is practically no co-ordination between the work done in universities and that in professional institutions and between the training given and the needs of the profession.

The problem has become urgent owing to the need for a large number of technically qualified statisticians of all types and levels in connexion with the development programme under the Second Five-Year Plan. Concerted action may therefore be taken with the support of the government in three main directions: first, expansion of the facilities in existing professional institutions and provision of new facilities in other institutions; second, introduction of specialization and practical training in some of the universities and careful planning of the new courses proposed to be introduced; third, assistance to universities from professional institutions and statistical sections of government departments in the matter of providing practical training to their students.

In view of the inadequate practical training of graduates and postgraduates employed in statistical work, it seems essential to organize on the job and in-service training for these recruits. Government offices have been taking steps in this direction, but the difficulty again is the shortage of the right type of personnel and organization.

Facilities for training persons in employment need to be developed further by universities through general and special courses in the evenings. The incentives for a worker to qualify himself further in statistics are many. At a high level, he can take the external examinations of the Indian Statistical Institute and qualify for the statistician's diploma or the associateships of the institute.

In contrast to the remarkable growth of statistical education in India, the progress of research has been rather backward. No large

university has yet developed first-rate teaching and research activities. The handicaps in the way of research may be removed by appointing professors who have done outstanding research work and are free to devote most of their time to conducting and guiding research, and inviting experts from abroad to given courses of lectures on recent developments and to initiate new lines of research, particularly in applied fields. Adequate research grants and fellowships are needed also to enable promising young men to work as research assistants or as research scholars.

APPENDIX A

Syllabuses for the M.A./M.Sc. degree

PATNA UNIVERSITY

Paper I: General Mathematics. (a) Algebra of matrices with special reference to algebraic forms. (b) Geometry of dimensions. Flats and lines, measurement of distances and angles. (c) Integral calculus with special reference to elementary properties of B and T functions, multiple integration including transformation. Infinite integrals. (d) Differential equations of second order including Legendre Bessel and hypergeometric functions. (e) Orthogonal polynomials. (f) Contour integration and theory of residues.

Paper II. (a) Probability. Addition and multiplication. Theorems of probability and their uses. Bernoulli's theorem. Mathematical expectation and law of large numbers. Probability in centinum Laplaces. Central limit theorem. (b) Numerical mathematical analysis. Interpolation formulae and the elementary finite difference equations. Quadrature formulae. Theory of normal law of errors. (c) Curve fitting; fitting of the important types of Pearsonian curves to numerical data.

Paper III. Elementary theory of statistics. Tabulation and representation of data. Continuous and discrete variates. Frequency distribution. Measure of central tendency, dispersion, skewness, kurtsis. Moments. Binomial, Poisson and normal distribution. Use of normal probability integral. Correlation. Contingency and association. Bivariate normal distribution, concept of regression. Intra-class correlation.

Distribution of linear function of normal variates. The distribution of mean, S2, t, F.Z, r. and their applications. Elementary tests of significance. Elementary cases of analysis of variance and covariance and their uses. Fisher's Z-transformation of the correlation coefficient and its use.

Elementary ideas of fiducial and confidence interval with reference to mean, variance and correlation coefficient.

Approximate distribution of statistics in large samples. Standard errors of moments and other statistics with uses. Transformation of variates.

Paper IV. (a) Design of experiment. The basic principles of designs of experiments. Randomization, replication and local control. Randomized block and Latin square and factorial designs. Interactions. Split plot experiments. Principle of confounding. Incomplete block designs. Sample survey. (b) Industrial statistics and quality control. Specifications. Standardization of quality and detection of lack quality control. Meaning of statistical control. Use of control charts. Buyer's and seller's risks. Single, double, and sequential sampling plans.

Paper V. Advanced Theory of Statistics. (a) Multivariate analysis including Wishart distribution and Hotelling's generalized T. (b) Estimation. Elements of sequential analysis. (c) Theory of statistical inference, including testing of hypothesis.
Paper VI. (a) Actuarial and Vital Statistics. Construction and use of life table. Logistic curve. Measurement of growth of population. (b) Economic statistics—time series, analysis, construction of index number. Forecasting. Demand analysis. (c) Statistics applied to genetics. Measurement of linkage in heredity. (d) Educational and psychological statistics. Application of various distributions in educational and psychological problems. (e) Official statistics.

LUCKNOW UNIVERSITY

Part I

Paper I. Analysis and Functions of a Complex Variable.
Paper II. Differential and Integral Calculus.
Paper III. Linear Methods and Design of Experiments. (a) Algebra, linear equations, matrices, quadratic forms, Cochran's theorem, vector spaces. (b) Method of least squares. Linear and polynomial regression lines, Markov's theorem, orthogonal polynomials, analysis of variance. (c) Design of experiments. Randomized blocks, Latin squares, incomplete block designs, lattice designs, factorial experiments (2, 2×4, 3×3), confounding, split-plot designs, missing plot technique, analysis of covariance.
Paper IV. Probability and Probability Distributions. Laws of composition of probability, with applications, discrete-valued random variables and distributions; theory of recurrent events and random walk; the normal distribution as a limit of the binomial.
    Introduction to the general study of continuous distributions; marginal and conditional distributions and regression in the multivariate normal distribution.
    Introduction to characteristic functions and limit theorems of probability theory.
Practical: based on Papers III and IV.

Part II

There will be three papers and one practical as under: Paper I. Applied Statistics. Two of the following topics to be chosen with the approval of the Head of the Department of Mathematics and Statistics: (a) Industrial quality control, control charts, estimation lot quality, acceptance sampling, sampling inspection, operation characteristic curves, sequential sampling, sequential estimation. (b) Economic statistics. Analysis of time series; periodogram, correlogram, linear autoregression, variate difference. Distribution of income; national income; mathematical models in economics; elements of the theory of games. (c) Probit analysis. Methods of bioassay; dose response curves; sensitivity data; the probit transformation; concomitant information. (d) Psychometrics. Mental tests and their scoring; rank correlation; methods of psychological scaling.
Paper II. Factor analysis—contributions of Spearman, Thurstone and Hotelling.
    The Neyman-Pearson lemma and the testing of statistical hypotheses, optimum properties of common tests like the t-test; derivation of the distribution of t, F and x^2; large sample tests of independence, homogeneity and goodness of fit; simple non-parametric tests like the sign test and the run test.
    Point and interval estimation; unbiased estimates of minimum variance; Cramer, Rao inequality and extensions; maximum likelihood estimates; sufficiency, efficiency, etc.; best confidence intervals, fiducial argument.
    Elements of sequential analysis and decision functions.
Paper III. Multivariate Analysis and Sample Surveys. (a) The null distributions of rectangular co-ordinates, Hotelling's T^2, Mahalanobis'. D^2; Wishart's distribution,

109

regression coefficients, discriminant function. This will constitute about 25 per cent of the total work for this paper. (b) Aims and methods of sampling and sample surveys; stratified sampling, ratio estimates, double sampling, etc., as indicated by Cochran: *Sampling Techniques* (1953).
Practical: based on the above papers.

APPENDIX B

Curriculum of the three-year statistician's training course at the Indian Statistical Institute, Calcutta

The training comprises lectures, laboratory work, tutorials and assisted reading, seminar discussions, visits and demonstrations, in-service training and participation in large-scale applied work. The detailed syllabus for the course together with a list of recommended books is available separately. The general scheme of training during each of three years is as follows.

First year. Training during the first year of the course consists in giving the trainees a general ground-work in mathematics, economics and theoretical statistics and initiating them to the different branches of applied statistics. Subjects covered during the year are algebra, analysis, and mathematical economics, foundations of statistics, statistical inference and specialized applications such as sample survey, quality control, population studies, psychological and educational measurements and design of experiments.

Second year The programme for the second year is divided into several parts.

The first four months are devoted to advanced courses in statistical theory and practice. During this period, subjects of practical importance such as economics and economic statistics, sample surveys, statistical quality control and advanced courses in analysis of variance, design of experiments, estimation and testing hypothesis are covered.

The next four months are exclusively set apart for practical training in various aspects of large-scale sample surveys. An intensive programme is arranged covering various aspects of sample surveys such as preparation of schedules, design drafting of instructions to field staff, scrutinizing field schedules, etc. The trainees are required to work on live problems at this stage. Field experience is provided by sending the trainees out to collect information based on household inquiries and on actual investigation in the case of crop surveys for the area and yield. The training during this period is more in the nature of participation with the trainees taking responsibility in actual work on a current project.

The rest of the year is devoted to in-service training in the various branches of the institute, in addition to some theoretical lectures and practical work. The in-service training is arranged in the electronic computation laboratory, workshop and printing press, machine tabulation by punched card methods, cost accounting and administration, etc.

Third year. The programme of training given for the third year comprises three parts: First, a three months' training on various aspects of Official Statistics, by the Central Statistical Organization, New Delhi, in co-operation with the other statistical offices of the central and state governments.

Second, a specialization course of three months in which trainees are given the opportunity to specialize in any two of the following subjects, for which are provided both theoretical and practical (and field if necessary) training in the special applied and research sections of the institute; biometric methods including probit analysis and

110

bioassays, population studies and vital statistics, advanced probability, decision functions, psychometric methods, econometrics and economic planning, statistical quality control, construction of designs, sample surveys, cost accounts, etc.

Third, a period of four to six months during which each trainee is required to carry out, on his own responsibility, a statistical project which calls for planning and organizing abilities, analytical competence, skill in presentation of results, etc. The item of work may be a statistical survey or investigation, a theoretical or applied problem for research, or a special report. The trainee is required to submit a report on the work done by him during this period, which would supply a basis for the assessment of his professional competence.

Appropriate facilities would be provided for this purpose to each trainee, the arrangements made according to his field of specialization. For example, in a certain number of cases, the Central Statistical Organization may place the trainees in selected government agencies. The Indian Statistical Institute may provide opportunities and funds for work in surveys and projects. Arrangements may also be made in some cases for the trainees to undertake directed research, including review of current literature relating to special problems or participating in lecturing or other academic work.

ISRAEL[1]

FACILITIES FOR TEACHING

Teaching Centres and Courses

There are three institutions which provide statistical courses at a university level.

The Hebrew University of Jerusalem provides undergraduate as well as post-graduate training, the normal period of study extending over three years for the B.A. degree with an additional two years for the M.A. Statistics is being taught at the undergraduate level and there is a three-year programme of courses for the B.A. given jointly for the Faculties of Social Sciences, Mathematics, and Natural Sciences. The Hebrew University also provides: (a) one-year courses in statistics which are compulsory for students of economics and sociology and optional for students of other social sciences, humanities and law; (b) a course of statistics for students of the Faculty of Agriculture.

1. Based on original papers by Hildegarde Kneeland ('Statistical Education in Israel'), and B. Gil ('University Teaching of Statistics in Israel').

At the School of Economics in Tel Aviv there are three faculties— Law, Economics and Political Science and the Institute of Accountancy. The curriculum lasts for four years and is based on the Continental model. Statistics is taught at undergraduate level in the Faculty of Economics and in the Institute of Accountancy and is obligatory for all students.

The Technion-Israel Institute of Technology provides training for degrees in engineering, M.A., and D.Sc. Statistics is taught as a minor but socialized subject in three faculties. In the Faculty of Economics, industrial statistics is taught for a year. In the Faculty of Natural Science probability theory and statistics is taught for half a year. In the Faculty of Chemical Technology statistics is also taught for half a year.

ORGANIZATION OF TEACHING

Hebrew University of Jerusalem. The several courses offered at this university are of one year's duration, the number of hours per week varying from three to four. The course on mathematics for social scientists dealing with calculus and fundamentals of analysis requires a preliminary knowledge of mathematics up to the matriculation standard. There are two courses on statistical methods. The second requires for entry the course on mathematics for social scientists; the first is mainly descriptive while the second goes further into sampling and statistical inference. Another course on demography covers sources and methods of analysis of demographic data, population trends, etc. An advanced course, probability and mathematical statistics, includes probability measure, random variables, distributions tests of hypotheses, estimation and decision problems.

There are three seminars—in statistics, in mathematical statistics, and in demography, lasting for a year each, with two hours per week. Students may attend these seminars after completing some of the earlier courses. The mathematical statistics and demography seminars are alternative choices. There is a further course in statistical methods for the natural sciences. Occasional additional courses are also organized by the university.

Students of the social sciences and natural sciences (including mathematics and humanities) may choose statistics as one of the two subjects required for the B.A. degree. All the above courses must be completed during the three-year period. All students of economics and sociology must take the first course on statistical methods which, however, is optional for the students of geography, humanities and law.

A first course in statistical methods for natural sciences is taken by students of biology, medicine and other disciplines.

School of Law and Economics. In the Faculty of Economics, there are three statistics courses of one year each covering general theory and a range of topics of relevance for economists. Two courses on mathematics are given which are prerequisite for taking the Statistics II and III. In the Institute of Accountancy, a statistical course of a rather elementary level is given.

Methods of Teaching

The main method of teaching is the lecture method but classes are held systematically for discussing statistical problems and supplementing knowledge. Exercises and applications are included in the programme of work and some practical training is provided. There is no field work but active participation in analytical research work is required in the seminars.

Teachers

The staff of the statistics department of the Hebrew University included two full professors (one jointly with the mathematics department), one lecturer and one assistant. In addition, two external teachers gave some of the courses. It is proposed to increase the staff shortly. At the School of Law and Economics, the staff is part-time and consists of two lecturers and one assistant.

TRAINING

The School of Law and Economics at Tel Aviv (with a branch in Haifa providing the first two-year courses), being an evening school, affords opportunities for employed persons to obtain university education. Civil servants, army and police personnel as well as employees in business agencies form about three-fourths of the regular students. In addition, some persons working in statistics in government or other agencies may take the elementary courses in statistics. Occasionally, a special elementary course is given to those in the clerical profession.

A number of institutions of a semi-university character provide vocational training in public administration, social work, etc., lasting for a period of two years. They give one-year courses of elementary statistics and sometimes also courses on applied statistics.

RESEARCH

The Statistical Department of the Hebrew University has been engaged in the last two years mainly in demography research and in

methodological research on geographical-statistical series. The department takes part in various research projects and also advises on research work in other university departments. There are at present two research students working for the Ph.D. degree.

CONCLUSIONS

In 1954–55, at the Hebrew University, the number of first year students taking statistics was 56. There were 129 students from the social sciences, humanities and law attending Statistics I. About 200 from the natural sciences also attended statistics courses. At the School of Law and Economics, Tel Aviv, the numbers taking Statistics I, II, and III courses were 130, 65 and 33 respectively. These figures are quite striking and it is hoped that they will increase with the contemplated expansion of these centres.

Within one or two years it is expected to enlarge the Hebrew University courses in theoretical statistics, in general applied statistics and in various special fields (mainly economic statistics). This will enable students to take statistics as their major subject for the M.A. degree.

Plans are afoot for raising the level of statistical teaching in the Faculty of Economics up to that of a major subject. In the year 1956–57, it is proposed to introduce six to eight new statistical subjects.

ITALY[1]

FACILITIES FOR TEACHING

Historical Review and Teaching Centres

Schools of statistics with two years' curricula were established in Italy in 1927, at the State universities of Rome, Padua, Florence, Bologna (later abolished), the Catholic University of Milan, and

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1. Based on an original paper by Nora Federici and Fernando Pedroni entitled 'Faculty of Statistical, Demographic and Actuarial Sciences at the University of Rome'.

recently at the State University of Palermo. The fundamental purposes for which these schools were founded were to train directors of government and semi-official statistical offices, and to impart general technical knowledge required for performing statistical functions. Their curricula have been planned to provide adequate preparation for the special examinations which must be taken by all those desiring to hold positions in statistical offices.

In 1936, the school of Rome was combined with the University's School of Statistical and Actuarial Sciences which also had a two-year curriculum. As a result the programme of the Faculty of Statistical, Demographic and Actuarial Sciences was revised. This faculty now has two aims: (a) in the scientific field to further the advancement of the statistical, demographic and actuarial sciences by giving its students a solid background for research in these fields; and (b) in the vocational field to prepare its students for statistical and actuarial positions either as independent professionals or as directors of statistical and insurance offices. There is no other faculty or school in Italy whose scholastic programme thoroughly covers statistical and actuarial sciences and at the same time keeps the two specializations distinct.

The faculty has courses leading to the diploma in statistics after two years of study and the doctorate in statistics after a further two years.

To enable a study of statistical methods by technical experts in other fields, provision is made for a graduate in economics and commerce to join the last year of the doctor's course in statistics and demographic sciences. Graduates in the mathematical sciences and in mathematics and physics may also register with the last year of the course for the doctor's degree in statistical and actuarial sciences. Students who have passed the two-years' study for a doctor's degree in engineering, mathematical sciences, mathematics and physics, natural sciences, biological sciences and geological sciences, and students who have completed successfully the first two years of study for degrees in law, political sciences, economics and commercial sciences may join the last two years' course for the degree of doctor of statistics, in either statistical and actuarial sciences or statistical and demographic sciences.

Information is not yet available concerning the teaching of statistics for students majoring in mathematics, psychology, sociology, biology or in engineering and agricultural sciences.

Careers for Statisticians

The students trained in the Faculty at Rome are prepared for statistical posts in different fields according to their specialization.

115

Diploma holders may take up statistical careers in private or government statistical offices. Those with the doctor's degree can pursue scientific or teaching careers, practice as independent statisticians or actuaries or direct statistical offices of private or public bodies and insurance offices.

ORGANIZATION OF TEACHING

Requirements for Admission

For admission to the four-year course leading to a doctor's degree in one of the two branches, statistical and actuarial sciences or statistical and demographic sciences, a student must have passed the secondary school examination. As mentioned earlier, admission to the first year of the two-year course for the doctor's degree is open to those who have completed the first two years in some other discipline; admission to the second year of the two-year course to those who have completed four years in certain other disciplines.

Courses in Statistics: Aims, Duration and Content

In the Faculty of Statistical, Demographic and Actuarial Sciences at the University of Rome, the curriculum for the first two-year course for the doctor's degree consists of 13 one year's duration courses of which two are electives chosen from five.[1] In the first year, the following courses are taken: elements of mathematics, statistics with graphic presentation, anthropometry, health statistics, general and conoidal sociology, economic statistics I, and political and economic geography. In the second year, students take economic statistics II, legal statistics, social statistics, demography, and two of the five elective courses (elementary political economy, biometrics, anthropology, introduction to public and private law, other courses as approved by Dean of the Faculty).

In the second two-year course, the courses are of an advanced character and are intended to give specialized training. The demography major requires 10 courses of which three are electives while the actuarial major requires 11 courses of which three are electives. These courses are listed below.

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1. The courses in statistics, sociology and demography given in the first two years are in common with the faculties of Law and Political Science, and are attended by students of still other faculties. During both two-year courses the students in the Statistical, Demographic and Actuarial Faculty may select electives from among courses taught in other faculties provided that in the dean's opinion they are relevant to the student's programme.

Demography major. *First year:* statistical methodology, development of population, biometrics, and advanced economic statistics. *Second year:* applications of statistics to the physical sciences, calculus of probabilities, and actuarial mathematics and techniques of private human life insurance. *Electives:* chosen from mathematical analysis, algebra and infinitesimals,[1] analytical geometry with elements of projection, advanced political economy, and ethnology.

Actuarial major. *First year:* statistical methodology, private and social insurance law, economics and finance insurance organizations, and mathematical analysis, algebra and infinitesimals.[1] *Second year:* calculus of probabilities, actuarial mathematics and techniques of private human life insurance and social insurance. *Electives:* chosen from development of population, biometrics, advanced economic statistics, applications of statistics to the physical sciences, analytical geometry with elements of projection, numerical and graphic calculus, advanced political economy, techniques of damage insurance, and other courses as approved by the Dean of the Faculty.

The curricula to be followed by students from other subject fields joining in the first or the second year of the two-year course for the statistical doctor's courses (demographic or actuarial sciences) are fixed by the Council of the Faculty for each individual case on admission.

The curricula in the School of Statistics at Padua, Florence, Milan, and Palermo, follow closely the curriculum of the first two years of study in the Faculty at Rome.

Methods of Teaching

Lectures and seminars supplemented by practical work, are the main teaching methods. The faculty attempts to provide all the teaching aids necessary to give substance to the theoretical material taught in the classes. Slides are available for illustrating subjects like graphic presentation and laboratory demonstrations of anthropometric research techniques. Calculating machines and IBM machines are available to students attending classes in statistics. Practical exercises consist of applications of statistical methods to concrete problems.

The library facilities are excellent. Students have access to other specialized libraries—the Faculty Library of the Institute of Statistics, the Sociological Library, the Library of the Actuarial Institute, the Library of the Italian Committee for the Study of Population Problems.

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1. Two-year course.

117

As an aid to students preparing for examinations, the faculty staff have begun publishing the lecture courses given by them.

Methods of Testing Competence

In addition to passing the 11 courses, the examination for the diploma, consists of the preparation and discussion of two topics (themes), one written and one oral—one on statistical methodology and the other on some fundamental topics (themes) in the course of study. For the doctor's degree, after passing the prescribed courses, the examination consists in the preparation of four topics (themes), one written and three oral, and discussion of at least three of them, one written and two oral. All these topics must bear on the material in the required courses of the candidate's major and must demonstrate a working knowledge of the methodology. One of these must specifically deal with methodology of statistics and the other must discuss the development of population methods (for demography doctor) or actuarial methods (for actuarial sciences doctor).

RESEARCH

The Faculty at Rome carries on direct scientific activity through its affiliated Institute of Statistics and the Institute of Actuarial Sciences. The Institute of Statistics directed by Professor Gini is open to students of other faculties also and is attended particularly by those in the faculties of Political Science and Law taking statistical courses.

Seminars in statistics are held periodically in the Institute of Statistics; professors, lecturers and assistants of the faculty, research scholars of the institute as well as other students participate.

The Institute of Actuarial Sciences is still in process of organization.

CONCLUSIONS

The schools of statistics plan courses to qualify students for positions in statistical offices. They are required to pass the special examinations instituted by an Act in 1923. The Faculty at Rome also has facilities for training professional statisticians.

The number of students taking diplomas or degrees in the University of Rome is fairly large. In 1946–48, 166 registered for the diploma course, 76 for the doctor's degree in statistics and actuarial sciences and 29 for the doctor's degree in statistics and demography

sciences. In addition to these, there were 106 outside *(Fuori Corse)* students for the diploma and 47 and 19 for the two doctorates. Many foreign students have enrolled in the faculty, some of whom were sent by their governments. These have been given particular attention and, on their return, have filled directive posts in government statistical offices and in scientific organizations.

JAPAN[1]

FACILITIES FOR TEACHING

Teaching Centres and Courses

Of the 89 national universities (including 17 junior colleges), 78 public universities (including 44 junior colleges) and 329 private universities (including 207 junior colleges), the institutions providing courses in statistics are 63 national, 20 public and 62 private universities.

ORGANIZATION OF TEACHING

There is no distinct course of study leading to a degree in statistics. Statistics is taught in courses in mathematics, economics, agriculture, medicine, etc., as shown below. The duration of statistics courses varies between six months and two years, the majority being of one year's duration.

Faculties or departments and courses of study	Subjects
General education; Law; Literature; Natural science and social science courses	General statistics (introduction to statistics)
Commerce; Economics Economics course	Economic statistics, industrial management statistics, enterprise statistics
Gakugei (Art and Science) Mathematics course	General statistics

1. Based on an original paper by Ryokichi Minobe, entitled 'Teaching of Statistics in Japan'.

Faculties or departments and courses of study	Subjects
Education Education course	Education statistics
Science and Engineering Mathematics course	Mathematical statistics, statistical mathematics, stochastic statistics, theory of sample survey, statistical mechanics, inductive statistics
Agriculture Agricultural economics course	Agricultural statistics, biological statistics
Fisheries Manufacturing and culture fishery course	Fishery statistics
Medicine Medical course	Hygiene statistics

In Japan a very large number of students take courses in statistics. The distribution of students in the various departments in the year 1953-54 was as follows:[1] general education course, 5,523; law department, 1,038; literature department, 2,022; commerce department and economics department, 13,204; Gakugei (art and science) department, 1,768; universities: education department, 1,470; science and engineering department, 4,201; agriculture department, 1,425; medical department, 801; other, 930; graduate schools (universities of Tokyo, Tohoku, Tokyo Technical, Waseda and Keio), 71; total, 32,453. Of these 15,457 were at national universities, 2,860 at public universities, and 14,136 at private universities.

The teachers of statistics number approximately 343, of whom 157 belong to the national universities, 32 to public universities and 154 to private universities. The teaching load, per teacher, is usually two hours a week although some teach up to eight hours a week.

No information is available about post-graduate teaching and research in Japanese universities.

TRAINING

There are extensive facilities for in-service training of civil servants and others in Japan.

The Training Centre of Statisticians (Prime Minister's Office) gives a six-months' course to persons employed in the statistical agencies of the State or of local authorities. About 70 trainees are admitted to this full-time course which includes general statistics, mathematical statistics, statistics applied to special fields and practical work.

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1. The figures include some overlapping.

The Statistical Technicians' Training Centre attached to the Institute of Statistical Mathematics (Ministry of Education) has a three months'part-time course for about 100 trainees. The subjects of study are general statistics, mathematical statistics and educational statistics.

The Autonomy Academy (Autonomy Agency) gives part-time training to the personnel of local bodies for a period of six months. The number of trainees is 140.

The Forestry Training Institute (Forestry Agency) gives an intensive general course to the staff of forestry offices for three to four weeks. About 600 trainees attend the classes.

The Technician's Training School of the Geographical Survey Institute limits its admission to the personnel of the Ministry of Construction. It is a part-time course (two to three hours a week) spread over one year.

MEXICO[1]

FACILITIES FOR TEACHING

Historical Review

Although interest in statistics has been manifest in Mexico since it became independent, no organized systematic studies were introduced until recently. During the years 1904 to 1912, the first official statistics system was introduced in Mexico relating to death rates. At about this time the first elementary course in statistics was instituted in the School of Economics which is a branch of the National University.

It was only after the Mexican revolution and successive régimes that the Secretariat of Industry and Commerce was formed which became, after several changes, the present Secretariat of National Economics. This office has been responsible for the introduction of the study and practical applications of statistics. Other continued efforts in this direction culminated in the creation in 1952 of the

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1. Based on an original paper by Anna Maria Flores entitled 'Statistical Education in Mexico'.

Sampling Department, a branch of the Directorate General of Statistics. This department introduced modern methods of mathematical statistics into Mexico.

Before and after the establishment of the Secretariat of Economics, several universities in the country had paid special attention to the study of statistics.

Teaching Centres: Degrees and Diplomas in Statistics

At the pre-university stage, i.e., in the secondary schools, pupils are made familiar with statistical data and given an appreciation of the role of statistics in different school subjects. At the preparatory school which leads directly to the National University of Mexico, the students are initiated into statistics although it is treated only as a subsidiary subject. The preparatory school is divided into two major sections, one leading to the bachelor of science course and the other to bachelor of arts. These have different syllabuses to prepare the scholars for their respective university careers. The bachelor of science course leads to courses in political and social sciences, commerce and administration, economics, chemistry, engineering, medicine, etc., while the bachelor of arts course is for students interested in architecture, plastic art, history, philosophy, literature, etc. The bachelor of science preparatory course provides elementary studies in statistics and is supplemental to the basic syllabus.

At the National University specific studies of statistics are provided in the Faculty of Science which includes mathematics, actuarial mathematics, physics, astronomy and biology. Intensive studies are undertaken only by those who require a knowledge of mathematical statistics. The school of political and social sciences of the university provides courses in social statistics. Similarly, economic statistics is taught in the School of Economics.

In addition to the National University, the universities, institutes and colleges of the different States of the Mexican Republic devote special attention to the study of statistics in their courses of commerce and administration, public accounts, nursing and obstetrics. The National Polytechnical Institute of Mexico which is affiliated to the Secretariat of Public Education has special courses in statistics for commerce students. The National School of Agriculture provides a course in agricultural statistics at the Chapingo School in the State of Mexico.

The only official institution where statisticians are specially trained and where the syllabuses include all the branches of statistics and required mathematics is the Sampling Department of the Directorate General of Statistics under the Secretariat of Economics.

There is no full degree (*licenciado* or doctor) in statistics in any university. The Sampling Department issues certificates or diplomas after completion of the various courses.

ORGANIZATION OF TEACHING

Conditions for Admission

For admission to the Autonomous National University (ANU), a student must have graduated from the *preparatoria* as *bachillerato*. To get to the Faculty of Science where courses in statistics are given, the student should have graduated in science.

Information is not available on the requirements for entrance to courses given by the Sampling Department.

Courses in Statistics: Aims, Duration and Content

In the Faculty of Science of the ANU, there are courses leading to a *carrera* (actuarial career) and to a mathematical career. The syllabus for the first course for actuaries contains the following topics: introduction (definitions and fields of applications); frequency distributions; graphic presentation; measures of central tendency; moments; scatter measures; normal distributions, curve fitting; and elements of correlation and regression. The second course for actuaries deals with probability calculus, distribution functions, Pearson's curves, curve fitting, adjustment of a biometric function, sampling theory and a few advanced topics of interest to actuaries.

The course entitled 'Introduction to mathematical statistics' covers practically the same range of topics as the actuarial course with greater emphasis on sampling distributions, tests of hypotheses and estimation theory.

The above elementary courses extend over one year.

The teaching programmes of the National Polytechnical Institute, the National Institute of Agriculture and all the universities, institutions and schools in Mexico follow almost the same sequence of topics: collection and compilation of data, descriptive statistics, sample correlation and regression, index numbers and time series.

Since 1952, the Sampling Department of the Directorate General of Statistics has organized annual courses in statistics. Some of these courses are quite advanced and need a large amount of mathematics, which also is provided through special lectures. In the 1955 programme, there were two such introductory courses, one on notions of mathematical analysis and the other on introduction to the probability calculus. There was a course on theory of sets.

123

The statistical part of the curriculum consisted of the following courses: introduction to statistics, intensive course in sampling method, mathematical foundations of statistics, design of experiments, and quality control. The syllabuses for these courses are appended.

Methods of Teaching

Lectures are the main teaching medium in statistics in Mexico. Practical work with calculating machines is also included in the teaching programmes of applied statistics. For the *licenciado en economia*, there is laboratory practice on computation of trends, correlation analysis, etc., based on data from the Mexican economy.

Standard books in the English language are used, supplemented by teachers' notes.

On the whole, the classes are small but there does not appear to be much individual teaching. For preparation of a thesis, however, there is individual consultation and tuition.

Methods of Testing Competence

Examinations follow the American pattern rather than the central European pattern. Oral examinations and written tests are held periodically at the teacher's discretion, usually at the end of each course. Written homework is important and is a requirement for admission to final examinations.

TRAINING

The courses organized by the Sampling Department are intended for the training of statisticians in all the branches of modern statistics. These are taken by persons in employment as well as by others. Courses have been organized on SQC for industrial engineers and a course on analysis and design of experiments for physicians of the General Hospital.

The requisite mathematical background is also supplied to employed persons who desire to take statistical courses. Those concerned with the descriptive aspect attend lectures in arithmetic, algebra, geometry and calculus, and those concerned with the mathematical aspect take tuition in probability calculus, theory of sets and theory of measure.

An essential part of the training offered to students of the Sampling Department is the practical work carried out in connexion with the activities of the department, including the planning of a sample sur-

vey—preparation of questionnaires, maps and plans, instruction of survey personnel, field work, interpretation of results and estimation of means, variances and correlations, etc.

The Sampling Department has been training both technical personnel and administrative staff who will be in charge of statistical offices.

RESEARCH

The report for Mexico does not refer to the research courses in statistics or the conditions for research in the universities and institutes. It can, however, be inferred from the advanced courses given by the Sampling Department that some research students must be working on mathematical statistics and sample survey techniques.

CONCLUSIONS

There is a large measure of uniformity in the methods, programmes and textbooks followed by the universities, institutes and colleges of the different states of the Republic and those of the Autonomous National University of Mexico. Schools of political and social science teach social statistics and schools of economics teach economic statistics. These courses are at elementary levels. Those given by the faculties of science are only a little more advanced. There are no systematic courses in other faculties of the universities.

Really advanced courses in some branches of statistics are given by the Sampling Department, a government department. Clearly, advanced instruction and research should be given by the universities. But the main difficulty is the shortage of teachers, and here assistance from outside would be welcome and fruitful. There is also another difficulty—the want of proper recognition of the value and scope of statistics in the country. Anna Maria Flores, the Director-General of Statistics, says in her report to the International Statistical Institute (1955):

'For any international organization seeking to collaborate in the economic development of Latin America, and hence of Mexico, the obvious first step must be to encourage a keen interest in statistics, to further the study of statistics and to secure government aid for statistical activities in the country concerned.

'The second step would be the training of teachers of statistics, an undertaking which would be the responsibility of the National University of Mexico which has trained teachers in other branches of science and could do the same for statistics.

'As soon as a sufficient body of statistics teachers is available, one could seek to introduce statistics as an obligatory subject, not only as a constituent part of various university "careers", but even in secondary schools. A significant improvement in the standard of pupils leaving the secondary schools will be a boon not only to the universities but also for those who go into industry, commerce, agriculture, etc.'

APPENDIX

Syllabuses of courses offered by the Sampling Department

INTRODUCTION TO STATISTICS

Frequency distributions of one variable. Classification of data. Presentation of frequency distributions.

Theoretical frequency distribution of one variable. Continuous and discrete distributions. Normal distributions. Binominal and Poisson distributions.

Theory of large samples of one variable. Distribution of the mean, of the difference of two means, and of the difference of two percentages.

Frequency distribution of two variables. Linear regression. Linear correlation.

Normal distribution function of two variables. Marginal distribution. Conditional distribution.

Distribution functions of more than two variables. Multiple linear regression. Coefficient of multiple correlation. Linear discriminant functions.

X^2 distribution. Student's t distribution. Snedecor's F distribution. Range distribution.

Estimators of distribution parameters. Properties. Confidence intervals.

Hypothesis tests of the mean of a normal population, the difference of means, the variance of a normal population, the goodness of fit, and the independence in contingency tables.

INTENSIVE COURSE IN SAMPLING

Concepts of census and sampling.

Advantages of the sampling method: (a) cost reduction; (b) shorter time; (c) greater accuracy; (d) possibility of measuring the error; (e) better control of field and office personnel.

Probability sampling.

Mathematical expectation.

Bias—concept of bias and commentary on biased estimates.

Unrestricted random sampling. Means and variance. Unbiased estimators. Total and variance. Random sampling with and without replacement.

Size of the sample. Finite correction factor or finite multiplicator. Criterion for its rejection.

Stratified random sampling. Cochran's criterion of proximity. Problem of sample allocation: (a) proportional allocation; (b) optimum or Neyman allocation. Gain in precision of the stratified sample compared with the unrestricted random sample, using different allocations. Variance in each case of sample, allocation. Neyman allocation for fixed cost and minimum variance, or for fixed variance and minimum cost. Estimators employed. Demonstration of their lack of bias.

Sampling for clusters. Clusters of equal size. Interclass correlation coefficient. Efficiency compared with unrestricted random sampling. Problem of costs and variances.

Stratified sampling of clusters. Costs and efficiency compared with unrestricted random sampling. Estimators. Variance of the estimators.

Subsampling. Two-stage and multi-stage sampling. Estimators and their variances. Equal and unequal first-stage units. Stratification of first-stage units.

Double sampling (Neyman). Cost conditions for the use of double sampling. Estimators. Variances.

Systematic sampling. Conditions under which systematic sampling is efficient. Estimators. Expression for the variances, works of Madow, Cochran, etc.

Sampling with probability proportional to the size. Problem of sampling with and without replacement.

Ratio and regression estimates. Concept of consistent estimator (Fisher). Bias in these estimates. Variances and estimators. Applications.

Special designs. Design recommended by Deming. Calculation of variance by means of the properties of the range distribution. Shewhart constants.

Complication of questionnaires. Spirit of the questionnaire. 'Loaded' questions or questions with implied meaning. Interview technique.

Instruction of enumerators and list compilers. Control of the field personnel. Inspection through sampling the enumeration and lists. Practical problems. Estimate of the number of dwelling.

Maps. Examples of maps which are useful for the sampling. Exercises: maps in the Urban Zone, at Milpa Alta, Tlahuac, Cuajimalpa, etc.

MATHEMATICAL FOUNDATION OF STATISTICS

Notions of the theory of sets.

Leberague measure of linear sets of points. Lebesgue integral. Additive set functions. Lebesgue-Stieltjes integral.

Theory of measure and integration in R_n.

Laplace transforms and application to the solution of systems of integro-differential equations and with finite differences.

Fourier transforms. Characteristic function of a distribution in R_n.

Matrices, determinant and quadratic forms. Orthogonal matrices, characteristic numbers.

Elementary theory of probability. Conditional probabilities. Markoff chains.

Infinite probability spaces. Borel probability spaces.

Random variables and multi-dimensional distribution functions. Probabilities in a space with an infinite number of dimensions. Different types of convergence.

Mathematical expectation. Tchebycheff inequality. Criteria of convergence.

Independence. Laws of large numbers. 'Nought of one' law in the theory of probabilities.

Birkoff-Kintchine's ergodic theorem.

Stationary stochastic processes. Spectral presentation.

Syllabus of Selected Subjects of Mathematical Statistics

Stieltjes integral. Fourier transforms.

Orders of magnitude. Euler-MacLaurin formula. Gamma function. Orthogonal polynominals.

Study of moments and distribution cumulants.

Standard distributions. Adjustments of sample distributions to theoretical distributions.

Association and contingency.

Theory of regression and correlation.

General notions.
Completely random design. Degrees of freedom. Mathematical models of (a) variance analysis; (b) variance component. Mathematical expectations of the mean squares. Bartlett test of the homogeneity of variances. Concept of comparison. Individual degrees of freedom. Satterthwaite's approximate test; subsampling. Comparison of individual means. Efficiency. Covariance analysis in the case of two variable with linear dependence.
Complete random block. Variance analysis. Mathematical expectation of the squares. Means. Missing observations. Relative efficiency compared with the completely random design.
Latin square. Variance analysis. Mathematical expectation of the squares. Means. Missing observations. Relative efficiency compared with the complete random block design and with the completely random design.
Factorial designs.

QUALITY CONTROL

Normal distribution. Relation between standard deviation and the point of inflection of the curve. Area below the normal, as a function of units standard deviation.
Use of the range distribution of the computation of the standard deviation. Shewart constants, limits of $^1/_{1000}$ and $^1/_{40}$.
Control charts for $\overline{X}$ and R (range).
Control charts for p. Examples for each type of charts.
Acceptance sampling.

NETHERLANDS[1]

FACILITIES FOR TEACHING

Teaching Centres: Degrees and Diplomas in Statistics

There is no provision for major courses in statistics leading to a degree in any institution in the Netherlands. Statistics is taught only as an auxiliary or minor subject, in the degree courses in economics, mathematics, psychology, sociology, actuaries, engineering and agriculture.
The following list gives the universities and the subject fields in which statistics is taught:
Municipal University of Amsterdam: mathematics, actuarial science, economics and psychology;

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1. Based on an original paper by D. van Dantzig entitled 'Present Position of Teaching of Statistics and Statistical Research in the Netherlands'.

Free University of Amsterdam: mathematics, economics, psychology and sociology;
University of Utrecht: mathematics and psychology;
University of Leiden: mathematics, biology and psychology;
University of Groningen: mathematics, economics, psychology and experimental science;
Technical University of Delft: civil and mechanical engineering, mining, shipbuilding, aircraft construction;
Economic University of Rotterdam: economics;
Agricultural University of Wageningen: agriculture.
The students in mathematics attend the lectures on statistics as far as they need them as an auxiliary science. At the Municipal University, Amsterdam, actuarial sciences can be taken as a major subject and this includes thorough courses in statistics and probability. Statistics is obligatory, as an auxiliary subject, for students of psychology and economics. At the Municipal University, Amsterdam, and the Economic University, Rotterdam, students of economics can take statistics as a main subject—a course on advanced statistics is provided.
There are a few other centres of teaching in the Netherlands. The Mathematical Centre at Amsterdam offers two different courses on applied statistics and operations research for persons in employment. The Quality Service for Industry offers courses for persons working in industry.

ORGANIZATION OF TEACHING

Courses in Statistics: Aims, Duration and Content

There are auxiliary courses in mathematical statistics at several places for students doing a mathematics major. At the municipal universities of Amsterdam and Leiden the duration is two hour-years (which is the number of hours a week multiplied by the duration of the course in years). At Utrecht the course is on theory of probability for two hour-years. At Groningen advanced statistics can be taken by students of mathematics for four hour-years.
At the Municipal University, Amsterdam, statistics and probability are parts of the major course and four hour-years are devoted to them.
Courses on elementary statistics (two hour-years) are generally available to economics students, but studies at the Municipal University, Amsterdam, and the Economic University, Rotterdam, have the benefit of courses on advanced statistics (two hour-years) and statistical analysis (one hour-year).
Courses in psychology are common—the time given to them is

129

two to four hour-years, including the time for practical work. At Leiden only, biology students are given a statistics course and they are combined with mathematics and psychology students.

At the Agricultural University, there are three courses, elementary statistics (one hour-year), theory of probability (two hour-years) and advanced statistics (one hour-year). Very few students take the advanced courses. In 1954–55, there were only six compared with 80 taking the first course and 15 taking the second.

For all engineers except mechanical engineers, a short common applied course is available (one hour-year). The mechanical engineers take mathematical statistics for two hour-years.

Methods of Teaching

At the universities, the lecture method is most prevalent. Practical work is also included and exercises are done by students. This is not as important for students of mathematics as for those studying economics and psychology. Information is not available on what proportion of the total time is devoted to practical work with computing machines.

Psychologists and economists gain practical experience by participating in statistical investigations. At Amsterdam, most students specializing in statistics get practical experience by working as assistants at the Mathematical Centre.

For advanced courses in statistics, the numbers are small and there is the possibility of individual attention and for discussion classes.

Teachers

There are about 17 university teachers, of whom 11 are of professorial rank and the rest are lecturers. In the other institutes, a number of experts are in charge of the teaching, but no precise figures are available.

University courses are given by professors of mathematics, economics or psychology.

Centralization of Statistics Teaching and Co-ordination

In the same university courses in different departments are generally given by different teachers. For instance in the Municipal University, Amsterdam, there are three professors in charge of teaching students of mathematics and actuarial sciences, psychology, and economics (both elementary and advanced statistics). On the other hand the same professor may also teach students for two or three majors as, e.g., economics and sociology at the Free University of Amsterdam.

Little co-ordination is reported between institutions organizing courses on statistics. For instance, the course in applied statistics given at Delft University is identical with the first part of the course with the same title given by the Mathematical Centre.

TRAINING AND IN-SERVICE TRAINING

The applied statistics course is given by instructors with different levels of education. It is conducted twice a month during the winter semester. The subjects dealt with are: introduction, the sign test, Wilcoxon's two-samples test; probability distribution, expectation and variance, the normal distribution and correlation. About 20 people attend this course.

The operations research course is intended for higher staff in industry, advisory bureaux and universities. The lectures are held once a month. About 40 to 50 persons participate.

The Quality Service for Industry organizes lectures and practical classes for persons connected with industry. The lessons, extending over one day, are given once a fortnight. Each course is specially meant for one branch of industry.

An interesting method successfully tried in the Netherlands for training large numbers is that of correspondence courses. The Netherlands Foundation of Statistics offers two correspondence courses:

General statistics: 15 lessons are sent during nine months, containing elementary theory and exercises. There are 180 participants at higher grade school level who work mainly in the Netherlands Central Bureau of Statistics and other government offices.

Statistical analysis for industry: 24 lessons are sent by post during 18 months. Six days are allotted for oral instruction in groups. The subjects treated are the following: collection of statistical data, tables, graphs, description of statistical population; principles of the theory of probability, sampling tests of hypothesis, theoretical distributions, correlation, analysis of variance, industrial experiments, statistical quality control and applications to industrial problems.

There are 80 participants at secondary school level, who work mainly in industrial quality control.

RESEARCH

The main centres of research in statistics are the Mathematical Centre, Amsterdam, the Universities of Leiden and Utrecht and the

131

Netherlands Central Bureau of Statistics (The Hague). At the universities, research is done mainly to complete the scientific training. There seem to be no regular courses in statistics leading to post-graduate degrees.

The Mathematical Centre is a foundation independent of the universities. It is sponsored by the Netherlands Government, the Municipality of Amsterdam and by several industries. In the statistical department of the Mathematical Centre, research is done in mathematical statistics and probability. The Central Bureau conducts research studies mainly in sampling theory.

CONCLUSIONS

In the Netherlands, statistics as a university discipline does not appear to hold a high position. Nowhere can it be taken as a major subject and post-graduate study and research are not well developed in the universities. The Mathematical Centre meets the need to some extent, but is scarcely adequate to produce teachers and theoretical statisticians.

As an auxiliary or a main subject, statistics figures adequately in the different curricula, particularly of economics and psychology. The fact that these courses are given by capable professors from the corresponding subject departments may mean that greater emphasis is placed on applications than on the mathematical theory.

Statistics of students participating in the various courses are given in the Appendix. Some courses have only very recently been instituted and figures for them are not available. It is reported that there are plans of extension of statistical education in many universities.

In the matter of training, particularly in industry, the country is well served. The system of correspondence courses helps people scattered in different places and the occasional meetings afforded the trainees helps to obviate the usual defects of such courses.

APPENDIX

Student statistics in the universities in the Netherlands

University	Subject	No. of students 1954-55[1]
Municipal University of Amsterdam	Mathematics	6
	Actuarial sciences	6
	Psychology	50

1. In some cases it has not been possible to give precise data, as the lectures only started in 1955.

University	Subject	No. of students 1954-55[1]
Municipal University of Amsterdam (*continued*)	Economy I Economy II Economy III	50 40 15
Free University of Amsterdam	Mathematics and physics Psychology Economy Sociology	. . . 20 60 10
University of Utrecht	Mathematics Psychology	. . . 60
University of Leiden	Psychology Biology Mathematics	35
University of Groningen	Mathematics Experimental sciences Psychology Economy	5 20 . . . . . .
Technical University of Delft	Civil engineering Mining Shipping Aircraft construction Mechanical engineering	100 30
Economic University of Rotterdam	Economy I Economy II	15 . . .
Agricultural University of Wageningen	Agriculture I Agriculture II Agriculture III	80 15 6

1. In some cases it has not been possible to give precise data, as the lectures only started in 1955.

PAKISTAN[1]

FACILITIES FOR TEACHING

Historical Survey

Pakistan at present has five universities with a large number of affiliated colleges. A large proportion of these institutions have come

1. Based on original papers by Hildegarde Kneeland ('Statistical Education in Pakistan'). M. Zia-Ud-Din ('Position of Training in Statistics in West Pakistan') and Q. M. Hussain ('Report on Teaching of Statistics in East Pakistan').

into existence since the birth of Pakistan and many of those which were in existence at the time of Partition have undergone considerable reorganization and expansion during the past few years. Under the educational system in Pakistan the universities serve two major functions. They are teaching institutions at the post-graduate level and in some cases also at the undergraduate level and they are examining institutions for the affiliated degree colleges which do most of the teaching at undergraduate level.

Statistics is now taught in all the five universities—Dacca, Punjab (Lahore), Karachi, Peshawar and Sind (Hyderabad). The development of statistics has been, however, very uneven. The most developed departments are found in Dacca and Lahore. The M.Sc. degree course in Lahore was initiated in 1950.

Teaching Centres: Degrees and Diplomas in Statistics

The following centres for the teaching of statistics exist in Pakistan:

Punjab University. The Institute of Statistics provides teaching up to the master's degree in statistics. There is also provision for teaching for the honours degree to supplement the two years' undergraduate course in statistics in some of the local colleges in Lahore. The Institute of Statistics also organizes evening courses leading to the certificate in statistics or diploma in statistics. The duration of each is one year. Auxiliary courses for students of economics, mathematics, commerce and agriculture are also given at the institute. Usually these subjects are optional but for the students preparing the B.Com. degree and the diploma in public health statistics is a compulsory subject.

Karachi University. There is no full-fledged course in statistics either for the B.A. or M.A. degree; but some teaching is given in the departments of Commerce, Economics and Mathematics equivalent to one or two papers out of eight papers at the university examination.

Peshawar University. Statistics is an optional subject for M.A. mathematics, economics and also for the B.Sc. degree for which there is a paper under mechanics.

Sind University. Here also, there is no teaching of statistics as a separate discipline, but some elementary courses are available in the Mathematics, Economics and Commerce faculties.

The University of Dacca in East Pakistan is an important centre of teaching in statistics. There is provision for statistics at the undergraduate level, both pass and honours degrees, and also at the post-graduate level. Statistics also occurs as a subsidiary subject in courses of mathematics, economics, commerce, etc.

In addition to the above university centres, the Agricultural Institute,

Tejgaon, imparts training in statistics to students taking the B.Sc. degree courses in agriculture. There is some statistics taught in the course for teachers in the Teachers' Training College, Dacca.

The university system of studies in Pakistan, both West and East, consists of a two-year intermediate stage followed by two years of undergraduate work leading to the B.A. or B.Sc. degree. The difference between pass and honours degrees in West Pakistan universities consists not in the duration of study required but in the emphasis placed on the special subject of study. In East Pakistan (Dacca University), the honours course is of three years' duration and has a different curriculum from that of the pass course.

The post-graduate degree of M.A. or M.Sc. is ordinarily conferred after an examination following two years of study after the B.A. or B.Sc. degree. It is also possible to substitute some of the papers in the examination by a dissertation or a minor thesis. At Dacca honours graduates may join the second year of the post-graduate course. The Ph.D. degree is mainly based on research conducted under the supervision of a university professor for not less than two years after taking the M.A. or M.Sc. degree.

Careers for Statisticians

Professor M. Zia-Ud-Din reports that the want of recognition of the importance of statistics in Pakistan is hampering its development. Few social or economic surveys employ sampling methods. Recently, however, some large-scale surveys have been undertaken by the Departments of Agriculture and the Central Statistical Office. Until recently, posts of statisticians were held by persons not suitably qualified and not aware of the scope and field of its application. The Central Statistical Office is now well staffed with qualified statisticians and the employment of statistically trained graduates in government departments is therefore increasing. There is considerable scope for employment in general administration, planning and research and various government offices. There is also scope for statisticians in industrial and commercial institutions and, for the next few years at least, also in higher education (both teaching and research).

Most of the students trained by the Institute of Statistics, Lahore, have found employment in the Central Statistical Office, Karachi, and in the statistical cells attached to various ministries and departments of government, such as Public Health, Food and Agriculture and Industry. In the teaching profession, the field is limited as so few colleges offer courses in statistics. The same situation exists at present in business and industry which have not sufficiently recognized the value of statistics. Although most holders of honours and post-graduate degrees are finding employment at present, it is

likely that the problem of finding suitable careers may become serious unless more industrial concerns and business houses employ statisticians or more educational institutions open courses of study. Professor Q.M. Hussain is of the opinion that instead of appointing men with degrees in economics, commerce or mathematics having only a smattering of statistics to government statistical posts, trained statisticians with good university degrees should be employed.

ORGANIZATION OF TEACHING

Requirements for Admission

For admission to the B.A./B.Sc. honours courses in statistics at Lahore or Dacca a student should have passed the intermediate examination, securing high marks in the science subjects, one of which should be mathematics. For admission to the pass course also, mathematics in the intermediate is a prerequisite. In other undergraduate courses in statistics, preference is given to those having a knowledge of mathematics.

The M.A./M.Sc. course in statistics is open to honours graduates in statistics or mathematics. An honours graduate in a science subject such as physics who has taken mathematics and statistics as pass subjects may sometimes be admitted.

Courses in Statistics: Aims, Duration and Content

The B.A. degree curriculum requires statistics to be taken along with mathematics and another science subject. For the pass degree, statistics has the same importance as the other two subjects. The syllabus of the Dacca University comprises the following: descriptive statistics, elements of probability, elements of large sample theory, correlation, regression, analysis of variance and simple applications in economics, education, industry, agriculture and vital statistics.

The syllabus of the Punjab University is similar to the above and is equivalent to two written papers and a practical paper in the final examination as in the Dacca University.

In the honours course at Dacca, statistics forms the main subject and mathematics or any other allied subject has to be taken as a subsidiary. The syllabus covers a wide range of theoretical and applied topics: probability, descriptive statistics, numerical mathematics, sampling distributions, estimation, economic and business statistics, sample surveys, agricultural statistics, genetics, vital and educational statistics.

This course is spread over three years. It corresponds to five

theoretical and three practical papers. The aim of this course appears to be partly academic and partly professional. The honours graduate can proceed to the master's degree with one further year of study, or he may take up statistical work in a junior post.

Unlike the honours at Dacca, the honours degree at Lahore requires only two years and the study of some extra topics in addition to those for the pass degree; these are covered by two theoretical papers and one practical paper.

For the M.Sc. degree, there are courses in mathematical preliminaries, theoretical statistics and a number of applications. The syllabus of the Dacca University is given in the Appendix. At the Lahore University the applied subjects are taught more intensively and a student has an option of choosing from amongst mathematical, economic, vital and agricultural statistics.

The courses given to students of commerce and economics are at an elementary level. For the B.Com. degree the teaching covers graphical and tabular representation, measures of central tendency and dispersion, normal distribution and index numbers. For the honours students in economics, in addition to the above, curve-fitting, time series and demand and supply curves are included in the course.

In the Agricultural Institute, in addition to elementary methods, special topics such as layout of experiments and analysis of experimental data are included. The Teacher's Training College offers a short course on elementary statistics including applications to standardization of scores and reliability and validity of tests.

Methods of Teaching

Lectures are the most important means of imparting instruction at all levels. At Lahore the seminar method is also being tried. Seminars on population studies, national income and on problems of current interest are held very frequently. Tutorial instruction is also reported to be available to the post-graduate students, but it is likely to be rather limited owing to the shortage of teachers.

Practical work with calculating machines is an essential part of the teaching programmes for the bachelor's and master's degree in statistics. At Dacca the time devoted to practical work per week is about one-fourth of the total time devoted to lectures, while at Lahore the proportion is larger. There does not appear to be any practical training with calculators for students in the departments of Economics or Commerce. Laboratory facilities are almost entirely lacking outside the university department of statistics.

The M.Sc. students of statistics at Lahore conduct small sample surveys of their own and thus gain some field experience. They sometimes visit government offices such as the Central Statistical Office.

the State Bank, Planning Board, Railway Headquarters and Board of Economic Enquiry for study of official statistics.

Methods of Testing Competence

Information is not available on the nature of periodical tests for assessing the progress of the students. The university examination for bachelor's and master's degrees in statistics, conducted at the end of the two- or three-year period of study consists of written and practical papers in the proportion of two to one. The M.A./M.Sc. examination of the Dacca University is, however, held in two parts. Part I at the end of the first year and Part II at the end of the second.

The written and practical examinations are supplemented by oral examinations for the three-year honours and the M.Sc. degrees. In partial fulfilment of the requirements of the M.Sc. degree of the Punjab University, a student must submit a dissertation on a chosen topic.

Teachers

The two departments responsible for post-graduate teaching are reported to have qualified staff. The teaching load per teacher appears to be rather high, however, so that little time is available for conducting research. Teaching conditions in the other departments may not be satisfactory, as few teachers have special qualifications in statistics. The shortage of competent teachers of applied statistics is an obstacle to the expansion of statistics teaching in departments of social and biological sciences.

TRAINING

The Institute of Statistics, Punjab University, gives evening courses for the benefit of persons employed in government or elsewhere. The academic requirement is a bachelor's degree. The subjects covered are general statistics, applied statistics, and mathematical or agricultural and vital statistics. There is also practical and field work. The duration is one year. On the basis of an examination, consisting of four papers of which one is practical, a diploma is awarded. Those who cannot find time to go through all the subjects can take classes in general statistics and applied statistics and qualify for a certificate. The institute gives individual training (three to six months) in basic statistics and relevant applications to officers designated by government departments. The recently started Institute of Statistics in

Dacca, with the help of the university, has been giving computer's training courses. For the computer's certificate Part I 25 candidates qualified in 1955, and six in 1954.

The in-service training is very limited in Pakistan. The Central Statistical Office seems to have proposals for in-service training for its junior technical staff.

RESEARCH

The Institute of Statistics, Lahore, and the University of Dacca have some facilities for research work, but information on the number of research students, their lines of work and the conditions of award of research degrees is not available.

Through its periodical conferences, the Pakistan Statistical Association brings together university teachers and statisticians working in difficult fields for discussion of statistical problems and presentation of research papers, thus stimulating research and general interest in statistics.

CONCLUSIONS

At the university and college levels, the present facilities for statistical education in Pakistan may be considered fairly satisfactory and there are encouraging signs of expansion in the next few years. The Institute of Statistics, Lahore, has plans to develop project work (sample surveys and planning) and set up machine tabulation units, thus providing better training facilities. There are proposals in the Dacca University for introducing statistics in the undergraduate courses of the affiliated colleges and for instituting a degree course with two honours subjects—statistics and mathematics. There are also plans to expand the Institute of Statistics in East Pakistan.

Advanced courses in all the universities are urgently needed, as are improved facilities for research at Lahore and Dacca. This would require highly competent staff, well-equipped libraries and laboratories.

In regard to ancillary courses for students of psychology, education, engineering, medicine and agriculture, very little has been done yet owing partly to lack of recognition of the value of statistics, and partly to lack of qualified staff. Economics and commerce should also introduce courses at intermediate level, including in them the requisite mathematics.

The present statistical teaching in colleges and universities is sometimes criticized as not suitable for work in government agencies.

Without giving up the educational or scholastic objectives of university teaching, some orientation of the courses may be necessary to make them more realistic and enable the students to get more practical training on live problems. This is particularly important because, in Pakistan, as the statistical offices or units have been newly set up, on-the job training may not be possible or effective.

There are a large number of persons working in government offices who need statistics in their work. Except in Lahore, they have no means of studying statistics. More evening courses in the larger towns may have to be organized either by the universities or by the Pakistan Statistical Association. Persons in business and industry will also benefit by such courses.

APPENDIX

Syllabus for the M.A./M.Sc. degree of the University of Dacca

PART I

Theoretical Paper I

Mathematical preliminaries. Elementary properties of determinants and matrices— theory of n-vectors. Linear and orthogonal transformations. Elementary properties of n-dimensional geometry—volume of n-dimensional sphere. Beta and gamma functions. Elements of real and complex variables. Contour integration. Galois fields, EG and PG.

Numerical mathematics. Accuracy of approximate calculations. Interpolation, forward, backward and central difference formulae, inverse interpolation, double interpolation. Numerical differentiation and integration with errors. Simpson's, Weddle's and trapesoidal rule. Euler-Maclaurin's formula. Stirling's approximation to the factorial. Numerical solution of algebraic and transcendental equations, method of iteration, Newton-Raphson method, Graeffe's root-squaring method. Numerical solution of differential equations. Fourier's theorem. Harmonic analysis of empirical functions.

Descriptive statistics. Various kinds of statistical data. Summarization, tabulation and representation of such data by tables, graphs and charts. Elementary ideas of statistical populations, random samples. Frequency distributions. Measures of central tendency. Dispersion, skewness and kurtosis. Binomial Poisson and normal curves of probability. Probability integral table and its uses. Curve fitting: method of moments, least squares and maximum likelihood. Pearsonian and Gram-Charlier system of curves. Contingency tables, measures of association. Simple correlation and regression. Bivariate normal distribution and its properties. Curvilinear regression, correlation ratio, rank correlation, m-ranking. Multivariate data, multiple regression and correlation. Partial correlation. Grade correlation

Theoretical Paper II

Probability. Basic ideas and measurement of probability. The laws of compound and total probability. Inverse probability. Transition from binomial to normal. Bernoulli's theorem. Mathematical expectation. Law of large numbers with simple applications.

Continuous probability with geometrical applications. Concept of statistical distributions. Calculation of moments and cumulants from given theoretical frequency functions, moment generating and characteristic functions. Statements and uses of inversion theorem. Existence of cumulants. Problem of moments. Statement of central limit tendency theorem (Laplace-Liapounoff). Standard errors of moment statistics. Sheppard's corrections for grouping.

Distributions and estimation. General concept of sampling distributions—analytical method, geometrical method, and method of characteristic functions. The distribution of a linear function of normal variates. Estimation of linear function of parameters. Markoff's theorem. Distribution of mean and standard deviation. The t-distribution. F-distribution. Chi-square distribution. Distribution of correlation coefficients and regression coefficients. Distribution of frequency. Chi-square and its multifarious uses: contingency tables and tests of independence. Tests of goodness of fit. Distributions of medians and percantiles. Uses of t- and F-distributions. The z-transformation of correlation coefficients.

Theoretical Paper III

Economic statistics. Analysis of time series: secular trend, seasonal fluctuations, periodogram analysis, harmonic curve fitting. Correlation of time series lag and serial correlation. Methods of business forecasting. Price changes, index number of retail and wholesale prices, index number of volume, index of wages and cost of living. Family budget inquiry. Engel's law. National income: Bowley Robertson Committee Report. Distribution of income and wealth, Lorentz curve, Pareto curve, acquaintance with current official statistics of Pakistan and India. Critical study of some of them.

Agricultural statistics. Design of field experiments. Randomization. Replication and local control. Randomized block design. Latin squares: use and analysis of balanced incomplete blocks. Missing plot technique. Factorial designs (2^m) and (3^m). Confounding, partial confounding and balancing. Split plot and strip arrangements.

Sample survey. Preliminary notions of sampling. Different types of sampling procedures and their analysis. Purposive selection, random sampling, collection of primary data. Enumeration errors and their effects on estimate and precision. Preparation of forms. Bias in sampling. Crop forecasting. General principles. Validity and precision of estimates. Increasing precision for a fixed amount of labour. Pre-survey test. Choice of sampling unit (structure, size and shape), optimum size of plot for fixed amount of information per unit of cost. Double sampling and its various uses. Organization of enumeration work and statistical analysis of large scale survey. Method of checking and controlling enumeration errors. Critical study of a few sample survey reports.

PART II

Theoretical Paper I

Mathematical theory of statistics. (a) Theory of point estimation and information. (b) Theory of confidence intervals. (c) Theory of fiducial limits. (d) Theory of testing of hypotheses and some common tests of significance. Standard errors of statistics, transformation of variates to avoid nuisance parameters. Limiting theorems (statement only) with applications.

Theoretical Paper II

Sampling distribution. Multivariate normal distribution and its properties, critical angles between two flats and their invariance properties. Distribution of multiple and partial correlation coefficients. Distribution of multiple and correlation coefficients of the second kind, Wishart's distribution and Hotelling's T-distribution. Classical D^2-statistical discriminatory analysis.

Design and analysis. Analysis of variance and covariance and its application to field experiments. Construction of orthogonal latin squares and balanced and partially balanced incomplete block designs. Use and analysis of the important designs. Factorial experiments. Confounding, partial confounding and their uses. Detailed study of 2^3, 2^4, 2^5, 3^2, 3^3, 3^4 designs. Missing and mixed up yields; split plot experiments.

Theoretical Paper III (Group A and any two groups of B, C and D)

A. Economic statistics and social surveys. Utility and indifference curves, Linear preference scales, laws of demand and supply, Demand curves from time series and family budget data. National income and Social accounting. Theory of Index numbers, Index of business activity. Time series, trends, different systems of weights, Seasonal fluctuations. Tests of seasonals, Autoregressive schemes, Periodogram and correlogram analysis. Tests of periodograms, Harmonic analysis. Official Statistics: Discussion of Current Official Statistics.

B. Advanced genetics. Cell divisions and formations, Chromosomal Inheritance, Autosomal Inheritance, Mendelian laws, Detection of linkage, Disturbed Segregations. Human Genetics: Sib method and proband method, Blood groups.

C. Statistical mechanics. Methods of Statistical Mechanics: Classical mechanics, and Thermodynamics. Generalized Co-ordinates and velocities. Canonical form of equations of motion, Statistical ensembles; Phase Space; Liouville's Theorem. Application to molecular systems; x-weight and r-weight, Maxwell Boltzmann distribution law, Average values of velocity; Number of collisions; Mean free path; Equipartition law and specific heat; Elements of Quantum Theory; Simple rotator; Correspondence principle; Harmonic oscillator; Bose-Einstein Statistics. Statistical mechanics and Thermodynamics; Entropy and probability.

D. Quality control. Quality control in industry, Sampling problems in industry, Control charts, Performance tests and Indices of quality, Sampling inspection plan, Single sampling, Double sampling, Sequential tests and Inspection plan for continuous production.

POLAND[1]

FACILITIES FOR TEACHING

Teaching Centres

Courses in statistics are provided in Poland in higher educational establishments and in vocational secondary schools.

Higher statistical training is provided by: (a) the academics of economics at Warsaw, Lodz, Czestochowa, Cracow, Stalinogrod,

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1. Based on an original paper by Bokdan Sculc entitled 'The Teaching of Statistics in Poland'.

Wroclaw, Poznan and Sopot; (b) the law faculties of the universities of Warsaw, Lodz, Wroclaw, Poznan, Cracow and Lublin; (c) the faculty of political economy at the University of Warsaw; (d) the faculties of science at the universities of Warsaw and Wroclaw; (e) the academies of agriculture at Warsaw, Cracow, Lublin, Olsztyn, Poznan and Wroclaw; (f) the economic department of the Higher Technical School of Warsaw.

Statistics is an extra subject in the vocational secondary schools of economics, except in 12 schools specializing in this subject, which provide training for the staff of the territorial agencies of the Central Statistical Office and the statistical and planning services of large enterprises.

ORGANIZATION OF TEACHING

Courses: Aims, Duration and Curriculum

In the academies of economics, courses in statistics are taken during the first two years of study. The curriculum is the same in all faculties and all departments.

During the first year, the theory of statistics is studied, and in particular the following subjects: the rudiments of statistics, collation and presentation of statistical data, analysis of frequency series, analysis of correlations, analysis of time series and index numbers, sampling method and history of statistics. The total is about 50 to 70 hours of class instruction and the same amount of time for practical work. The textbook generally used is Stefan Szulc's *Metody statystyczne*, which is roughly comparable with the work by F. E. Croxton and D. Cowden, *Applied General Statistics*, but deals more briefly with the theory of probability and its applications. The practical work covers statistical technique and the interpretation of the results of calculations.

During the second year, the teaching deals with economic statistics. and, in particular, with the following subjects: organization of statistics in Poland, population statistics, statistics of the means of production, production statistics, labour and wages statistics, statistics of production costs, transport and trade statistics, statistics of national income, statistical analysis of the living conditions of the population, statistics of investment and national accounting. The total is about 50 to 70 hours of class instruction and the same amount of time for practical work. The course more or less follows A. Gozulov's handbook, *Ekonomiceskaja statistika*, Moscow, 1953.

The same curriculum is laid down for outside students, 200 to 300 of whom obtain the diploma of the academies of economics each year.

143

Out of 3,000 resident students who graduate from these academies every year, about fifty specialize in statistics and take further training. This specialized training is available only at the Academy of Planning and Statistics in Warsaw.

In addition to the general courses mentioned above, students specializing in statistics at this academy are obliged to take special courses which differ according to whether the student has chosen economic statistics or mathematical statistics as applied to economic research.

In general, about thirty students choose economic statistics and are required to take the following special courses: statistical technique, demography, elements of mathematical statistics, and history of statistics. In addition, they have to take 30 hours of class instruction and 50 hours of seminar work on one of the following subjects chosen by the student: population statistics, industrial statistics, commercial statistics, agricultural statistics, or transport statistics. During the seminar period, that is, during the sixth and seventh semesters of the course, the students do three months' practical professional work and prepare a thesis for their diploma.

Students who choose mathematical statistics as applied to economic research are obliged to take the following special courses: theory of probability, mathematical statistics, sampling method, planning of experiments and statistical quality control. The courses on the theory of probability and on mathematical statistics generally follow the handbook by J. Dunin Borkowski and N. Smirnov, *Theoria verojatnostej i matematiceskaja statistika v tehnike*, Obščaja čast, Moscow 1945, which is broadly comparable with P. Hoel's *Introduction to Mathematical Statistics*. The course on the sampling method corresponds roughly to W. Cochran's book on *Sampling Techniques*, New York, 1853; and the course on planning of experiments to that by C. Goulden on *Methods of Statistical Analysis*, New York, 1952. The course on quality control by statistics follows J. Oderfeld's handbook, *Zarys statystycznej kontroli jakosci*, Warsaw, 1954, which is broadly comparable with A. Duncan's work, *Quality Control and Industrial Statistics*, Chicago, 1952. During the seminar period the students do three months' practical professional work and prepare a thesis for their diploma.

In the law faculties of the universities, the study of statistics is not compulsory. The courses take up 20 hours in the fifth semester and constitute an encyclopaedic summary of the theory of statistics and of judicial and criminal statistics.

At the Faculty of Political Economy of the University of Warsaw, which awards 30 to 60 diplomas a year, the statistics courses are almost the same as the general courses at the academies of economics mentioned above.

In the faculties of science of the universities, special courses on the use of mathematics in statistics enable students to specialize in this field after five semesters of general mathematical studies. The special syllabus includes the following subjects: theory of probability, mathematical statistics, stochastic processes, industrial applications of mathematical statistics, and applications of mathematical statistics to experimental agriculture. The students, 10 to 20 of whom are awarded diplomas every year, must also attend the seminar on mathematical statistics (90 hours).

In the faculties of agriculture, zootechny and horticulture of the academies of agriculture, 30 hours of class instruction and 30 hours of practical work are devoted to the 'method of experimentation with the elements of mathematical statistics'. In addition, general statistics and agricultural statistics are taught at the Faculty of Agricultural Economy of the Academy of Agriculture in Warsaw; 70 hours of class instruction and 60 hours of practical work are devoted to these subjects during the sixth, eighth and ninth semesters.

At the Higher Technical School in Warsaw, statistics is taught in the economic department of the Faculty of Technology. The subjects in the syllabus are: statistical theory: elementary methods of analysis, introduction to the theory of probability, elements of the theory of distributions, introduction to the method of estimation and to the theory of statistical hypotheses; industrial statistics: its organization in Poland and in other countries, elementary methods of analysing important economic phenomena occurring in industrial undertakings; statistical quality control (same syllabus as in the academies of economics).

In the other faculties and departments of the higher technical schools there are not even optional courses on mathematical statistics, and more particularly quality control by statistics and the analysis of variance; this is a shortcoming which must be made good as soon as there are enough teachers.

In the vocational secondary schools of economics, the syllabus provides for instruction in the rudiments of statistical theory and economic statistics. Several textbooks have been published for the use of these schools. As was stated above, 12 of them specialize in the teaching of statistics and, between 1953 and 1955, trained about a thousand students. But there is now a tendency to consider even elementary statistical problems as too advanced for students of 14 to 17 years of age. A change in the form of these specialized schools is therefore being considered.

Teaching Staff

There are still not enough teachers of statistics in Poland.

The eight chairs of statistics in the academies of economics employ a total of 20 scientific workers (professors, lecturers and assistant lecturers) and 35 auxiliary scientific workers (tutors, assistants and technical assistants). The faculties of law of Cracow and Lublin, the academies of agriculture of Cracow and Poznan, and the Higher Technical School of Warsaw, call on the services of teachers from the local academies of economics, who thus hold several teaching posts at the same time.

The chairs of statistics in the law faculties of the universities of Warsaw, Lodz, Wroclaw and Poznan employ four scientific workers and two auxiliary scientific workers.

The Faculty of Political Economy in Warsaw has a chair of statistics.

The faculties of science of the universities of Warsaw and Wroclaw each have a chair of statistics and employ four scientific workers and five auxiliary scientific workers. The Academy of Agriculture in Warsaw has two chairs of statistics, while the academies of Lublin, Olsztyn, Poznan, and Wroclaw each have one. Together, these academies employ five scientific workers and 11 auxiliary scientific workers.

Professional Training

As was stated above, practical professional training in statistics is available only at the Academy of Planning and Statistics in Warsaw, for students who wish to specialize in statistics.

Training for the staff of the statistical and planning services is provided in professional training courses which often consist of class instruction and practical work on the elements of statistics. These courses are organized, according to the needs of the services, by the Statistical Section of the Polish Society of Political Economy or by the principal institutions whose staff require training in this field, for example, the Central Statistical Office. No precise data on the syllabus of these courses and the number of persons who take them are available.

CONCLUSIONS—PRESENT TRENDS

Though instruction in statistics is provided in Poland by many higher and secondary educational establishments, only a few of them are able to give specialized training in this subject. It is now planned

to extend statistical training so far as the number of teachers will permit. In particular, the organization of courses in mathematical statistics in all the higher technical schools is advocated. Moreover, according to the plans for reform now under discussion, the special courses in economic statistics at the Academy of Planning and Statistics in Warsaw would in future include specialized courses in such subjects as national income statistics, productivity statistics, etc., while the broad general courses in economic statistics would be cut down.

As regards secondary education, the general opinion is that the difficulty of this subject makes it unsuitable for that level of education. The vocational schools specializing in statistics teaching may very shortly be replaced by continuation schools which would provide evening courses for the staff of the statistical services.

SPAIN[1]

FACILITIES FOR TEACHING

Historical Review

The teaching of statistics in Spain began more than a century ago. In 1844, the Economic Society in Madrid instituted a course in statistics under the charge of Jose Maria Ibanez, a member of the society and secretary of the Statistical Commission set up by the Royal Decree of 21 August 1843. The first course was attended by 38 students, the tuition being based on a manual of elementary statistics prepared by Mr. Ibañez. This course continued for several years. It is uncertain whether the courses were open to the public like similar courses in economic administration, as desired by the sponsors. Towards the year 1933, a chair of statistics was established in the Faculty of Science of the Central University. Later in 1942, the Statistics Bill was introduced with the aim of creating an official school of statistics but this school, for some reason or the other, did not come into existence. A number of special courses given during

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1. Based on an original paper by M. J. Ros Jimeno entitled 'Report on the Teaching of Statistics in Spain'.

147

recent years at the University of Madrid and the National Institute of Statistics created a certain amount of interest in statistical teaching. A Decree dated 11 January 1952 was issued empowering the Ministry of Education to introduce instruction in statistics in the University of Madrid.

Through an Act of 31 December 1945 evidence had already been given of the interest taken by the State in providing for statistical services and in training the necessary staff for the establishment of statistical bodies. Much attention had therefore to be given to the problem of teacher training so as to ensure adequately trained statisticians to meet later demands. To meet the situation in general, by an Order of 31 January 1952, a School of Statistics at the University of Madrid was established for the purpose of promoting statistical research, teaching and practical applications. The administration of the School of Statistics is entrusted to the governing body of the University of Madrid assisted by a board of advisers comprising the director of the School, a representative of the National Institute of Statistics and several professors of the university. The board of advisers submits to the Ministry the syllabus and the proposed list of teachers for the various subjects for each academic year.

Centres of Teaching, Degrees and Diplomas

The School of Statistics awards a certificate of statistical studies and a diploma in statistics. Statistics is taught in the different faculties of the university along with other subjects, such as in the Faculty of Science (mathematics), Faculty of Political Science (economics and commerce) and Faculty of Philosophy and Letters, special School of Forestry Engineering, special School of Industrial Engineering, special School of Agro-economic Engineering, School of Commerce, School of Journalism and the Institute of Political Studies. Since the school year 1953–54, elements of statistics have been included in the mathematics curriculae for the school leaving certificate.

ORGANIZATION OF TEACHING

Requirements for Admission

To obtain the certificate of statistical studies at the School of Statistics, a candidate must hold a school leaving certificate or have qualified as a schoolteacher, an agricultural or industrial expert, a civil engineering assistant or should have a similar professional qualification. To obtain the diploma in statistics, one must hold a university degree or have qualified as an engineer, architect, actuary or char-

tered accountant. The certificate and the diploma courses may be pursued simultaneously, subject to certain conditions laid down in the school regulations.

Courses in Statistics: Aims, Duration and Content

The syllabus of the School of Statistics covers an intermediate course, a diploma in general statistics and a diploma in mathematical statistics. The syllabus for the intermediate course consists of general mathematics, compilation of statistics, general statistical methods and three courses in applied statistics, viz., population statistics, application of statistics in industry and application of statistics in education and psychology. These courses last one year. The diploma course is of two years' duration. For the diploma in general statistics, during the first year, mathematics, general statistics, statistical methods, and applied courses in industrial statistics, population statistics, sampling techniques, econometrics and education and psychology are included. During the second year, mathematics, mathematical statistics, statistical methods and a course of applied statistics are given. During these years, the student produces a piece of work combining theory and practice, under the supervision of a teacher. For the diploma in mathematical statistics, during the first year, mathematics, mathematical statistics and statistical methods and two courses in applied statistics are given. During the second year, mathematical statistics covering theory of probability and theory of inference, statistical methods and two courses in applied statistics are given. The students submit theses prepared under the supervision of a teacher. The standard of the above courses is approximately equivalent to that in such as textbooks *Applied General Statistics* by F.E. Croxton and D.J. Cowden, *Statistical Methods* by F.C. Mills, *Elementary Statistical Methods* by S.S.Wilks, *Introduction to the Theory of Probability and Applications* by W. Feller, *Mathematical Methods of Statistics* by H. Cramer, *Tratado de Estadística* by O.F. Banos, *Introducción a los Metodos estadísticos* by S. Ríos, etc.

Apart from these courses, statistics is taught as part of the courses in mathematics in the Faculty of Science. During the third year a compulsory course is given in the theory of probability and mathematical statistics and during the fourth year an optional course in mathematical statistics. The syllabus includes frequency distributions, concepts of probability, sampling, estimation and tests of hypothesis, design of experiments, stochastic processes, correlation analysis. Mathematical statistics includes frequency distributions and other axiomatic systems, convergence in probability, Gaussian processes, Markov's processes, Montecarlo sample methods. Ney-

149

man-Pearson theory. In the Faculty of Political Economy and Commercial Studies, there is a third-year course in theory of statistics and a fourth-year course in statistical methods and econometrics and in the actuarial section, actuarial statistics. The syllabus for these generally includes frequency distributions, correlation theory, time series, index numbers, elementary probability and sampling distributions, statistical inference and quality control. In the Faculty of Philosophy and Arts, the syllabus on technique of educational research includes statistical topics such as frequency distributions, correlation and factor analysis.

In the Special School of Forestry Engineering, statistics is taught in the fifth year, covering probability, tests of hypothesis, correlation and experimental designs. In the Special School of Industrial Engineering, two courses are given—one on fundamental statistics in the fourth year and one on advanced statistics in the sixth year. In the Special School of Agricultural Engineering, theory of probability and statistics is taught in the fifth year. In the School of Commerce, economic statistics is taught in the fifth year for the professional certificate and mathematical statistics in the third year for the teachers' diploma. The School of Journalism teaches statistical documentation. In the Institute of Political Studies, during the second year of the psychology course, elements of statistics are taught. Statistics is taught in the fourth, fifth and sixth years for mathematical papers for the *bachillerato* (school leaving certificate). The subjects taught cover graphical presentation, mathematical averages, concept of probability, notions of dispersion, simple correlation and distribution curves. The course is designed just to initiate the student to the statistical way of thinking and instruction is not carried beyond demonstrating simple results in statistics.

CONCLUSION

The teaching of statistics in Spain, which started about a century ago, follows a centralized system. Besides providing for professional certificates and diplomas, statistics is taught along with many other subjects in the university and other specialized institutions. One remarkable feature is the introduction of statistics at the secondary school stage. There however appears to be no separate course leading to a degree in statistics.

SWEDEN[1]

FACILITIES FOR TEACHING

Teaching Centres: Degrees and Diplomas in Statistics

Statistics is a well-developed subject of study in the universities and special schools of Sweden. It is included as an independent examination subject in the teaching programme of the universities of Uppsala, Lund, Gothenburg and the Stockholm University College. These institutions also provide courses in elementary statistical methods (generally obligatory) to students of sociology, psychology and pedagogics. Statistics is also taught at the Stockholm School of Economics and the Gothenburg School of Economics. Applications of statistical methods to social sciences are included in the courses at the social institutes at Lund and Gothenburg. These courses in statistics are obligatory only for the master's degree.

The importance of statistics in technology and engineering is recognized in Sweden and compulsory courses are given at Stockholm Technical University and the Chalmers Technical College at Gothenburg. The Royal Agricultural College, Ultuna, provides teaching of statistical methods as applied to agriculture, genetics and agricultural economics.

The first degree is the *Filosofie Kandidat* corresponding to the B.A. degree. The examination for this degree requires a combination of subjects making up six units; two units must be taken in each of two subjects. The period generally required for the first degree is three or four years. The next degree is the *Filosophie Licentiat* in statistics, which is slightly higher than the M.Sc. degree in standard. This requires about three years of specialization. After this a student may continue his work on a doctor's thesis. The *Filosophie Doctorat*, which is higher in standard than the Ph.D. degree, is conferred after publication of the thesis and its successful defence. The requirements for a doctor's degree in Sweden are high; the dissertation usually takes a long time to prepare and is presented after several years of work as a statistician.

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1. Based on original papers by H. Wold, assisted by A. Rand ('Instruction in Statistics in Sweden') and by H. Wold ('Supplementary Information to the Report on Instruction in Statistics in Sweden').

Careers for Statisticians

The field for employment of statisticians is fairly large in Sweden. Of the students who have majored in statistics, about 90 per cent have found employment in various civil service departments. The remainder have continued their studies or have gone into special assignments.

ORGANIZATION OF TEACHING

Requirements for Admission

Entry into the universities and special schools in Sweden requires the university matriculation examination and a fairly high standard of mathematics. For the *Licentiat* degree, a candidate must first have taken the first degree of *Kandidat*.

Courses in Statistics: Aims, Duration and Content

Professor H. Wold refers in his report to the differentiation in levels of teaching statistics, with respect to aims. He says: 'Basic teaching in statistics is intended to carry a general orientation in statistical methods of approach, directed primarily towards the critical scrutiny of statistical raw material and subsequent derivation of numerical values and conclusions and, in addition, towards training in elementary statistical methods. Teaching at the higher level aims at providing a very comprehensive picture and deeper understanding of statistical problems and their applications, the principal purpose being to enable the student to apply, unaided, the statistical method of approach to a concrete problem.'

With these aims in view, two courses have been planned: (a) statistics from a sociological point of view (mainly designed for those who study statistics in conjunction with other sociological subjects), and (b) statistics from a scientific point of view (intended for students whose subjects are more closely related to the natural sciences).

In statistics, there are three unit courses, each more advanced than the previous one. A candidate must take at least two units to be able to appear for the *Fil.Kand* examination. There are different types of courses for these units with varying emphasis on sociological, demographic, economic and mathematical statistics. For the *Fil.Kand* degree, it is usual to progress at the rate of one unit certificate per semester (half-year term). Specimen courses in statistics at the university level are given in the Appendix.

Studies at a higher level depend to a great extent on individual

inclination. Advanced courses are given regularly for those quali-
fying for the *Filosofie Licentiat* degree. *Doktorat* candidates also take
special courses in statistics.

The courses in elementary statistics are common for sociology,
psychology and pedagogics, and comprise about 25 periods of
lectures dealing with graphic representation, descriptive statistics,
scatter index, normal distribution, mean error, *t*-test, correlation
index and chi-square method. The aim of these courses for the first
and second units is to enable students in these subjects to become
familiar with the statistical techniques relevant to their work.

There is a basic course in statistics for the economic *Fil.Kand*
degree and there is also a slightly advanced course for those taking
the degree of master of social science. This advanced course com-
prises 20 or 25 periods of lectures and exercises dealing with sampling
methods, testing of hypotheses, confidence limits, application to
market research and S.Q.C. The students participating in the course
at the Stockholm School of Economics generally carry out a market
analysis on a small scale.

The courses at the social institutes of Lund and Gothenburg are
intended to convey general information on the application of sta-
tistical methods to social sciences. The lectures, about 12 to 16,
include elementary statistical theory, population statistics, social
statistics and official statistics.

At the Stockholm Technical University there is a general course of
the level of H. Cramer's *Probability Calculus*. There is a theoretical
course of longer duration corresponding to the level of Hald's *Sta-
tistical Methods*. The Swedish Technical Association in conjunction
with the Department for Actuarial Mathematics and Mathematical
Statistics occasionally arranges courses on such subjects as the plan-
ning of statistical surveys, quality control, etc.

At Chalmers Technical College, there is a course in mathematical
statistics which is obligatory for several sections.

The teaching of statistics at the Agricultural College is intended
to convey a knowledge of statistical principles and working methods
which may be needed for study of genetics, plant growth, general
agricultural theory, agricultural economics, etc. The subject of sta-
tistics can be taken either for the lower or the higher examination,
the former being reckoned as a half certificate. The lower course
comprises 10 periods of lectures and 45 periods of exercises and
deals with general statistical theory and some simpler applications.
The course for one certificate is an amplication of the lower course
and extends over 20 periods of lectures and 70 periods of exercises.
Theory is emphazised and the syllabus includes linear regression and
statistical inference. There is another course of two certificates which
goes deeper into the theoretical basis of statistical working methods.