Statistical Education in Japan

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Editor's Note

The three papers which follow were presented as part of a special session with the above title, organised by Professor Midzuno and his colleagues from the Statistical Association of Japan. In arranging them for publication in the Proceedings, however, we have preferred to group them with the sessions into which they naturally fall.

The first three papers, presented here, give an overview of statistical education in Japanese schools. They are closely thematically linked, follow each other in natural sequence, and have been treated here as three parts of one general paper. Other papers in the session, dealing with more particular topics, will be found in Sessions A3, B1, B2, B3 and C3.

Part I :   A General Picture of Statistical Education in Japan -
Hiroshi Midzuno

Roughly speaking, the system of schools and higher educational institutions is: kindergarten of up to 3 years, primary school of 6 years, junior high school of 3 years, senior high school of 3 years and junior college of 2-3 years or universities of not less than 4 years at the Bachelor's level, at least 2 years at the Master's level and at least 5 years at the Doctoral level. Organisation, standards, teaching staff, textbooks at schools, financing, etc. are all specified in a group of educational laws. Education at the primary schools and the junior high schools is compulsory.

Statistics education is introduced in the curricula of the primary schools. While statistics is not recognised as a separate stream of instruction, the basic statistics education is implemented as part of the arithmetic course while uses of statistics are included in other streams of social and natural science. Although not very elaborate, orderly arrangement of data is included in the coverage of the first grade of primary school. At the second grade, the arrangement and classification of data and presentation of the results in tables and graphs is started, and further developed in the subsequent grades, noting the relationship between data. At the fifth grade, average and ratio are

introduced, while the final sixth grade explicitly aims at developing ability in thinking statistically and representing statistically. There, the course explicitly introduces the notion of dispersion, the possibility of determining an overall tendency from sample data, and the ordered arrangement of theoretically possible cases. Some special activities are frequently organised for practical or experimental projects of a statistical nature.

At the junior high schools, statistical education is a part of mathematics and the actual use of statistics becomes more strengthened in the social sciences. More specifically, at the second grade, the curriculum includes the collection of data, their arrangement and presentation in tables and graphs, use of representative values and dispersion to summarise tendencies in the data, along with the notion of frequency distribution and histograms, averages and ranges, correlation tables and graphs, approximate values, errors etc. The meaning of probability as the basis of sampling is included in the third grade curriculum with a view to deepening statistical understanding and reasoning.

At the senior high schools, statistics is again included in mathematics. The subjects of probability and statistics are included in Mathematics II and they are specifically treated in a section "Probability and Statistics". Recent revision of the Instruction Guide changed this scheme, so that probability is now included in Mathematics I, which is obligatory. More detailed aspects are a part of Mathematics B, and statistical methods are a part of Mathematics C. A detailed account is taken up in Professor Araya's paper (Part III).

At the higher educational institutions, the contents of instruction are not standardised nor monitored and therefore statistical education is quite diversified. Hundreds of texts are in use and a considerable number of new ones appear every year. Surveying of statistical education at the university level was conducted in the past, and last year the Japan Statistics Society conducted a complete survey, collecting descriptions of the education programmes. The result of the survey is still being processed but some findings are reported in the paper by Murakami and Murakami (Session B1).

Before switching to statistics education conducted by bodies other than schools and educational institutions of the ordinary type, reference to the "Hoso Daigaku" or "The University of The Air" may be in order. It carries out education by broadcasting, and registered students who pass the examination are awarded degrees. A separate report on this institution by Hayashi and Midzuno appears in Session C3.

Teaching statistics in the government and in the industrial sector is another field of significance. The Statistics Institute of the General Affairs Agency, which has a history of about 70 years, runs courses regularly to provide special statistical education to the staff of Central and Local Governments. The regular courses last for six months of full-time study. Included are subjects like Descriptive Statistics, Inferential Statistics, Statistical Analysis, Sampling, Statistical Operations, Data Processing, statistics in various subject fields and so forth. Advanced courses take up special subjects and last for a few weeks. Statistics education facilities under the Public Health Institute were well established and provide specialised statistics teaching in that field, but were reorganised recently. Local Training Courses are organised from time to time at different locations by the National Statistical Association, for the staff of government offices.

In the industrial sector, teaching of statistical methods, in particular Quality Control, is important. The Japan Science and Technology Association takes a key role

in organising courses themselves and in assisting the establishment of such courses by the enterprises concerned. In passing, credit for the remarkable progress of Japanese industry in the post-war years has been given to such statistics education in the industrial sector.

The Statistical Institute for Asia and the Pacific (SIAP) is an international organisation sponsored by the member countries of the ESCAP region and carries out specialised statistical training for officials of member countries. As is well-known internationally, no specified account is included in this report. As to statistics education to foreigners, training courses organised under the Colombo plan are another important facility. The Statistics Institute occasionally accepts trainees who can follow teaching in the Japanese language. Naturally, universities receive students from abroad, though the language used is exclusively Japanese, except in some instances.

Statistics education as such is an important concern of universities, primarily for teacher training, but also for some professional societies and associations like the Japan Statistical Society, the Japan Mathematical Education Society, the Mathematics Education Society, and National and Professional Associations of Statistical Education Research. They hold special courses and seminars from time to time and publish regular and occasional materials for teachers, besides carrying out research on statistics education.

The last kind of statistics education is that for the general public. While not intended for statistics education *per se*, the rather common use of statistical notions and methods in connection with the general reporting of economical, sociological and scientific matters, and the publicity campaigns organised for statistical undertakings and so forth, develop statistical concern and the interest of the public and strengthen statistical understanding through the accompanying articles and explanations.

There also exist a variety of special training courses on statistics open to any interested persons, but detailed discussion of these is beyond the scope of this report.

Part II :   On the Development of Statistical Education in Schools - Yoshimasa Ukita

Before the war, statistics was not taught at schools except for the use of statistical notions and figures in some streams. After the war, statistics education was taken up with a high priority and full recognition of the statistical weakness and insufficiency of the society, backed up by a strong push of the Occupational Authorities.

In the post-war curricula for education, statistics was therefore included in all school levels of primary, junior high and senior high. Because of the considerable number of different streams of instruction already included, it was decided not to recognise statistics as an independent stream of instruction but to divide it among various streams especially arithmetic for the primary schools and mathematics for the junior and senior high schools, where mainly notional and procedural aspects were to be handled.

Thus statistical education is prescribed in the Official Instruction Guide, which is the immediate basis of school education in Japan, and is implemented according to that Guide.

Statistics education starts at the lower grade of primary school and continues to higher grades. At the primary schools, statistical terms are not taught but the approaches and methods are. At the junior high schools, statistical education is conducted with terms, definitions, meaning and uses, including basic probability. As mentioned before, they are implemented through various streams of instruction. They come under the coverage of compulsory education.

At the senior high school level, basic elements of the so-called descriptive statistics are included. The place for instruction of standard deviations and the correlation coefficients has changed nearly every time the programme is revised. Fundamentals of probability are also covered. Inferential statistics, in particular, the sampling survey method and an introduction to estimation and testing, is included in the curriculum. Details are given in Part III by Professor Araya and need not be repeated here.

The Official Instruction Guide is revised every 10 years, but the basic nature of statistics education has remained more or less the same, though the detailed aspects show certain changes from one Official Instruction Guide to another. In earlier ones the level was upgraded and the contents were increased, but in the latest revision it appeared lowered and lightened, due to the push to make available less tight timetables and to allow significant time for work with computers.

Statistical education in streams other than arithmetic and mathematics is fairly abundant. The kinds and nature of statistics, however, are not specified in detail, so statistics education in this category may not be very uniform.

In this connection, practical education in statistics that is classified under "special activities" is also being implemented. Early in 1947, a system of "Schools Cooperating in Statistics Education" was voluntarily set up. Noting the need for and interest in statistical subtables and the collection of statistical data on school education and local data, this line of statistics education was widened and strengthened with the back-up of statistical units of municipalities, regional associations of statistics, and later by Education Committees.

In every prefecture, bar a couple of exceptions, an Association of Statistics Education Research was set up, and a number of Schools for Statistics Education were designated. They were further grouped under the National Association of Statistics Education Research. It convenes national and regional conventions regularly and publishes regular and occasional publications supporting statistics education and schools. As the total membership is in the order of some 40,000 it is quite influential.

Part III :   The Statistics Curriculum in the Revised "Official Instruction Guide" - Kensei Araya

1.   Introduction

The Official Instruction Guide (Shido-Yoryo) issued by the Ministry of Education is the basis of school education at primary and junior high school levels, which are compulsory, and at senior high school level, which is not compulsory but nonetheless covers almost the whole population. It provides the frame of school education in regard to its extent, contents and methods. It is prepared for each course at each level. It is reviewed and revised every 10 years, and was last revised in 1989.

The Ministry has 13 advisory councils. The Central Council for Education is the highest advisory organ to the Minister and concerns itself with those problems related to fundamental policies for education, submitted to it by the Ministry. The concerns of the other councils are indicated by their titles as Curriculum, Health and Physical Education, Science, Social Education, etc.

The Official Instruction Guide is written on the basis of recommendations from the Curriculum Advisory Council, which pays much attention to current trends, to the situation of school education, and also to the actual problems of realising the policies of the Central Council. We survey the main frame of the report.

2.   Main frame of the report by the Curriculum Advisory Council

The report mainly treats two problems. One is improving the standard of the education curriculum, and the other is the actual conditions for realising the improvement. In view of our research, we will only take up the former problem, as set out in the following six headings:

(i)   The objectives of the improvement of the course of study:
  (a)   to bring up persons so that they can fully develop their humanity and can live with a brave spirit;
  (b)   to help a child develop his or her own willingness to learn and ability to actively respond to social changes;
  (c)   to evaluate the importance of the fundamental and basic knowledge required for a citizen and to promote the education for developing individuality;
  (d)   to cultivate the mind to promote international understanding and, at the same time, to respect the culture and tradition of Japan.
(ii)   The composition of the course of study:
  (a)   the domain of the course of study;
  (b)   the composition of each subject and curriculum.
(iii)   The total teaching hours:
  (a)   the total education hours for kindergarten;
  (b)   the annual school hours for primary school;
  (c)   the annual school hours for junior high school;
  (d)   the number of subjects and their total credits required to graduate from senior high school, including obligatory and elective subjects, and the annual hours for special activities;
  (e)   the definition of one teaching unit in primary school, and in junior and senior high school.
(iv)   The contents of the subject and curriculum:
  (a)   the common improvement of each subject and curriculum;
  (b)   the individual improvement of each subject and curriculum.
(v)   Six years high school and the credit oriented high school.
(vi)   Part-time courses and correspondence course education.

3. Statistics-related topics in the course of study issued by the Ministry of Education, revised in 1989

3.1 *Primary school*

Learning of statistics-related topics is included in arithmetic from the 3rd year through 6th year. The aims and contents of learning in each year are stated as follows:

3rd year
Aim: To train pupils to be able to arrange the numerical data and use arithmetic formula and graphs, to realise their usefulness, and to enable them gradually to examine and express quantitative relations.
Contents: To train pupils to understand and express data in tables and graphs: (a) to classify data from the point of date, time and places and arrange them in a table; (b) to learn to read and write bar charts.

4th year
Aim: To enable pupils to understand and express quantitative relations in arithmetic formulae and to examine their dependence relations and to learn the arrangement and classification of them for the purpose.
Contents: To develop the ability to collect relevant data and classify and arrange them to find out characteristics of interest: (a) to examine jointly occurring events; (b) to examine lack and overlap in data; (c) to express data in line graphs and examine their characteristics and tendencies.

5th year
Aim: To enable pupils to write formulae using letters and to examine the relations between the quantities expressed in formulae, and to enable them to consider statistical data, applying percentage and circle graphs.
Contents: To classify and arrange data appropriately and express them in circle graphs and belt charts.

6th year
Aim: To understand the notion of a function with operating proportions and apply it to understand the quantitative relations. To develop statistical understanding and techniques through studying distributions of data.
Contents: To develop statistical skills and understanding through observing the scatter diagram in simple examples: (a) to learn the tables and histograms of frequency distributions; (b) to learn how to infer the total tendencies by combining the proportions found from parts of the data; (c) to select an appropriate type of table or graph, or make up a more suitable one. To be gradually able to order and count possible outcomes of simple events.

3.2 *Junior high school*

Statistics-related problems are taught in the mathematics course in junior high school through 1st to 3rd year. Aims and contents of learning in each year are stated as

follows:

1st year

Aim: To deepen the knowledge of quantitative change and mathematical correspondence, and develop the ability to understand and apply functional relations.

Content: To deepen the understanding of proportion and inverse proportion with formulae and graphs, and develop the ability to examine and express quantitative relations.

2nd year

Aim: To further extend the knowledge of quantitative changes and mathematical correspondence, and develop the ability to understand the characteristics of linear functions and apply them. To learn to express the numerical relations with appropriate precision and to find out the general tendencies of stochastic occurrences.

Content: To collect data for a given purpose, and arrange them in a frequency table or a histogram, and to understand the general features of the given data from the characteristics and distribution of the data: (a) understanding of frequency distribution and histogram; (b) meaning of relative frequency; (c) meaning of mean and range; (d) understanding of correlation diagram and correlation table.

3rd year

Aim: To further develop the ability to explain and apply functional relations, and deepen the understanding of the function and its characteristics, as well as to understand the meaning of probability and basics of sample surveys, and deepen the ideas and techniques of statistics.

Content: To recognise the idea of frequency through observations of many trials, then to get a general concept of probability: (a) uncertain events and probability; (b) to calculate probability of simple cases. To appreciate the possibility of inferring characteristics of the population from characteristics of the sample.

3.3 *Senior high school*

In the senior high school curriculum, statistics-related topics are taught in the subject "Mathematics". It is divided into six subjects, namely Mathematics 1, 2 and 3, and Mathematics A, B and C. The teaching of statistics is included in Mathematics 1 (compulsory) and Mathematics B and C (both elective).

Mathematics 1

Aim: To enable students to understand quadratic function, graphs and calculation, arrangement of events, and probability, by observing concrete events. To master the basic knowledge and skills in order to apply them correctly. In addition, to make students appreciate the value of mathematical skills.

Content: (a) quadratic function; (b) graphs and calculation; (c) arrangement of events (principles of counting (principle of exhaustion); sequences of numbers; number of events, permutations and combinations); (d) probability (probability and its basic principles; independent trials and probability; expectation).

Mathematics B

Aim: To enable students to understand vectors, complex numbers and complex plane, probability distributions, computer algorithms, and to master the basic knowledge and skills so as to develop the ability to formulate problems mathematically.

Content: (a) vectors; (b) complex numbers and complex plane; (c) probability distributions (calculation of probability; random variables and probability distributions, binomial distribution); (d) computer algorithm.

Mathematics C

Aim: To enable students to understand, with the aid of computers, matrix and linear calculation, various kinds of curves, numerical calculation and statistical procedure, and to master the basic knowledge and skills in order to develop the ability to examine and treat problems from a viewpoint of applied mathematics.

Content: (a) matrix and linear calculation; (b) various curves; (c) numerical calculation; (d) statistical procedure (arrangement of statistical data, characteristics and measures of scatter, correlation; stochastic inference, population and sample, normal distribution, statistical inference).