

THE STOCHASTICS CURRICULUM IN PRIMARY AND SECONDARY EDUCATION IN SPAIN

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In this paper, we describe the Spanish stochastic curriculum (Probability and Statistics) for compulsory and optional education. We summarise the objectives, learning contents (conceptual, procedural and attitudinal contents), and evaluation criteria. Brief comments are also made.

INTRODUCTION

Statistics is a science of wide and increasing use in the current world, social media and numerous sciences. Consequently, society requires an adequate statistics training for all its citizen, from their educational institutions, that is, statistics for all the citizens (Jacobsen, 1991).

There has been a pressing need for the inclusion of statistical contents in the curriculum from elementary educational levels in the last few years in many countries, including, Spain.

Statistical contents were not included in Primary Education in the Spanish curriculum until 1992. Statistical contents were only recommended in secondary education, where descriptive statistics was introduced in the seventh year of E.G.B. (Basic General Education, 13 year-old students). There was another unit on statistics and probability in the first year of B.U.P. (secondary education, 15 year-old students) and another unit on probability and correlation in the third year of B.U.P. (17 year-old students). The topic was completed with several units in the last year of secondary education (pre-university education, 18 year-old students). In Spain, a reform of this primary and secondary education has taken place since 1992.

THE SPANISH EDUCATIONAL SYSTEM

The Spanish educational system is organised in four levels: Pre-school Education (0 to 5 year-old pupils), Primary Education (6 to 11 year-old pupils), compulsory Secondary Education (12 to 16 year-old students), and optional Secondary Education (17 to 18 year-old students). Consequently, the compulsory Education of system includes children from ages 0 to 16 . The Spanish educational system is regulated by the LOGSE,

(Ley de Ordenación General del Sistema Educativo (LOGSE) -published in 1990 -). This law establishes minimal curricular requirements for each stage, compulsory for all the Spanish territory, and involving from 55% to 65% of available school time). The content of the remaining school time is determined by the educational administrations of Spanish regional Communities, such as Andalucía. In this LOGSE framework, curriculum means an integrated plan including objectives contents (concepts, procedures, attitudes and values), methods and evaluation criteria. other complementary laws develop the curriculum at each educational level.

PRIMARY EDUCATION

In the Spanish curriculum Stochastics (Probability and Statistics) starts in Primary Education, which is a novelty with regard to previous curriculum, where it began at the age of 13.

The basic learning contents of Primary Education are organised in 4 sections: i) Numbers and operations; ii). Measurement; iii). Geometry and spatial sense; iv). Organising information (data handling).

These four sections have not been given the same weight, as regards the time devoted to their study. However, organising information has an outstanding status within the curriculum.

There are 8 general objectives for Primary Education in the LOGSE, all of which include some reference to stochastics, though this content is more explicit in objective number 6: “*Using elemental techniques of data collection for obtaining information about children’s real world phenomena and problems; graphical and numerical representation of data and making inferences*”).

There are three types of contents in the Spanish curriculum: Conceptual, procedural and attitudinal contents. These are the following contents concerning the Organisation of information in Primary Education: *Conceptual content*: 1. Graphical representation, 2. Frequency tables, 3. Statistical graphics: bar charts, line graphs, histograms etc., 4. Random character of some experiences; *Procedural contents*: 1. Systematic exploration, verbal description and interpretation of meaningful elements in simple tables related to familiar phenomena. 2. Collecting and organising data about familiar objects, phenomena and situations, using elemental sampling, observation, and measurement techniques. 3. Graphical representation of small data sets related to familiar

situations. 4. Using experiments to assign probabilities to events in a simple experiment.

Attitudinal content: 1. Critical attitude to graphical information and willingness to explore its meaningful elements. 2. Appreciating the power of graphical language to represent large data sets. 3. Sensibility about aesthetic qualities of graphics.

The LOGSE establishes 13 evaluation criteria related to data handling, two of which are more specific: 10. Constructing, reading, and interpreting data displays related to pupils' environment. 11. Explore the concept of chance, making estimations on the results of simple random games, and comparing these estimations with experimental results.

COMPULSORY SECONDARY EDUCATION

Ten general objectives of this stage are related to stochastics, though two of them refer more explicitly to it: 5. Using simple techniques of data collection to obtain information about familiar phenomena and situations, graphical and numerical displaying of the information collected, and making inferences about it; 8. Identifying mathematical elements (statistical data, graphs, calculations, etc.) in newspapers, advertising, etc., critical analysis of the functions performed by these elements and their contributions to a better comprehension of the messages.

The contents are organised into five sections: i). Numbers and operations ii). Measurement, and estimation iii). Space representation and organisation; iv). Interpreting, representing and dealing with information; v). Dealing with chance. Sections IV and V include the following stochastics content: *Concepts:* a) Data handling: Central value and dispersion parameters, b) Random phenomena. Relative frequency and probability, c) Conditional probability.

Procedures: a) Interpreting graphs in relation to the problem represented and using adequate vocabulary and symbols; b) Choosing and computing the most adequate parameters to describe a distribution; c) Finding errors in graphs and statistical language; d) Collecting individual and collective data from different sources and resources; e) Interpreting data samples according the population they represent; f) Using different knowledge and techniques for assigning probabilities, g) Using Laplace's rule to compute simple probabilities, h) Finding out usual errors in the interpretation of chance i) Making and checking conjectures about the behaviour of simple random phenomena, j) Using probability to make fundamental decisions in different problems.

Attitudes: a) Appreciate the relevance of new technologies for handling information and graphical representation of data, b) Sensibility, interest and critical assessment of the use of mathematical languages (graphical, statistical etc.) in information and argumentation). Willingness to investigate random phenomena and to use probabilities for decision taking, d) Caution and critical sense with beliefs and biases related to random phenomena and probability.

In general, the objectives of Spanish compulsory education agree with those recommended by Gal and Garfield (1997), for pupils' understanding and dealing with uncertainty, variability and statistics information in the world around them, and for pupils' effective participation in an information-laden society. On the other hand, the Spanish curriculum shows the influences emerging nowadays in the teaching of statistics: relevance in the curriculum, using of mathematical procedures and adopting constructivism as a learning model (Begg, 1997). Furthermore, the incorporation of attitudinal contents implies that teachers should pay greater attention to pupils' attitudes and beliefs which is highly relevant for teaching and learning processes (Gal, Ginsburg and Schau, 1997).

OPTIONAL SECONDARY EDUCATION (Bachillerato).

There are four modalities of Bachillerato (Optional secondary education) in Spain for students aged 17-18: Natural and Medical Sciences; Technology; Humanity and Social Sciences; Arts. Statistics and Probability depend on the modality chosen by the student at this educational level.

Natural and Medical Sciences and Technology

There is some stochastics content in the nine general objectives for Mathematics curriculum in these modalities, though there is no specific objective referred to in the topic.

Contents: Bivariate distributions. Studying the degree of relationship between two variables. Reinforcing the study of compound, conditional and "a posteriori" probabilities. Use of binomial and normal distributions to assign probabilities to events. Fitting a binomial or normal distribution to a data set.

Evaluation criteria: 3 out of 17 evaluation criteria for Mathematics refer to

stochastics: 1. Interpreting probabilities; assigning probabilities to events in simple and compound random experiments, using direct counting, combinatorial resources and elemental properties of probability. 2. Taking decisions about data that fit a binomial or normal probability distribution, with regards the probabilities of related events. 3. Using correlation coefficients and regression lines to evaluate and interpret the strength and type of relationships between two variable in real situations defined through a bivariate distribution

Humanity and Social Sciences

There are 8 general objectives with some stochastics content, though there is no specific objective referred to in this topic.

Contents: Bivariate distributions. Interpreting social and economic phenomena in which two variables intervene from scatter plots. Studying the degree of relationship between two variables. Using binomial and normal probability distributions to assign probabilities to events. Reinforcing the study of compound conditional total and “a posteriori” probability. Using elemental techniques (direct counting, tree graph, ...) to assign probability. Problems related to sampling: representativeness and the conclusions that can be drawn from them.

Evaluation criteria: 6 out of 17 evaluation criteria for this modality include stochastics content: a) Distinguishing whether the relationships between two variables in a bivariate distribution is random or functional and making qualitative conclusions from scatter plots. b) Interpreting the relationships between variables through correlation coefficients and regression lines in real situations described by bivariate distributions; c) Using elemental statistical techniques to compute probabilities and make decisions about situations that fit binomial or normal probability distributions. d) Assigning and interpreting probabilities of simple and compounds random events (dependent or independent), using direct counting, tree graphs or simple calculations. e) Planning and carrying out concrete studies by building questionnaires, selecting samples and analysing data to obtain conclusions, with a given confidence level, about the parameters of the population. f) Critical analysis of statistical reports from media and other areas, finding out possible mistakes and manipulations in the data representation.

Some probability contents (Probability calculus and random variables) are similar

to those in other countries (Nemetz, 1997). The curriculum recommends the use of real data sets and problems. Interpretation and relational capacity is stressed as opposed to mere parameters computation. Furthermore, it is intended that these students relate the new knowledge to concepts learned in the previous educational levels, in addition to being able to use it. This is the basis on which capacities as relevant as abstraction, reasoning, problem solving, investigation, analysis and understanding will be developed.

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