ELEMENTS OF MEANING AND ITS ROLE IN THE INTERACTION WITH A COMPUTATIONAL PROGRAM

Teresita E. Terán and Mercedes Anido de López
Universidad Nacional de Rosario, Argentina
teresitateran@hotmail.com

This paper is part of a research study, the objective of which is to investigate the meaning of confidence intervals for first year students in the Statistics course in the Universidad Nacional de Rosario. Within the framework of Godino's theory (1999), by means of students' dialogues in front of the computer, we try to surmise the presence of the diverse elements of meaning – extensive, ostensive, actuating, intensive and validating – which reveal the topic comprehension. Statistical inference is one of the largest branches of Statistics and a fundamental methodological tool in the empiric sciences, in particular. It allows us to quantify our confidence in conclusions drawn from random samples, and therefore, to verify our impressions by means of calculations (Batanero, 2001); hence, the importance of an updated teaching.

RESEARCH PROBLEM AND THEORETICAL FRAME

Since its beginning, numerous mistakes have been described in the application of statistical inference in research, with its subsequent implications for the validity of the results obtained. Yates (1951), for instance, suggested that scientists devoted too much attention to the results of hypothesis tests on contrasts, avoiding the estimation of the magnitude of the effects they were researching. Numerous research works would indicate that these lacks survive. We could think that this situation is due to an insufficient teaching of the topic although Statistics is a compulsory subject in most degree courses.

In seeking a model to use for the teaching of statistical inference, we adhere to Godino's Model of Mathematical Cognition (1999).

Within this theoretical framework, the mathematical objects, in our case confidence intervals, emerge from the problem resolution activity.

Godino and Batanero (1994) introduce two types of primary entities: significant practices and object meaning, for which they propose two interdependent dimensions: personal and institutional.

A practice is significant for a person or for an institution if it carries out a function in a problem resolution or if it is useful to communicate, validate or extend the solution to other problems.

When constructing meaning and comprehension upon a mathematical object (concept, procedure, proposition, etc.) diverse types of objects take part:

- Problems and situations from which such object arises.
- Expressions of language, graphics, manipulations and any other representations of the object.
- Definitions, properties and relationships with other objects.
- Actions and procedures to solve problems and operate with the object.
- Arguments we give to prove properties or validate solutions to the problems.

Godino and Batanero (1994), define the following types of objects involved in the mathematical activity (and that we will name *types of elements of meaning*) that made their analysis easier:

Extensive: situations problems from which the object (problem-situation, application) arises, the context from where it is induced and to where the Confidence Interval is applied.

Ostensive: material representations used in the mathematical activity (terms, expressions, symbols, tables, graphics); in which, generally, the linguistic/notational entities, for instance, the Confidence Intervals notation, is included as well as the notation of different distributions that are used, the graphics of the density function of such distributions, etc. These ostensive or representative elements can be seen and handle and they have a double function. On one side,

they are useful to evoke the non-observable abstract objects; on the other side, they are used to operate with them (representing the corresponding mathematical objects) and produce applicable results to such objects.

Actuating: procedures and strategies to solve problems (procedures, algorithms, operations), which become evident, for example, by means of diverse procedures that are carried out when a graphical representation of a simulation is performed.

Intensive: characteristic properties and relationships with other entities: definitions, theorems and propositions (concepts, propositions), as for example, the ideas of statistics, parameter, population or sample as regards the confidence intervals.

Validating: types of arguments used to validate propositions (demonstrations, testing, justifications).

DESCRIPTION OF A RESEARCH STAGE

Within the frame of Godino's "Model of Mathematical Cognition," a pluri-methodic research is carried out on the elements of meaning "institutional" and "personal" of the students involved in the Confidence Intervals learning. Both meanings are confronted and an improved didactical course is provided.

One of the phases of this research work studied how the personal meanings achieved by students is related to the analysis of the different meaning elements as solved by computational tools. The data arise from listening the tapes of the students' dialogues during their interaction with the computer.

Following an analysis of such dialogues obtained in a two-hour laboratory related to the Confidence Intervals topic is presented.

- Subject and course: *Biostatistics. 2nd year, Medical Veterinary Career, School of Veterinary Sciences. U.N.R.*
- Year: *First Term – 2005.*
- Time: *A two-hour observation on the topic Confidence Intervals.*
- Place: *Computing Room.*
- Software used: *Program included in the bibliography of the Department based on Excel worksheet.*
- Number of students:
  - *In class: 40 students.*
  - *In magnet-phonic record: 2 students in interaction with the teacher and a computer.*
- Mode: *Observation.*
- Type: *Active participating observation.*
- Criteria used in the observation: The aim is to detect how the different meaning elements that arise from the students' dialogues and of their interaction with the computer are shown.

BRIEF DESCRIPTION OF THE SOFTWARE USED

This software was developed by Prof. Arturo Arango Durán and is based on Microsoft *Excel*. Its aim is to solve the practice proposed in L. Kazmier's book *Statistics Applied to Management and Economy* (1999), although it can also be operated with any set of data available.

The software is made up of 19 files, each of which corresponds to one of the chapters of the book. Chapter 8 refers to the Estimation of Confidence Intervals.

The *Excel* file corresponding to this chapter is made up of 10 work sheets. Either a complete exercise or one of its items can be solved in each of these sheets.

In each of the sheets, those cells in which data can be input are clearly distinguished by a color code. The rest of the cells remain blocked so that the user cannot eliminate any of the formulae or program components.

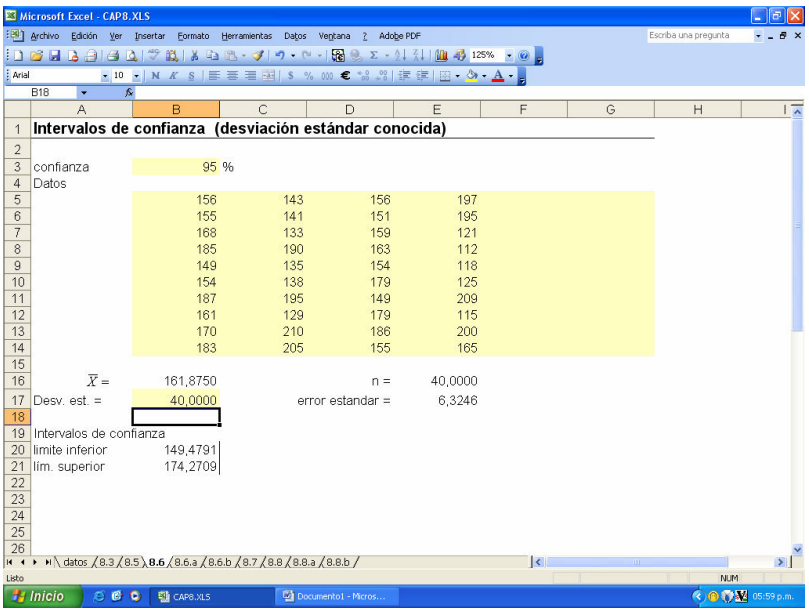
We record the dialogue between two Students (S1 and S2) in front of a computer while they solve the problem.

Here we present the first and the last part of the dialogue of these students.

First dialogue:

S1- Come, sit with me. You're faster than me with the keyboard. I'll dictate you the data.
S2- OK
S1- I start now!!
S2- Don't go so fast.... just wait a bit
S1- Look, when entering the data below the values vary
S2- Which values?
S1- Look, mean, standard error, and it provides you the sample size and the interval too.
S2- Now I see! As I was writing I didn't notice.
S1- Look what figure we have, 'cause I got lost.
S2- 32
S1- I go on. Now, write 33
S2- This is the last one
S1- Yes, it's OK, it's 40.
S2- And now, what do we do now?
S1- Well. Let's input the confidence.
S2- And what confidence shall I input?
S1- I'd input 95% because it's the most widely used.
S2- Oh. Look, we have to input the population deviation.
S1- Which is?
S2- Gosh! Look!!! Read the problem.
S1- It's 40
S2- Well done!!! You've read the problem.
S1- Which is the interval then?
S2- 149.48 – 174.27

They interpret the problem, input data and obtain the first result. Extensive, ostensive and intensive elements are used.



Last dialogue:

S1- Hurry up, buddy, we've got to arrive to a conclusion.
S2- And... what do you see?
S1- If the figure increases, the interval decreases.
S2- Look. Although with the same data, if the confidence level changes, the interval changes, too.
S1- Yes, the higher the confidence level, the higher the interval.
S2- Hey. And what happens with the deviation?
S1- I think that if the deviation increases, the same does the interval.

They obtain conclusions starting from the results. They show intensive and validating elements.

S2- Let's see what we did.
S1- Yes. I told you.

CONSIDERATIONS

The possibility of interacting with the computer increases the students' involvement. They explore and they experiment and different situations of action, formulation and validation arise.

They justify from praxis exploring, starting from the same problem, with variations of the elements that take part in building up a confidence interval.

They state opinions relating:

- Higher standard deviation with higher interval amplitude
- Higher confidence coefficient with higher interval amplitude
- Higher estimation error with higher interval amplitude
- Higher sample size with smaller interval amplitude

REFERENCES

Artigue, M. (1990). Ingénierie idactique. *Recherches en didactique des mathématiques*, 9(3), 281-307. Grenoble, Francia: La Pensée Sauvage.

Batanero, C. (2001). *Didáctica de la estadística*. Granada: Grupo de Investigación en Educación Estadística.

Cruise, J., Dudley, R. and Thayer, J. (1984). *A Resource Guide for Introductory Statistics.* Dubuque, IA: Kendall/Hunt.

Godino, J. D. (1998). Un modelo semiótico para el análisis de la actividad y la instrucción matemática. Comunicación presentada en el *VIII Congreso Internacional de la Asociación Española de Semiótica.* Granada.

Godino, J. D. (1999). Implicaciones metodológicas de un enfoque semiótico-antropológico para la investigación en didáctica de la matemática. In T. Ortega (Ed.), *Actas del III Simposio de la SEIEM*, (pp. 196-212). Valladolid.

Godino, J. D. and Batanero, C. (1994). Significado institucional y personal de los objetos matemáticos. *Recherches en Didactique des Mathématiques*, 14(3), 325-355.

Tauber, L. (2001). *La Construcción del Significado de la Distribución Normal en un Curso de Análisis de Datos.* Tesis Doctoral. Universidad de Sevilla, España.

Vallecillos, A. (1999). Some empirical evidence on learning difficulties about testing hypotheses. *Proceedings of the Fifty-second Session of the International Statistical Institute. Tome 58, Book 2*, (pp.201-204). Helsinki, Finland: International Statistical Institute.

Yates, F. (1951). The influence of Statistical methods for research workers on the development of the science of statistics. *Journal of the American Statistical Association*, 46, 19-34.