WHAT WE KNOW AND WHAT WE SHOULD KNOW: EXAMPLES OF WAYS OF HELPING REAL USERS OF STATISTICAL INFORMATION

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With and within our classes we would like to effectively contribute to create an evidence-based society. From our past experiences with the students in various services courses, the project work approach seems to have the main components to motivate teachers and students to develop a cooperative work mainly aiming the students to be acquainted with the statistical methods. Since our students (future Engineers and Oenologists) will be users of statistical information they developed a survey to study the use(s) of statistics in their own areas. With the project approach we used the data to explore statistical concepts and to use statistical information to make some decisions in their one professional area of (future) work and even in their own lives.

INTRODUCTION

Snee (1993) wrote that "the collection and analysis of data is at the heart of statistical thinking. Data collection promotes learning by experience and connects the learning process to reality." We feel that the project work approach will accomplish those aims and it is also supported by Fillebrown (1994) who wrote that, "Having students do projects in a statistics course is not a new idea (…). It seemed that requiring projects in an elementary statistics course would be … [a] valuable experience (…)". Also about the project approach Halvorson and Moore (2000, p. 31) stated that "[s]*tudents projects foster active learning through their involvement in practical, day-to-day issues statisticians confront in doing their work"*.

From our past experiences with the students in various services courses (Nascimento and Martins, 2008), the project work approach seems to have the key components to motivate students to develop a cooperative work mainly aiming the students to be familiar with the statistical methods. In our view this approach in addition allows students to focus in reasoning and sense making of "their data" and we think will contribute to "produce citizens who make informed and reasoned decisions (…) about which public policies deserve their support, and about which insurance or heath plans to select. It will also [contribute] to produce workers who can satisfy the increased [statistical] needs in professional areas (…)" (NCTM, 2009, p. 3). Already in the 90's Gal and Garfield (1997, p. 2) believed that "the overreaching goal of statistics education is that students, become *informed citizens* who are able to: Comprehend and deal with uncertainty and variability, and statistical information in the world around them, and participate actively in an information–laden society; [and C]ontribute to or take part in the production, interpretation, and communication of data pertaining to problems they encounter in their professional life."

Since our students (future Engineers and Oenologists) will be – at least – users of statistical information they developed a survey to study the use(s) of statistics in their own areas. With the project approach they used the data to explore statistical concepts and to use statistical information to make some decisions in their one professional area of (future) work and even in their own lives. So, in this first semester students where active contributors for an evidence-based society: a bridge was built between their knowledge as students/citizens, and their discovery of everyday statistics in their (future) professional life.

METHODS, RESULTS AND DISCUSSION

Our students were from the school year 2009/2010; 120 were from the First Cycle of Bologna (Graduates), future Engineers–Civil, Mechanical–and Oenologists and 10 Graduates were from the Second Cycle of Bologna (Majors) from UTAD, Vila Real, Portugal. For their project–everyday statistics and statistics in the different job areas–students built their own a survey: In the first phase each group suggested some questions and then we all met–teachers and students–and we agreed which questions were include in the final version of the survey. In the second phase each student fills one survey in order to test it and to register the time needed. At the same time they

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built tables with the variables codification. It was a convenience survey and each student gathered 10 or more surveys and each group built a group spreadsheet data base that they sent to the teachers to be gathered by job area. Each group had to include tables and graphs done with a spreadsheet. They were also encouraged to use the spreadsheet to do their statistical analysis. Finally, each group presented a written report and did an oral presentation/discussion.

The questions of the survey were about personal data, statistical learning data, everyday and job statistical related questions and data of expectations about other ways how to use statistics and statistical consultancies. To present this paper we put together all spreadsheets of all the data colleted (Civil, Mechanical, Oenology, Zootechnical and others such as Agriculture or Tourism), a total of 679 surveys, but here we only describe some of the aspects of that survey. A total of 679 surveys were analysed. The questions that student asked and that we have decided to present were from the four groups stated and involved qualitative nominal (such as gender, scholarship, "Did you have statistical classes" and "At your work statistics is done with a spreadsheet or a statistical software") and ordinal variables in a Likert type scale (1–Strongly Disagree; 2–Disagree; 3–Neither agree, nor disagree; 4–Agree; 5–Strongly Agree; such as "Daily I can see the presence of statistics in consumptions of cars, electricity, water, shopping, taxes, stock market, lottery games, and so on…" "In my profession I use statistics"), also few quantitative variables (such as age and number of the workers in the work place).

Personal data

Men were 69,5% of the respondents and the ages varied from 18 to 64 years old (Figure 1) with 10 years of standard deviation. Their professions were in 50,4% from the Civil Engineering area followed by 37,9% of Agronomical Sciences (Agriculture, Oenology and Zootechnical) area, 7,6% in the Mechanical Engineering area and the remaining 4% in the Tourism area. In the Figure 1 (left graph) we can see the employment category (helpers, technicians, graduate technicians, managers and others such as, for instance, teachers at the universities, Masters and PhDs to whom students had an easier access) crossed with those professional areas. We can see that if joined technicians and graduate technicians they will be more in Civil, Mechanical and Oenology areas. Also crossing labouring in the employment (right graph) we have persons labouring on their own behalf or labouring to other persons or doing both things (such as many cases in others).

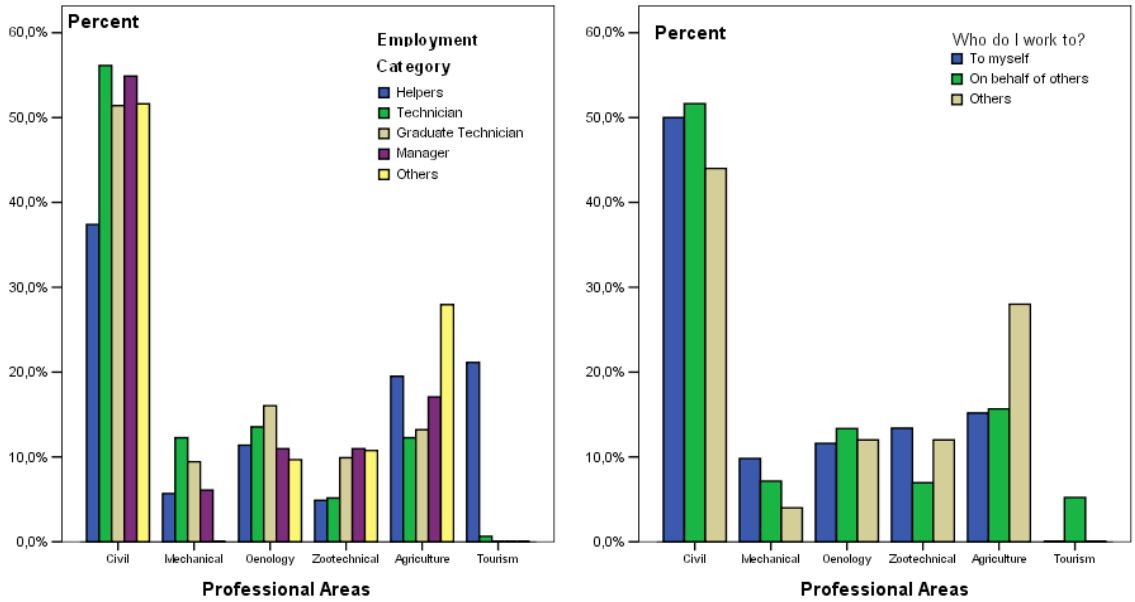

Figure 1. Professional areas crossed with employment category (left) and with labouring type of work (right)

In 2003 the European Commission adopted a new recommendation regarding the SMEs definition. So, the micro enterprises have number of workers, n.o.w., less then 10; small enterprises have a n.o.w. between 10 and 50, and medium-sized enterprises a n.o.w. between 50 and 250 (EC,

2004, p. 5). The professionals surveyed worked mainly in small (46%) or micro enterprises (34%) and 12% in medium-sized ones, and only 7 % worked in a large enterprise (more than 250 workers, maybe UTAD). This may be seen in Figure 2 (left graph), and there (right graph) we also can see the graph that the scholarship grade (EB, meaning until the 9th grade; Sec until 12th grade and Sup, university or polytechnic schools) with the employment categories: we may see that helpers mostly complete only until the 9th grade, that if the workers has completed until the 12th grade they will be technicians and if the workers complete graduate courses they will be graduate technicians. We also verify that the Civil engineering area had 56% of managers and 50% worked for themselves.

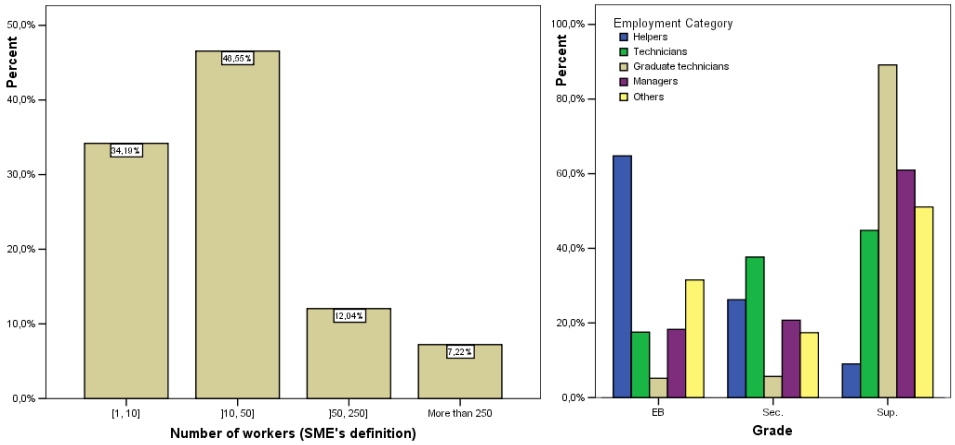

Figure 2. Number of workers in the enterprises (left) and Employment category by grade (right)

Statistical learning data

In this survey 67% people remembered having statistical classes. That is not strange because since the 80's that Statistics was introduced in the Mathematical (until the 12th grade) or in Statistics (in the university) programs/curricula. So it was also expectable that the percentage of "yes" rises from 7% until 9th grade to 76% at the university. People that answered "yes" then had to classify (in the above referred Likert scale) the sentences "classes of statistics were interesting"; "classes of statistics were very theoretical"; and "what you learned is enough for what you do in your job".

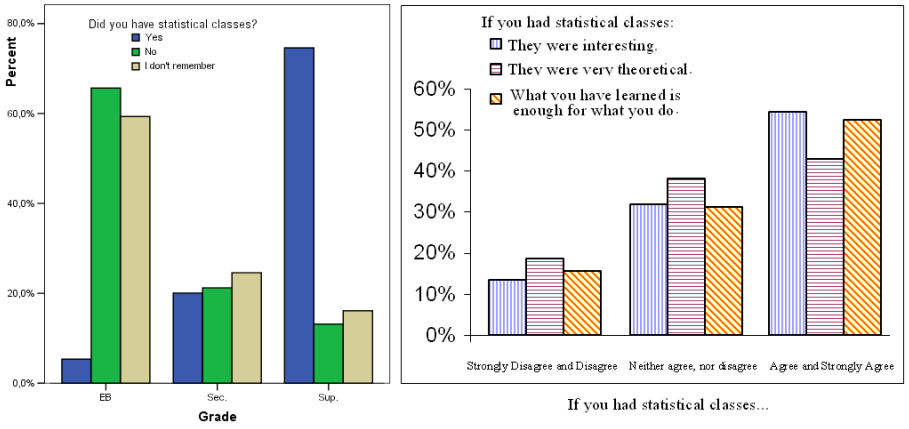

Figure 3. Grades and statistical classes (left) and
if you had statistical classes what is your opinion about … (right)

In an overall analysis of the Figure 2 right graph, we may say that the respondents that had statistical classes, the major idea is that – despite thinking of them as theoretical – the classes were considered interesting and they think they have provided them the tools for their professional needs.

In the cross tabulation presented in the Figure 4 (left) we can see that the majority of the respondents (those that had and that didn't have statistical classes) gave less importance to statistics when studying it then now as they are professionals. On the contrary, the students that "don't remember …" think the opposite, that is, now they give less importance to statistics.

			"… statistical classes"			
			Yes	No	I don't remember	Total
Gives now (as a professional)	More	Count	201	18	12	231
		% within "Gives now (as a professional) … "	87,0%	7,8%	5,2%	100,0%
		% within "Statistical classes"	47,3%	62,1%	46,2%	48,1%
	Less	Count	224	11	14	249
		% within "Gives now (as a professional) … "	90,0%	4,4%	5,6%	100,0%
		% within "Statistical classes"	52,7%	37,9%	53,8%	51,9%
Total		Count	425	29	26	480
		% within "Gives now (as a professional) … "	88,5%	6,0%	5,4%	100,0%
		% within "Statistical classes"	100,0%	100,0%	100,0%	100,0%

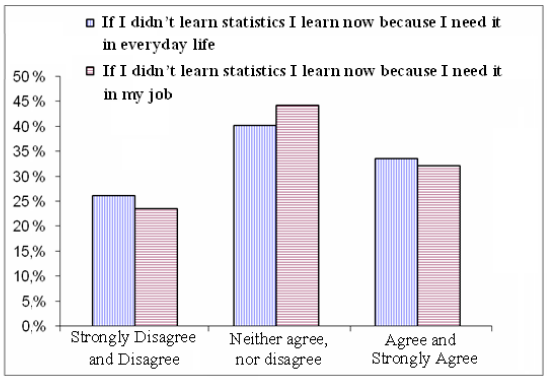

Figure 4. Cross tabulation: the statistical classes and the actual importance given to statistics (left) and the (right) graph for those you didn't have statistics or don't remember.

Analysing the respondents that didn't have statistical classes in respect to their marks about the sentences "If I didn't learned statistics I learn now because…" "…I need it in everyday life" or "… in my job" the majority of the opinions are neither agree nor disagree. These opinions drew our attention to the fact that nowadays we need to have statistical literate citizens in everyday life as well as in their jobs.

Everyday life and job data

Among the questions in this point of the survey we selected some cross tabulations to get a first glace at the respondents to statistics in everyday life and job. In the cross tabulation between the statements "In everyday life I use statistics" and "Nowadays statistics is more and more important" (Figure 5) a match emerges among the agreement level in relation to the increased importance of statistics nowadays and its level of use in today's life. That is the majority of the respondents that stated that they agree that use (strongly use) statistics in everyday life also strongly agree that nowadays statistics is more and more important. Taken as a whole, the majority declares that nowadays statistics is more and more important.

			"In everyday life I use statistics" (19)			
			Strongly Disagree and Disagree	Neither agree, nor disagree	Agree and Strongly Agree	Total
"Nowadays statistics is more and more important" (21)	Strongly Disagree and Disagree	Count	26	5	5	36
		% within 19	72,2%	13,9%	13,9%	100,0%
		% within 21	19,8%	2,2%	1,8%	5,6%
	Neither agree, nor disagree	Count	39	78	30	147
		% within 19	26,5%	53,1%	20,4%	100,0%
		% within 21	29,8%	34,5%	10,6%	23,0%
	Agree and Strongly Agree	Count	66	143	248	457
		% within 19	14,4%	31,3%	54,3%	100,0%
		% within 21	50,4%	63,3%	87,6%	71,4%
Total		Count	131	226	283	640
		% within 19	20,5%	35,3%	44,2%	100,0%
		% within 21	100,0%	100,0%	100,0%	100,0%

Figure 5. Cross tabulation: "In everyday life I use statistics" (19) and "Nowadays statistics is more and more important" (21).

In the other table (Figure 6) we cross the statements "Nowadays statistics is more and more important" and "Daily I can see the presence of statistics in consumptions of cars, electricity, water, shopping, taxes, stock market, lottery games, and so on…". Simple analysing its values we

get another match that confirms the previous cross tabulation: it seems there is an agreement connecting the conscience rising of the presence of statistics around us and the agreement of the use of statistics in the everyday life.

			"Nowadays statistics is more and more important" (21)			
			Strongly Disagree and Disagree	Neither agree, nor disagree	Agree and Strongly Agree	Total
"Daily I can see the presence of statistics in consumptions of cars, electricity, water, shopping, taxes, stock market, lottery games, and so on..." (20)	Strongly Disagree and Disagree	Count	27	3	3	33
		% within 20	81,8%	9,1%	9,1%	100,0%
		% within 21	19,4%	1,3%	1,1%	5,1%
	Neither agree, nor disagree	Count	47	72	26	145
		% within 20	32,4%	49,7%	17,9%	100,0%
		% within 21	33,8%	31,4%	9,2%	22,3%
	Agree and Strongly Agree	Count	65	154	253	472
		% within 20	13,8%	32,6%	53,6%	100,0%
		% within 21	46,8%	67,2%	89,7%	72,6%
Total		Count	139	229	282	650
		% within 20	21,4%	35,2%	43,4%	100,0%
		% within 21	100,0%	100,0%	100,0%	100,0%

Figure 6. Cross tabulation: "Nowadays statistics is more and more important" (21) and "Daily I can see the presence of statistics in consumptions of cars, electricity, water, shopping, taxes, stock market, lottery games, and so on…" (20).

For one other group of tables we cross the statements "In my job I use statistics" and "In my jobs the statistical studies done we use …" (Figure 7, left). The first thing that is evident is that most of the respondents agree or strongly agree that they use statistics in their jobs. In the other hand it became evident that the respondents that don't use statistics in their jobs use or built more tables. The people that said that employed statistics' in their jobs use or built more graphs. However using and building tables (36%) and graphs (35%) is more or less the same for data presentation at work. Analysing the table with the statements "In my job I use statistics" and "In my jobs the statistical studies influence decisions" (Figure 7, right) the most part of the respondents (46%) is from those that agree or strongly agree that the statistical studies used in the work places do influence the decisions made. There seems to be a direct relationship between both of the levels of disagreements and of agreements with the use of statistical studies in the work place and the use of statistics their. For instance, 47% of those the claimed that there is no such connection also say that they don't use statistics in their jobs, 46% neither agree or disagree in both cases and 75% claimed that there a connection also say that they use statistics in their jobs.

			"In my job I use statistics" (22)			
			Strongly Disagree and Disagree	Neither agree, nor disagree	Agree and Strongly Agree	Total
"In my job in the statistical studies consulted or done we use..." (26)	Graphs	Count	18	43	125	186
		% within 26	9,7%	23,1%	67,2%	100,0%
		% within 22	21,4%	29,3%	40,7%	34,6%
	Tables	Count	37	69	90	196
		% within 26	18,9%	35,2%	45,9%	100,0%
		% within 22	44,0%	46,9%	29,3%	36,4%
	Graphs and tables	Count	22	27	71	120
		% within 26	18,3%	22,5%	59,2%	100,0%
		% within 22	26,2%	18,4%	23,1%	22,3%
	Others	Count	7	8	21	36
		% within 26	19,4%	22,2%	58,3%	100,0%
		% within 22	8,3%	5,4%	6,8%	6,7%
Total		Count	84	147	307	538
		% within 26	15,6%	27,3%	57,1%	100,0%
		% within 22	100,0%	100,0%	100,0%	100,0%

			"In my job I use statistics" (22)			
			Strongly Disagree and Disagree	Neither agree, nor disagree	Agree and Strongly Agree	Total
In my Job statistical studies influence decisions" (29)	Strongly Disagree and Disagree	Count	64	42	30	136
		% within 29	47,1%	30,9%	22,1%	100,0%
		% within 22	56,6%	21,8%	9,3%	21,7%
	Neither agree, nor disagree	Count	33	93	75	201
		% within 29	16,4%	46,3%	37,3%	100,0%
		% within 22	29,2%	48,2%	23,3%	32,0%
	Agree and Strongly Agree	Count	16	58	217	291
		% within 29	5,5%	19,9%	74,6%	100,0%
		% within 22	14,2%	30,1%	67,4%	46,3%
Total		Count	113	193	322	628
		% within 29	18,0%	30,7%	51,3%	100,0%
		% within 22	100,0%	100,0%	100,0%	100,0%

Figure 7. Cross tabulation: "In my job I use statistics" (22) and "In my jobs the statistical studies done we use or built…" (26, left table); and cross tabulation: "In my job I use statistics" (22) and "In my jobs the statistical studies influence decisions" (29, right table)

Before the end of this topic only a word to the answers of the question "In your job what software is used in statistical studies?" 46% of the respondents said they used a spreadsheet but statistical software was mentioned by 36% of them. To finish we may say that the most part of the respondents select as a main tool of their studies descriptive statistics (41%) but also a reasonable percentage chose confidence intervals – 36%. From all the answers 16% are from multiple responses and none of the options given failed to be answered, still non linear regressions was the least chosen one.

Expectations data

The last group of statements was about expectations: "To use statistics I would like to have more specialized qualifications"; "To use statistics I would like to have more textbooks with explanations and examples"; "To use statistics I would like to have software with textbooks with explanations and examples"; "To use statistics I would like talk to someone that could help me every time I needed"; and "To use statistics I would like talk to someone that could help me in my work place". The respondents agreed or strongly agree with all the five statements. Being so, we think that statistical literacy may be in their perspectives if they continue to feel its need and supported.

CONCLUDING REMARKS

Although our students had a smaller idea of the overall data colleted using their survey, this project approach allowed them to active contributors for an evidence-based society: a bridge was built between their knowledge as students/citizens, and their discovery of everyday statistics in their (future) professional life. With this presentation we begin to explore their data and we think (despite the convenience survey collected data) that a lot has to be done. Nevertheless, a step forward was given in the direction of what we know and what we should know. Essentially people agree that help is needed; now we have to develop ways of helping real users of statistical information, that is we have to devise strategies with and within society to reach the goal of an evidence based society. What we know and what we should know

REFERENCES

European Commission (EC) (2004). *The new SME definition: User guide and model declaration.* EN NB-60-04-773-EN-C 92-894-7909-4
On Line: *http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm*

Fillebrown, S. (1994). Using Projects in an Elementary Statistics Course for Non-Science Majors. *Journal of Statistics Education, 2*(2).
On Line: *http://www.amstat.org/publications/jse/v2n2/fillebrown.html*

Gal, I., & Garfield, J. (1997). Curricular Goals and Assessment Challenge in Statistics Education. Gal & Garfield (Eds.) *The Assessment Challenge in Statistics Education,* The Netherlands: International Statistical Institute.

Halvorson, K. T. J., & Moore, T. L. (2000). Motivating, Monitoring and Evaluating Student Projects. Moore, T. L. (Ed.) *Resources for Undergraduate Instructors – Teaching Statistics* (pp. 27-32). Washington, D.C.: *MAA and ASA.*

Nascimento, M., & Martins, J. (2008). Teaching and Learning of Statistics: The Project Approach, *11th ICME, International Congress on Mathematical Education*, Topic Study Group 14: Research and Development in the Teaching and Learning of Statistics. México: 11th ICME.
On Line: *http://tsg.icme11.org/ document/get/483*

National Council of Teachers of Mathematics (NCTM) (2009). *Focus in High School Mathematics: Reasoning and Sense Making*. Reston, Va.: NCTM.

Snee, R. D. (1993). What's Missing in Statistical Education? *The American Statistician, 47,* 149-154.