THE USE OF STATISTICAL TOOLS BY SALES MANAGERS: FORMS OF RATIONALITY AND DECISION-MAKING

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In this paper, we describe a project carried out with Business school students, in order to find out how different forms of rationality shaped a statistical decision-making problem and the use of statistical concepts by students.

TO LEARN BETWEEN SCHOOL AND WORKPLACE

A major well-known difficulty in vocational education is to help students to link professional experience to theory learned at school (see, for example, Hahn, 2000).

As the constitutive role of cultural practices on cognition is now widely recognised (Hatano & Wertsch, 2001), in order to enhance learning the aim is to confront students with epistemologically rich problems. These problems should be not only inspired by “real” situations but also familiar, part of their field of experience (Boero & Douek, 2008), and related to the community of practice (Lave & Wenger, 1991) at work.

However, linking disciplinary knowledge with work practices is not an easy task as work situations are always multidisciplinary. This is a major problem encountered by statistics teachers, especially in higher education where the use of sophisticated technology makes statistics mostly invisible (Dassonville & Hahn, 2002).

Although referring to different theoretical frameworks, some authors agree that learning appears through a dialectical process—between conceptualisations in action, embedded in the setting in which they occur and theories or “scientific” concepts—whether they stress the continuity between them (Noss & Hoyles, 2000) or the discontinuity (Pastré, Vergnaud & Mayen, 2006). This is different from the approach adopted by many researchers in statistics education who consider learning as a vertical process whose aim is the mastery of a particular theory, as in the SOLO cognitive developmental model (see, for example, Reading & Reid, 2006). Unlike this model, a dialectical learning process implies the construction of an internal space where knowledge of different levels of generalisation play/work/compete together (Brossard, 2008). From our point of view, this implies that the learner should be involved in the construction of the problem. But, on the other hand, how can we be sure that a problem enacted from the learner’s personal experience would fit with the school’s aims and help the learner to construct the knowledge that s/he is supposed to learn? In vocational and professional school education, curricula often force teachers to follow a prescribed pathway, leaving little room for such activities.

In the field of adult education, the problem differs: the pressure of curriculum is less important and learners usually already have work experience.

We have been studying the positive effects of the French “alternance” system on learning for some years now (Hahn, 2000; Hahn et al., 2005). As adult education, it offers the opportunity to link school content to students’ professional experience, and this system creates a two-way relationship, from school to firm and from firm to school. Students are then able to build problems out of their personal experience at work.

MANAGERS AND STATISTICS

When we work with our post-graduate business students on problems they have constructed, these problems rarely include a statistical dimension, not even a basic one. In fact, most decisions can be made without considering any statistical methods. This is what usually happens in the field, although statistics certainly provide much insight into many corporate questions and issues (Dassonville & Hahn, 2002).

The question is not only to help professionals to improve their understanding of the statistical tools they use in the workplace (see, for example, Noss, Hoyles & Pozzi, 2002; Bakker et al., 2008) but also help them to “see” the statistics that could be useful. Therefore, we need to

In C. Reading (Ed.), *Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia*. Voorburg, The Netherlands: International Statistical Institute. www.stat.auckland.ac.nz/~iase/publications.php

"enculturate" students into statistical reasoning (Pfannkuch, 2005) so that, as managers, they will be able to improve their decision-making processes by using statistical methods.

The decision-making process is not only a question of processing information and finding patterns in observed data. Our rationality is shaped by the values and beliefs that are raised through our participation in different communities and of which we are mostly unaware. Not all of this tacit knowledge can be codified and it shapes not only the means but also the evaluation of ends (Polanyi, 1966).

We must also consider that scientific rationality as it is developed at school—i.e., explicit logical reasoning—co-exists with other social forms of rationality. The way the learner solves a problem depends on what the problem means to her/him.

The aim of the experiment we will now describe was to find out how these different forms of rationality shaped a statistical decision-making problem and the use of statistical concepts by students.

THE EXPERIMENT

The device

We designed a 4-step pedagogical device focussing on the concept of variation. This concept is central in management (e.g., to consider investments' volatility in finance, segmentation in marketing, etc.), as in many other fields, and it is claimed that it is very hard to deal with at any age or level (Garfield & Ben Zvi, 2005).

We had planned to study how the device mediated the construction of statistical concepts and how students' personal experiences shaped their decisions.

The device was based on a mini case study about a firm ("T" sells office equipment) that is hiring a sales manager. Students were asked to choose which of three sales areas they would prefer to manage. They had to make their decision according to information they were given on a group of customers (businesses) located in each area (different group sizes in each area). This information consisted of an Excel File with a set comprised of one qualitative variable (date of first purchase) and five quantitative variables: previous year's amount of sales (with the client), distance (from the client to "T" location), staff (of the client), evaluation of commercial relation (a grade from 0 to 10), number of different items (sold to the client last year).

First, each student was provided individually with the distribution of one variable from one sales area, and was subsequently asked to write a brief summary of the information he or she received (step 1). Next, we formed groups of three students, with each of them having studied the same variable in a different area, and we asked each group to summarise the information it had received by comparing the three distributions of the same variable in the three different samples (step 2). Therefore they were able to consider two types of variability, within a group and between groups (Garfield & Ben Zvi, 2005).

Then we built new groups of 6 students, each of them having different information about one variable (among 6) in all three sales areas (step 3). Last we asked the students (in groups of 3, as in step 2) to make a final decision about the area they would choose by analysing all available data simultaneously (step 4).

We assumed that step 1 and 2 were closer to school practice and step 3 and 4 closer to professional practice (step 3 was more typically a situation faced by a salesperson, step 4 a situation faced by a manager). We also expected that passing from step 1 to 2 but also from step 3 to 4, would lead students to move from a local (data seen as a collection of individuals) to a global point of view and thus to the construction of the concept of distribution (Makar & Confrey, 2005).

The population

The device was first tested with 36 postgraduate students engaged in a 3-year master's level program including several periods of internship. Most of these students (n = 34) completed a 2-year commerce degree prior to entering the masters program. They all had previously undertaken at least a basic statistic course and had work experience, most of them as a salesperson.

Two questionnaires were given to the students at the beginning of the school year by the teacher in charge of the Business course. The first questionnaire focussed on their former experiences and professional project, the second on their statistical knowledge: given a list of statistical concepts they were asked if they had learned these at school and if they knew how to use them.

The experiment took place during the two first sessions (three hours each) of a compulsory statistics course during the first year. We split the group into 2 subgroups located in 2 different classrooms. Each subgroup followed the same procedure. At each step the students were able to use their personal calculator or computer.

The debates between students during steps 2, 3 and 4 were audio-taped; in addition we took field notes and collected reports written by the students at each step. Students were told that we wanted to keep track of the discussions in order to help to adapt the course to their needs, what I actually did. They were allowed to stop the recorder if they wanted. Some did occasionally during breaks.

RESULTS AND DISCUSSION

We will describe some results concerning the quantitative variables (30 students studied these variables, 6 per variable at the first step). Here we will mostly focus on the use of the mean, median and standard deviation.

Table1 compares, for 30 students out of 36 (The six remaining students dealt with the qualitative variable), answers to the questionnaire (what students claim to know) and observations we made at step1. What students claimed seems coherent with they were able to do—although they seem to underestimate their capacity to calculate a mean and a median.

Table 1. Questionnaire Step 1

	Learned at school	Met out-of-school	Know how to calculate	Know how to get the result from spreadsheet	Know how to use it out-of-school	Calculated (without mistake)	Calculated (wrongly)
Average	30	16	16	20	18	24	2
Median	18	5	6	7	6	10	5
Standard deviation	24	2	1	4	2	1	3

Although very few students calculated or used variation indicators, many of them expressed an intuitive conception of variation as evidenced by their references to the shape of distribution. As we suspected, as it is a natural process (Hammerman & Rubin, 2004), many students divided the data into subgroups. Nevertheless we found two different types of strategies. At this stage, 19 students out of 30 built subgroups based on the distribution (use of mean or median, of discontinuities in the data set) and 10 built subgroups referring to a “social norm”: the decimal system (hundreds), economic typology (size of firms), or a “school norm” (a good grade must be 5 or above).

Among the hypotheses formulated from our literature review, we forecasted that the students would refer more to school knowledge at step 1 and 2 than at step 3.Indeed, at step 1, many students tried to apply the statistical knowledge learned at school and calculated as many indicators as they could. Nevertheless, many of them already integrated elements of their commercial experience at this stage. Strategies seemed to depend on context and not only on the distribution of numbers: similar strategies were used for the same variable (for example all students who dealt with sales and distance calculated percentages for subgroups). We mostly found references to the context for sales and distance (most important for a salesperson, according to our interviews with professionals).

Our second hypothesis was that steps 2 and 4 would help them to move from a local to a global conception—in particular by using multiplicative strategies (as sample sizes were different). That was obvious in step 2: all students who had made lists or ranking of customers abandoned them. This seems to indicate a shift to a global point of view, although they used few indicators: they kept indicators when they were able to agree on a common interpretation. They dropped indicators that they could not make sense of. This is coherent with previous observations that students have difficulties with spontaneous use of indicators (Konold & Pollatsek, 2002) and, when they calculate indicators, they do not use common sense in solving the problems (Bakker, 2004). Here is an extract of the discussion in one of the two groups dealing with grade:

S1: you did not calculate the average for your area? For your 20 customers, how many?
S2: I told you that there were 10 [*customers who gave a grade under* 5] out of 20
S1: Yes, but the total average?
S2: but I told you, it is 10
S1: but the average grade, how much?
S2: I told you
S1: you did not calculate it
S3: the addition of grades divided by the number of grades
S2: oh this, I did not do it.
S3: the average is 6.76 in my area
S3: Is this good or not?
S3: This is not so simple... the average is 6.76...
S2: But how many have a grade above 5, this I am sure you did not do it?
S3: no, I did not
S1: in my area, there are 31 customers, the general average is 5
S2: exactly 5?
S1: yes those whose business relationship is under 5 are 13, that represents 42%, those whose relationship is above 5 are 18, that represents 58%, then the end result is positive but not good enough.
S3: In my area, 11 customers reach average 5, then we must improve commercial relationship and try to find out during appointments what they really need and adapt commercial policy to improve their satisfaction. [....]

We could claim that the 3 students were at different stages of understanding but it seems to us that they are not solving the same problem. The problem is shaped by the objective they set themselves: student 1 seems to plan a comparative study in order to understand differences between areas, student 2 is solving a school problem to answer the teacher's request and student 3 wants to answer the question "which is the best area?" at this stage already. Then of course strategies differ. Student 1 referred to what seems to be a scientific rationality: to compare distribution and use statistical concepts. Student 2's actions are based on technical rationality (Schön, 1996): he applied techniques learned at school but does not know how he can use the result to answer a question. Student 3's reasoning is pragmatic and he used a simple intuitive strategy.

The second group dealing with grade followed a similar path, although they all calculated the mean at step1.:

S4: For area A, the mean is 4.3
S5: For me, 5
S6: And for me 6.76
S5: Let me do the calculation again... yes it is 5, Ok
S6: Ok, then what do you want to do?
S4: The number of customers under 5
S5: It is important?
S4: But you must understand! There are 20 customers in my area, among them, 10 are not satisfied at all
S5: Ok
S6: They do not reach average
S4: Not average = not satisfied
S5: Ok
S4: Then this is global [....]

We can see that, finally, the same procedure is chosen by both groups: consider the number of values under 5 and above 5 and do not compare the means. They used an anchoring strategy (Tversky & Kahneman, 1974), comparing the values to midrange 5 which they called “average”: it is “global”, as all data can be compared to it when the other means are only “local”. It is known that students have difficulties with considering the mean as a good representation of a distribution (Konold & Pollatsek, 2002). But when both groups dealing with sales compared means, only the groups studying grade used the midrange. This is probably connected with the magnitude of grade values. But we suspect that is also linked to a strong social/school norm in France: “to obtain average” means “reach midrange value” which is usually the passing grade. If we refer to Vergnaud’s theory of conceptual fields (Vergnaud, 1990), it seems that students built a concept-in-action “average as middle value” linked with the theorem-in-action “a grade above 5 is good” and activated the scheme “compare number of data above and under 5”.

In both groups, students who referred to technical rationality switched easily to the strategy of comparison to 5, while students who wanted to study the distribution more deeply (student 1 in group 1 and student 2 in group 2) seemed more reluctant.

At step 3, when groups of 6 students had to draw a conclusion about one area from their individual study of each of the variables, we noticed that the use of indicators was less frequent and, as in step 2, dependent on the context (see table 2). They indicated standard deviation for 2 variables only, those for whom we found no occurrence of commercial comments. It seems that they calculated this indicator for variables that made no sense for them to consider the context. One group went back to a local strategy by numbering customers.

Table 2. 10 Groups

	sales	staff	items	distance	grade
Average	3	3	4	4	3
median	1	1	2	2	1
Standard deviation		2	2		
Use of effective commercial context	5			5	5

At step 4, when groups of 3 were supposed to decide on the area they would like to manage, we found almost no occurrence of the use of indicators: only two groups (out of 10) used in their argumentation the average for distance and grade. Their argumentation was based on commercial arguments and mostly built on comparison of percentages within sub-groups.

Considering the references to the context, sometimes even at step 1, it seems that students very quickly built a representation of the problem as a commercial problem. As they moved forward in the experiment they left behind their statistical knowledge. They found it not practical enough for the objectives they had set. Pragmatic rationality prevailed.

The difficulty in moving from a local to a global point of view seems somewhere to reflect the difficulty in moving from a salesperson identity to that of a sales manager, because a salesperson deals with his customers more individually. And this implies the need to mobilise more statistical knowledge.

CONCLUSION

We used this experiment as a basis for the statistics course that year. The course was unusually successful. Of course we could not evaluate on a scientific basis whether the experiment helped the students to change their views about statistics, but many of them mentioned in the evaluation that they became more aware of the utility of statistical methods.

This experiment is going to be extended to a larger population through a Computer-Supported Collaborative Learning system based on the same device (we have added 4 variables to the file). We plan to use this system with students from our 5 European campuses.

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