The Use of a Multimedia Tool in Teaching Factor Analysis to Business School Students. Is there a Statistical Significant Improvement?

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1. Introduction

Teaching factor analysis to non scientific audience is not easy. These methods should be taught with rigor so that students develop the capacity of interpreting correctly the results of the statistical analysis. But it can not be taught in a too theoretical way because it would be rejected by students who often have a difficult relationship with mathematics (Dassonville et Hahn, 1999). Development of technology, especially multimedia, allowed us to consider conception of new pedagogical tools that could improve learning (Legros, 1997). We know that human mediation is an essential part of the process of knowledge construction (Tall, 1994; Linard, 1998). So, the question of the position of such tools in a pedagogical programme is still fundamental. It is why the Paris Chamber of Commerce and Industry supported a research project on learning Principal Components Analysis (PCA). The first step of this project was to create a multimedia tool (Dassonville, 1997). The second step was to evaluate the efficiency of the tool.

In our presentation, we will first say a few words about teaching of statistics in French Business schools. Then describe shortly the pedagogical programme we experimented at Ecole SupÈrieure de Commerce de Paris (ESCP), integrating the multimedia tool. Then we will present the main results of the evaluation of this tool's efficiency we conducted in 1998/99.

2. Teaching of statistics in French business schools

In France, one can study management either at University or in a business school, where the curriculum is more operational. This curriculum include a statistics and data analysis unit. Data analysis is frequently used in marketing. PCA is commonly used by people who do market surveys (positioning of a brand for example). If learning PCA is absolutely necessary for marketing experts to be, it is not easy because to get an in-depth understanding, one needs to have good bases in linear algebra. But our students are no longer able to reach this level. Consequently, PCA is less frequently taught in statistics courses. It is mostly reduced to the presentation of some recipes by the

marketing teacher using professional software, but, it is not enough to teach our students how to manage this relation of input/output (Keitel et al., 1993). If the future professional wants to be able to correctly interpret the results of the computer printout, he or she must know about the type of algorithm performed by this software (Noss and Hoyles, 1996; Tall, 1994). We noticed that the complexity of PCA, hidden behind the apparent simplicity of graphical representations summarising analyses, leads to many errors in the workplace (Dassonville and Hahn, 1999). The question is to what extend should we teach the theoretical bases of the methods he or she will use in the workplace?

3. Our teaching method

We believe that there is an intermediary way of teaching PCA, between the deep mathematical approach and the marketing recipes approach. This consists of a strict conceptual approach based on graphical representations. It integrates a CD ROM (Dassonville,1997). This tool was organised as a virtual campus that allows the students a strong autonomy for experimentation and the possibility of simulation by using dynamic representations. We hoped that, this way, we would reduce epistemological anxiety (see Wilensky, 1997).

This multimedia tool was made of:

a welcome office where the student register, is able to consult his personal file and to get some help,
an amphitheatre where he get a presentation of the method,
a laboratory where he can work interactively on data bases,
a library with a dictionary and consulting documents
a park.

The question was: does the use of the multimedia really help students to understand PCA? To try to answer this question, during the school year 1998/99, we conducted a research study with Ecole SupÈrieure de Commerce de Paris (ESCP) first year students (350 students).

4. The study protocol

Out of a total of 323 students first year students, we selected a sample of 84 students (stratified sample, in relation with sex and school origin). 48 of them, randomly chosen, attended the regular course and were not allowed to use the multimedia tool during the three weeks of the PCA course. Thereafter, students in this group were free to make use of the tool in their learning. The remainder of the sample group population (36 students) were required to work only on the CD ROM. 24 of them study at school and their

attitudes (exchanges between students, reaction to the tool, duration of breaks) were observed by two observers trained in psychology and ergonomy, through a grid. The remaining twelve members of this subgroup were free to work where and when they wanted but they had to maintain log-books in which they had were required to record, for each use of the CD ROM :
which parts of the campus they went to and it which order;
how much time they spend working on the tool;
why they stopped;
which essential points they meet;
their understanding of these points (on a four level scale);
general comments.
The remaining students (not in the sample) were free to learn the way they wished to (course and/or CD ROM).

Data for the study consists of information gathered in five questionnaires administered to the students at various times between October and January and of the analysis of the logbooks and the observers' reports. The first questionnaire was given to all first year students (323) at the beginning of the school year (first week of October). Its aim was to know about students' attitude toward technology.

The second questionnaire was given to students who has to study with the CD ROM only (36), at the end of the three weeks course on PCA (third week of November). Its aim was to evaluate their reactions about learning with the tool.

The third questionnaire was given to the students in the sample (84) at the end of the three weeks course on PCA. In this questionnaire, we asked students, for six fundamental PCA concepts, first to self estimate (on a four level scale) their understanding of these concepts, then to explain the concepts. This explanation was evaluate by us, on a 4 level scale also.

The fourth questionnaire was also given to the students in the sample (84) at the end of the three weeks course on PCA. In this questionnaire, we present to students the results of a PCA processed on a set of real data. We asked them six questions corresponding to the six concepts in questionnaire 3. We also evaluate their answers on a four levels scale.

The fifth questionnaire was a general questionnaire on PCA teaching and learning and it was given to all first year students (323) at the end of the statistics course, in January.

The results

We will present here some results of the quantitative part of our study. We will first describe the students' opinions about the CD ROM and then discuss the cognitive effect of the tool by comparing the results of the students who learned ACP on the CD ROM (group A, 36 students) and of the students who attend to the regular course and were not allowed to use the tool1 (group B, 48 students).

The students' evaluation of the tool

This evaluation was made out of the answers to the last questionnaire that was given to the students at the end of the statistics course, in January. At that time, all of the students had been able to use the CD ROM, if they wanted. 85% of the students who used the multimedia tool (159 students), liked it. They did not seem to be handicapped by their lack of familiarity with computers: more than 80% of those who had never or only occasionally used software before said that this did not prevent them from using the CD ROM. Still, more than half of the students did not use the CD ROM and, the majority of those who did use it thought it could be used only as a complement to the course: 62% thought that this tool could not take the place of the teacher's course (20% thought it could) and 58% thought that the course was a necessary preliminary (20% did not think so).

One might guess that this could be explained by students' traditional school habits but this is probably not the only reason. It became obvious to us that the tool was not interactive enough by itself. For example, we noticed that students often shared headphones when they were working together and the majority of the students said that they would have liked to have asked questions while they were studying with the CD ROM (81% for group A and 61% for group B). We also realised how hard it was to construct a tool adapted to all students (in spite of the possibility given by the CD ROM for students to build their own way of learning); answers to some questions revealed important differences between students' behaviour. For example, 48% of the students explained that they had to take notes when 43% of them did not need to, 45% of the students thought that the repetition of the explanations was tiring when 42% did not think so, 39% said that the tool made concentration easier when 43% did not agree. In fact all this probably depends on the student's strategy: whether the CD ROM was used to learn ACP (group A) or as an extension to the teacherís course (group B). his could explain the difference we noticed between answers to some of the questions (see table 1).

Table 1: Evaluation of the tool by the students (questionnaire 5), items to which the difference between group A and group B students answers is statistically significant.

	Students who agree with the statement Group A2	Students who agree with the statement Group B 3
The CD ROM could not take the place of the teacher's course	75%	45%
It was a pity that I could not ask questions	81%	61%
I absolutely need to take notes while working with the CD ROM	75%	32%
I found the CD ROM's laboratory more interesting than amphitheatre	75%	45%
I concentrate better when I work on a book	64%	36%

In spite of these remarks, generally the students judged the tool positively. 78% of them said that the CD ROM was a great help in understanding the method (8% did not) and 71% that it was in-depth understanding (17% do not agree). For 73% of them, the visual aspect helped them to memorise more easily. For those items, the difference between answers of group A and group B students was not significant.

Tool's efficiency

We saw that students liked the CD ROM and thought it was a good learning aide but what was the real cognitive contribution of the tool ? To try to answer this question, we compare the marks of group A and group B obtained from the two tests at the end of the three week course on ACP (questionnaires 3 and 4). In questionnaire 3, we tested the understanding of concepts and, in questionnaire 4, the ability to use the concepts (interpretation of the results of an ACP made on real data). In both cases, the difference between groups was not significant (see table 2). Students' performance seemed to be the same, whether they studied alone with the CD ROM or attended to the regular course.

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Table 2: Results to evaluation of concepts understanding (questionnaire 3) and techniques mastering (questionnaire 4)

	Mean (grade out of 12)	Standard deviation	No. of students in the group
Group A			
Savoirs	6.44	3.13	24
Savoir-faire	5.73	3.27	

We discovered out that the marks to tests were correlated for group A (r=0.727) and not for group B (r=0.404). It then seems that students who studied with the CD ROM make better connection (right or wrong) between the concepts and the techniques.

Conclusion

As we thought, students were motivated by the use of the tool. At least, those who tried it, as half of them did not use it. This is probably cultural (we noticed that our Anglo-Saxon students have a different attitude toward technology) and this will certainly decrease in the future. If a great majority of students said that the tool helped them to understand the method, the evaluation we conducted shows that the multimedia tool helped them to apply knowledge they mastered more easily but do not help them to master knowledge more than a traditional course does.

Student's answers showed that if they thought about mastering the method at the end of the semester (almost 90% of the students say so), it was because of the whole programme and not only because of a part of it (like the CD). 78% of the students stressed the positive effect of the final report (processing and interpretation of their own data). Apparently, students who initially worked on the CD ROM thought that they master the method better than students who attended the course: 96,9% of group A students (32 answers) versus 82,2% of group B students (45 answers). But this does not mean that they effectively do: the difference between final reports means of groups A and B was not significant (t=1,22). We think that this lack of lucidity might be explained by the lack of human interactivity. The importance of the interactions between peers and between teacher and students is well known (see for example proceedings of the CIEAEM 49, 1998). It seems to us that the role of the teacher (but also of the interactions between students) is to lead students to permanently question their mastering of knowledge. Anyway, students answers to questionnaire 5 stressed the fact that they are asking for more communication and interaction.

This interactivity can not be reached by the kind of tool we experimented. It is an important limit of it. But the results of this study also showed what we think is a important positive effect: a better connection between concepts and techniques. This

leads us to imagine another programme integrating multimedia and allowing human interaction, between peers and with a teacher: we are now working on the construction of an Internet platform of co-operative distance learning.

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