USING A COMPUTER-AIDED PBL APPROACH IN THE DESIGN OF A COURSE IN ENTREPRENEURSHIP AND MANAGEMENT

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Abstract: In a Management Science MSc. course, we use a computer-aided approach to conjugate multivariate analysis with decision support through optimization tools. The targeted decision support is based on a methodology that relies on specific problems built to promote learning. The optimality of discrete decisions on uncertain environment is aimed, they are applied computational tools onto multivariate analysis and optimization frameworks and these tools support the development of decision rules. Case problems specifically built are focused, as investments programming, financial risk treatment, or supply chain planning and distribution activities, on a Problem Based Learning (PBL) approach. This PBL methodology is embedded on a context where we simulate enterprise computer-aided activities and this immersive approach is encapsulated by a blended learning framework. Considering the intensive schedule that is defined to cope with the student-workers availability, this approach avoids some dislike related to long lectures of quantitative kind, which can reach eight hours in continuum.

1 INTRODUCTION

In this paper, it is presented a computer-aided approach that we had applied to conjugate multivariate analysis and decision support, in a course of a Management Science MSc. program: the Entrepreneurship and Management of Small and Medium Enterprise (SME).

The lectures schedule assumes an intensive and aggregative form, defined this way to accomplish with student-workers availability. Ours lectures of mathematics kind are assigned in blocks of four hours, and this can originate some dislike among students. Then, we had built specific and realistic cases, where decision support principles are focused, based on optimization of probabilistic measures. Consequently, the computer-aided approach that underlies the learning process is compulsory.

The case problems are focusing investments programming and financial risk treatment, or supply chain planning and distribution activities. We present a Problem Based Learning (PBL) approach: this methodology is based on problems, and it is embedded on enterprise and businesses contexts. Also, enterprise computer-aided activities are simulated, and a blended learning framework encapsulates all the procedures.

The structure of the paper is as follows: in Section 2, the purposes of the Management Science MSc. program and the course addressed in this paper are synoptically described; in Section 3, it is described how the learning methodologies, based on problem specifically built are conjugated with the computer-aided environment and assessment; then, two illustrative examples are described in Section 4, focusing supply chain planning and investment and financial issues; finally, main conclusions are presented in Section 5.

2 BRIEF DESCRIPTION OF THE MSC PROGRAM

In this Section, they are synoptically described the purposes of the Management Science MSc. program that aims entrepreneurship and small and medium enterprises (SME), and the course that focuses optimal decision rules.

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2.1 The Entrepreneurship and Management of SME MSc. Program

The MSc. program in Entrepreneurship and Management of SME is developed (Mourato, 2007) with the purpose to train business professionals which are able to:

- Develop business plans;
- Implement businesses;
- Develop, implement and monitor business strategic plans;
- Develop, implement and monitor systems of performance assessment;
- Develop marketing plans;
- Engineer and re-engineer financially enterprises;
- Develop, implement and monitor innovation systems.

In this program, it is aimed that the student has competences to develop activities in each level of the enterprise. That means the student must be able to design a business plan, to assume risk as entrepreneur, to design a project and to develop the related technical activities, and to supervise the evolution of the planned activities. Also, the student must understand the environment where he is placed, together within the main line forces. The polyvalence targeted is developed through the conception of a final project.

Accordingly with the described characteristics, the following professional profiles are targeted:

- The entrepreneur, who must be able to transform and idea in a business, to develop strategic understanding, to materialize its organization capacities, to master bargain techniques;
- The project coordinator, who must present fine tuned leadership capacities and to master planning techniques and tools;
- The technical director, who must to master techniques of several fields, such the financial, the marketing and the organizational behaviour fields.
- The controller, who must be capable to monitor the enterprise performance in several specialties, and to promote relationships development.

It must be referred the wide interest revealed in this MSc. program dedicated to Entrepreneurship and Management of SME, with a large number of candidates. The selected candidates are student-workers, a status that is also addressed by the intensive schedule of lectures. Some of the students are in-between jobs, but there is also a group with responsible posts (Figure 1).

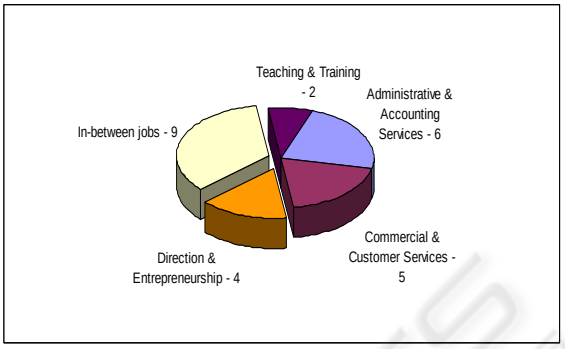

Figure 1: Function types of the Msc students.

Nevertheless the schedule or the time availability of the student-workers, a course that treats multivariate analysis and decision support is crucial on the real world of entrepreneurship and enterprises.

2.2 The Multivariate Analysis and Decision Support Course

The course dedicated to multivariate analysis and to decision support is focusing the treatment of uncertainty related to decision making, on a context of enterprise management. The treatment of uncertainty, together with the assessment of risk, is based on statistic analysis conjugated with computational implementation.

The target is the efficient use of multivariate statistics, from data gathering to data treatment, and also focusing the insight on results. Then, the decision support is based on probabilistic methods of optimization (Mathematical Programming), by applying parametric and stochastic approaches, to define and adjust decision rules. The course is thus formally partitioned in two modules, but there is built the underlying connection in between, through the learning methodology that is based in case problems and supported in computational tasks, as described in Section 3.

The specific purposes of the first module, dedicated to multivariate analysis, are related to the critical use of the methodologies that aims data gathering, data treatment, analysis of results, and it includes:

- The multivariate analysis basics;
- The organization and treatment of multivariate data;
- Forecasting;
- Hypothesis testing with multivariate analysis;
- Multivariate regression analysis;

- Several applications, of interest, to be described later in Section 4.

They are aimed competences on statistical methods related to multivariate data, and to develop perspective about computational results due to several difficulties foreseen from the graduation background of the students: mainly, the students are graduated on Management Science specialties, but they are also students from Engineering and Social Sciences fields (Figure 2).

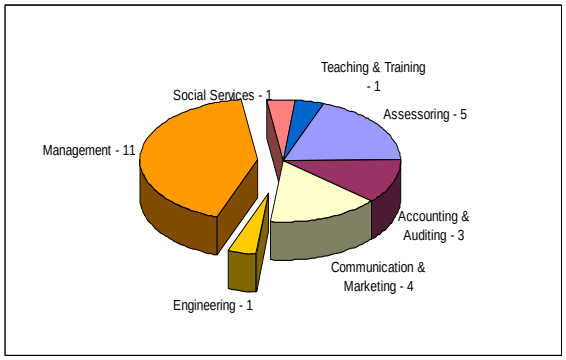

Figure 2: Type of graduates on the MSc course.

The second module is dedicated to decision support, and it is based on optimization (Mathematical Programming) tools from probabilistic nature. Then, recurring to parametric and stochastic methods, the procedure to build decision rules is addressed. They are focused the following subjects:

- Decision Theory;
- Game Theory;
- Stochastic Linear Programming;
- Network Optimization;
- Several applications, complementary to the first module, to be described in Section 4.

It is aimed to understand, to develop and to use quantitative methods in a way to optimize decision rules. As in the first module that addresses multivariate analysis, the oral presentation, the treatment of problems embedded on real cases, the resolution of basic exercises and the computational application of the notions are the main pedagogic subjects. The methodologies are presented in next Section.

3 LEARNING METHODOLOGIES

In this section, the learning methodologies are focused, and it is also described how they are conjugated with the computer-aided approaches, namely, onto the specific problems that are built and the learning assessment.

The computer support is necessary, due to the management environment that is intended to simulate, where statistics and optimization methods are day-to-day tools. Also, it promotes the learning success on the referred fields, which are commonly recognized as very difficult. We must remember the weak or delicate conditioning in quantitative basics of the incoming students, originated even from Social Sciences specialties.

Consequently, we had to search new approaches in the sense to promote the learning success of students with quite different profiles. We thus conjugate various approaches and methodologies, and we assume a blended learning and encapsulating framework. It includes a simulation of enterprise context, assuming characteristics of an immersive learning or virtual learning environment (VLE) approaches, and a selection of cases, based in real situations arising in business context, including a PBL approach.

Heinze and Procter (2004) developed a definition for blended learning that states the facilitation of learning through:

- The combination of different modes of delivery – we distributed ours efforts from oral presentation, theoretic support, reading of selected texts and cases and B-On search, computational applications and assessment;
- The combination of different models of teaching – assuming a virtual environment, like the student is working on a enterprise where he faced some problems (specifically built to combine multivariate analysis and decision support subjects);
- The combination of different styles of learning – the personnel way of learn of each one of the students is allowed, as is usual on the PBL approach;
- The effective communication between all the elements involved – the team work is stimulated, and faculty simultaneously assumes instructive, tutoring or mentoring roles.

We intend to conjugate the human intervention with the electronic learning component, from the themes introduction and theoretic support (by the faculty), to the computer-aided jobs (from the student). It must be noticed that we target difficult fields like multivariate analysis and optimization, which aim at decision rules on an enterprise context.

We thus develop an immersive learning approach, which allows us to apply the same kind of

quantitative tools that are used in enterprise or business contexts. This contexts that we simulated promotes the student experiencing, and it draws near the challenge and the competition occurring in real businesses situations.

Usually, immersive learning is used to promote experiencing of critical incidents to security and rescue staff (riots, plane crashes, terrorist attacks, etc…), through virtual simulation of the complexity of such real situations, and the staff personnel must be able to face the stressful context. The main purposes of our approach are:

- To provide a context, simultaneously innovative and defiant, in which students can achieve the professional competencies, as entrepreneurs or for the careers focused (project coordinator, technical director, and controller) in enterprise or business environment.
- To facilitate learning, by spreading the application field of action of lectures to other information deliveries, we can improve student self-learning through problem solving approaches.

We intend to recreate enterprise or business challenging situations, through simulations of the trial-and-error learning cycle: decision, followed by feedback, new and improved decision. When the student follows this iterative procedure, he gains experience on make decisions, he has knowledge of his difficulties, and he learns with mistakes of his own.

This immersive approach resorts to critical understanding of the problematic situations, instead of the usual passive role of the student: he reads or hears about some subject, he has to mentally assimilate it, and to repeat the pre-defined answer in final. The immersive approach avoids some dislike or nuisance of the long lectures scheduled, foreseen in blocks of four hours, which can reach eight hours in continuum if the blocks are allocated side by side.

In a similar way, we use various information means (introductory presentation, web-based or electronic tutorials, texts reading, computer business applications, computer assessment and self-assessment), and we tried to recreate realistic problems. Thus, we simulate problematic situations that arise frequently in businesses world, namely, we present in this paper the contexts of logistics and supply chains operations, and in investments and financial markets: we thus assume a PBL approach.

4 THE PBL APPROACH

In this section, an approach based on realistic problems is described and two illustrative examples are focused: logistics and supply chain operations; and investment planning considering financial markets. The approach relies on realistic cases specifically built to address the subjects of decision support, optimization tools and multivariate analysis.

In the PBL approach, we use the referred problem situations, originated from real and professional life, and this also allows the simulation of the real procedures used to solve them. To solve these specific problems it is required competences on basics knowledge, in learning strategies, and team work skills. The overall purposes of our approach intend to develop and deepen the graduation knowledge, to promote innovation and research activities, to integrate multivariate analysis within decision support issues, and to promote autonomous learning on the entrepreneurship and enterprise contexts.

In a way to hold the interest of the students and avoid nuisance of long and intensive lectures in mathematics fields, we included some challenging elements from real life, from professional cases, to improve the efficiency of communication.

The student had active role, and his participation relies on a trial-and-error learning cycle to integrate knowledge on multivariate analysis and decision support themes. To achieve this, a combination of information deliveries is used and we also built specific problems to create defying situations, even to stress it up to induce bad decisions. The feedback on decisions is promptly known, through pre-established rewards or consequences, despite the fact the student can gather information from external sources. We used a combination of technology-based materials, computer-aided sessions, and oral communication to present each one of the realistic case problems.

4.1 Logistics and Supply Chain

The logistics and supply chain case was objectively written, it included an overview of the situation on the petrochemical (Julka *et al.*, 2002; Lasschuit and Thijssen, 2004; Neiro and Pinto, 2004) and pharmaceutics (Shah, 2004; Kallrath, 2002) multisite networks, their specific context, and the major decisions to be made.

There is and introductory presentation of the open-ended problem, of the possible scenarios, the critical data of the situation, and the related

knowledge is refreshed. The context considers a petrochemical cluster (Julka *et al.*, 2002) and its overall strategic management, to make decisions related:

- To select projects from a group of proposals;
- To increase the net value generation of the cluster;
- And to appreciate the support organizations and shared services of the cluster.

The focus is on the basic concepts behind Stochastic Linear Programming (SLP): SLP limitations, probabilistic data, and the trade-offs achieved from the optimal activity analysis. The case problem aims to the comprehension and insight of a SLP multiperiod problem where the formulation of the objective function and restrictions are detailed.

It is intended to develop students reasoning, to frame the problem situation, and the features of uncertainty and complexity that characterize the problem-solving approach are incorporated. The main steps for the student are the development of a specific problem statement, to list the quantitative or qualitative information needed, to formulate and test alternative hypotheses, to present and support the decisions(s) proposed. Thus, competences to solve problems are conjugated with the knowledge of data treatment, forecasting, time series (Tavares *et al*., 1996), and possible extensions are balanced.

4.2 Investment and Financial Problems

Following the former supply chain case, instances of a case of high level of complexity are presented, and reformulations considering financial and investment issues are treated.

It is introduced a robustness framework for planning, with a probabilistic measure of performance (Suh and Lee, 2001), where the worst scenario addresses the reference solution and a Pareto analysis is proposed. Also, it was focused the decision-making procedure to select the best robust scenario, which uses the Pareto curve and considers the trade-off between the expected performance and the robustness measure.

The main objectives are to develop and deepen the graduation knowledge, in an innovation and research environment, where computational applications are compulsory. The usual paradigm of problem solving supposes that we know the resolution route, but this route implies a complex relationship between reasoning and feeling, involves bad partial decisions, and some negative results. Consequently, our PBL approach considers the trial-and-error learning cycle.

The case problem is open-ended, and various extensions are suggested, like the following ones.

- The treatment of risk on investment planning (Rodera et al., 2002), through a multiobjective programming that requires an iterative procedure (Augmented Tchebycheff Algorithm). This procedure allows the visualization of the efficient solutions in the multidimensional space and facilitates the assessment of the economical risk of the project.
- The financial risk assessment and management, through various probabilistic estimators (Barbaro and Bagajewicz 2004a). Among others, they are specifically considered the expected profit, the financial risk and the downside risk. The maximization of the first one considers the at the same time the minimization of the others at every profit level.
- The use of inventory and financial tools such derivatives (Barbaro and Bagajewicz 2004b), options and futures, which are balanced in a way to manipulate risk curves. These notions are intuitive, but to effectively reduce risk it is necessary to consider appropriate models for risk management. Otherwise, the use of inventory or financial tools can lead to higher risk exposures.

Alternatively, a simplified approach (Guerreiro *et al*., 1986) is suitable for students originated from Social Sciences field.

5 CONCLUSIONS

A computer-aided approach is applied to conjugate multivariate analysis and decision support, in a course of a Management Science MSc. program that aims entrepreneurship and SME management.

The schedule of the program is designed to meet the needs of student workers. Thus, mathematical lectures are provided in intensive four-hour blocks. However, students would prefer shorter blocks of time, to avoid some nuisance or dislike.

Thus, realistic cases are built, specifically aimed at Management Science students, and it is featured some decision support principles, based on optimization of probabilistic measures. The multivariate analysis tools are compulsory, such as it is the computer-aided approach underlying the learning process. The case problems are focusing, among others, investments programming, financial risk treatment, or supply chain planning and distribution activities.

A Problem Based Learning (PBL) approach is assumed. This methodology based on problems is embedded on enterprise and businesses contexts, and enterprise computer-aided activities are simulated. Consequently, this immersive approach is encapsulated in a blended learning framework.

Finally, the faculty's role is critical as he acts as learning facilitator, he introduces cases and partial questions, he supports computational tasks, and he supervises team work.

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