TEACHING MANAGEMENT TO ENGINEERING STUDENTS: ACTING AS A LEARNING ORGANIZATION

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Abstract ¾ This paper summarizes an experience in teaching Management to undergraduate Engineering students. The aim was to enable, motivate, lead and coach students in learning management skills and concepts through their engagement in organizational and management work. This was closely associated with their reflection on such practice, and was complemented with theoretical studies, mostly self-directed and carried out in a cooperative environment – as though each class was a learning organization. We describe the pedagogical design, the projects and the activities developed with and by the students, and the way practical projects and theoretical studies interrelated. We also describe the cooperative learning environment that was built around class and mailing list discussions, the dissemination of information on paper, and the use of the Web. Students have been evaluated, through projects and papers, as they would in real work situations. Every moment of evaluation led to further learning and there was no need to resort to conventional examinations.

Index Terms ¾ Management skills, learning organizations, learning by doing, reflection in action.

INTRODUCTION AND OBJECTIVES

In 1996, as part of the restructuring of the curriculum of the Informatics Engineering degree of the Department of Informatics Engineering of the University of Coimbra, a one term subject on Management, mainly concerned with the teaching of financial management, has been replaced by a two-term subject on Management.

The first Author, a professional manager and consultant, acting as Invited Professor at the Department, had been appointed for the design and management of that subject for a period of three years. The second Author, Chairman of the Department, acted as a sponsor and consultant to the experience.

It was clear, from the very beginning, that the major aim of the course was not to achieve a very high degree of student professionalism in management, but to create a learning environment where they could learn the essential management skills, as well as the management concepts and theories that could enrich those skills. Given our aim, the paradigm, still dominant in Portuguese education, of first teaching theory and subsequently applying that theory in practical classes, could not be used.

DESIGN OF THE LEARNING ENVIRONMENT

In the preliminary reflection that conducted to the design of that learning environment, we have observed that most professional managers on duty today have not followed management studies at an undergraduate level. On the contrary, they have initially studied some other discipline. They have then begun to exercise that discipline in some organization, where they were managed by others. It was only later in their careers, when they had already reached a significant level of maturity, that they started to hold management responsibilities. When this time arrived, they would then start to learn management concepts more formally, following short professional courses or MBAs, reading management books and magazines, and sharing and reflecting with others on their own growing management experiences and improved management skills.

As a coincidence, a similar type of collective learning had happened in the community of Portuguese Information Systems practitioners and users that had formed around the six "Portuguese Congresses on Informatics" (CPIs) that had been organized, biannually, in Lisbon, between 1980 and 1990. The first Author had been a member of the organizing committee of four of the six CPIs and the two Authors had first met as members of the organizing committee of the third Congress.

Those observations led the Authors to understand that, in order to fulfil the identified objective, the subject would have to be centred on real organizational activities that the students should carry out, so as to let them practice and learn management skills and, in context, understand better the key management concepts and theories. The idea of organizing a conference as one of the main learning activities (with invited speakers instead of refereed papers, to let control remain in the hands of the students/organizers) also became very attractive.

Fortunately, a model for understanding the relationship between theory and practice, putting the emphasis on the "theories in use" that spark in activity [1], was available in the literature and was already familiar to the Authors. The same applied to a model that explored the "reflective practice" through which practitioners learn the skills of their disciplines [7] and was pertinent for use in creating new approaches to teaching and learning [8].

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On the other hand, engineering students do not normally tend to include management in their main interests and, in many cases, as pointed out by Blair [2], have not yet developed the essential skills to communicate, interact, carry out group work, or manage projects.

The desired learning environment should then accumulate the following characteristics:

- It should be based on real life organizational projects that were challenging enough to motivate the students from the very beginning;
- It should be run by a professor that could maintain high levels of motivation and commitment -- through his own leadership and management of the learning environment, the class and the projects -- and act as a role model that students could emulate in their own management practice;
- It should promote many opportunities for students to share their own learning, both practical and theoretical.

The first two points were put to practice through a style of leadership that promoted the use of open space [6] and self-organization of the activities [11]. The second point means indeed that the whole class should be lead as a "learning organization", maximizing the sharing of knowledge and learning experiences of the students. This is a conception of the learning organization that does not put the emphasis on teaching some disciplines [9], but more on using all the activities to enhance learning, acting as a "living organization" [4], [5]. Put another way, we needed to create a real community of practice [10] that should be, simultaneously, a community of reflection and learning about that practice.

Those principles have been consistently applied in the design of the learning environment and the management of the experience during three school years, from 1996 to 2000. In the next sections, we will describe, simultaneously, the design of the learning environment and how that design has been implemented.

ORGANIZATION OF A CONFERENCE (FIRST TERM)

The main practical activity of the first term is the organization of a one day "Conference on Management and Information Technologies" ("Encontro de Gestão e Tecnologias de Informação" – EGTI), open to all kinds of professional public, where the whole class (40 to 60 students) acts as the Organizing Committee of the event.

The Project and the number of members of the Organizing Committee are large enough to impose that many subgroups and the corresponding levels of coordination are needed and that group work is encouraged. Normally, students organize themselves in sub-groups responsible for:

- Marketing and External relations (including relations with sponsors).
- Program (including definition of subjects, selection and invitation of speakers and organization of the sessions).
- Logistics.
- Web site of the event (archives at http://egti.dei.uc.pt).

The students dedicate to the preparation of the event all the practice classes, except the five referred to below, as well as some out of class time.

The organization by the whole class of an event of this magnitude, where the prestige of the Department is at stake, allows for the creation of a strong feeling that the class is a team, and the success of the event is more important than the 'show off' of any individual contributions.

This allows for the encouragement, among the students, of shared values, collaboration among individual participants and sub-groups, and collaborative learning, which are at the opposed extreme of the values of selfish competition often created in many universities, so negative for the preparation of future engineers that must work and collaborate with others during their professional life.

As the sponsors are outside organizations and the speakers are normally managers and practitioners working for outside organizations (including ex-students that are now working as engineers) a close relationship between the Department and the outside world is stimulated.

Finally, the Professors of the Department are normally invited to chair the sessions of the Conference and to propose speakers, and the staff of the Department is involved in the organization, hence contributing for a sense of collective purpose and pride in the Department.

ORGANIZATION OF OTHER EVENTS (SECOND TERM)

In the second term, students that so wish can organize, in groups of 2 to 5, another smaller event (students that do not want to organize a new project will have to carry out another assignment, as described below).

During the three years of the experience, the following types of events have been organized by the students:

- Management Seminars.
- Technical Seminars and Expositions.
- Arts Exhibitions.
- Cinema Exhibitions.
- Social and Sports Events.
- Presentations from Prospective Employers.

These projects allowed the students to improve the skills they had developed in the first term project and contributed to create a new dynamics in the Department, as well as in its relationship with the outside world.

PRESENTATION AND DISCUSSIONS OF MANAGEMENT TEXTS

To initiate the learning dialogue, five practice classes in the first term are dedicated to the presentation, by groups of 2-3 students, of important management texts that they have previously prepared, followed by discussion by the whole class. In the first year, a selection of important texts published at the *Harvard Business Review* (HBR) has been discussed; in the second year, students have presented texts on "Basic Management Skills" written by Prof. G. Blair and available on the Internet [3].

These activities imply that students will have to read, prepare and discuss professional texts on management, will begin reading management magazines and will discuss management subjects at a more theoretical level. Students must write a paper or report of their presentations that will be made available on the Internet (archives at www.dei.uc.pt/gestao) and sometimes also on paper.

The five 2-hour practice classes dedicated to these presentations and discussions alternate with the practice classes dedicated to the preparation of the Conference.

Each student has to prepare and present one text with one or two colleagues. But he or she must attend and discuss nine other presentations made by other groups of colleagues.

Students begin to understand (even if that is not stated by the professor) that, if they do well each assignment, all the others will benefit, as they will benefit from the learning and work of all the other groups of colleagues. In order to be well prepared for the discussions, many students choose to study all the ten texts under discussion in each year. If they so wish, they can read the summaries of all the texts discussed in previous years, as they are available on the web.

Overall, a strong sharing of learning experiences is encouraged through this design.

MAILING LIST DISCUSSIONS

Due to the specificity of the Department, mailing lists and the Internet are widely used in all the courses. To support the activities of the Management subject there are many mailing lists in use:

- PG (first term) and GE (second term) are an aid to the management of the class activities – all teachers and students of the Subject are subscribers;
- "forum-gestao" is a thematic mailing list to discuss management subjects among the teachers and students as well as ex-students, professional managers and engineers (some invited and some that spontaneously subscribe to the list);
- one list is set up per each project to discuss the organizational activities among the members (eg: egti, for the first term Conference).

All the archives of the mailing lists are available at www.dei.uc.pt/majordomo. The archive has a search engine that allows for the visitors to search for keyword and see the previous discussions on that subject. This allows for all exchanges of messages in one year to be reused as learning materials in the future.

WEB RESOURCES

There is a Web site available at www.dei.uc.pt/gestao, run each year by a group of students, where the different presentations and papers produced by the students are made available. It can be accessed by the students of that year or of the following years. This leads to the progressive creation of a rich web resource and imposes that the texts under discussion must change from one year to the next ones.

A list of the HBR articles discussed in the first year is available at:
    http://eden.dei.uc.pt/gestao/forum/temas/index_tc.html.
Clicking in each text one can see the summary reports written by the students (in Portuguese). The texts produced in the second year of the experience are available at:
    http://eden.dei.uc.pt/gestao/forum/temas/index_td.html.
Students also use other Internet sites on management, available on the web. Some are suggested by the teacher, like [3]; others are discovered by the students and shared on the mailing lists.

LECTURES

The tradition of the Department of Informatics Engineering allocates to theoretical lectures part of the time devoted to a subject. In the first term these lectures are normally run by the professor (with interruption and discussion allowed at all times) and cover topics that are related to (or are needed for) the organization of the Conference. Questions on Project Management, Group Work and Strategic Management (mission, values, etc.) are thoroughly discussed and must be applied in the projects and papers produced by the students.

In the second term, themes related with the management of organizations, namely business, are covered, as well as recent management concepts. A general curriculum is defined, and followed, but the presentations are made normally by students that previously prepared each subject, and are followed by class discussion. In the second term the professor normally seats among the students, listening and commenting when needed.

A VIRTUAL ORGANIZATION (SECOND TERM)

In the second term, there is no global project involving the whole class, but the experience of participating in the organization of the Conference and of cooperative learning that took place in the first term must be continued.

So, in the second term, the class is defined as a virtual organization collectively responsible for:

- the organization of many small events

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- the realization of other projects and assignments
- the learning of the whole class.

In that virtual organization, each student must define his or her own individual objectives, so as to carry our three assignments, chosen among the following:
- organize a small event, in groups of 2 to 5 students, as previously referred;
- organize staff activities to help the whole class (for instance, the maintenance of the management site);
- prepare individually a subject of the program and run a one hour class (and/or write a paper);
- conduct a theoretical project that includes reading, summarizing and commenting at least one serious management book or three management articles;
- individually study, summarize and criticize an article of a management magazine;
- develop a project to create an enterprise;
- develop a strategic or organizational study for a concrete enterprise.

The last two types of projects are not made available to the whole class, for confidentiality reasons – and those are the only two types of activities that are not shared and do not contribute directly to collective learning.

EVALUATION OF THE STUDENTS

In the first term, students are evaluated on the basis of:
- their participation in the Organizing Committee of the Conference, based on a self-evaluation of personal participation, the collective evaluation of each sub-group and an evaluation interview with the professor;
- a written paper and the presentation of an article in the classes;
- overall participation in class discussions (including the discussion of papers presented by other groups) and participation in the mailing lists.

In the second term students are evaluated through the accomplishment of the objectives they have chosen for each of the three assignments. Their participation in class and list discussions will allow for a small adjustment done by the professor.

In the Management subject the objective of individual and collective learning drives all the activities and the evaluation moments result from individual or group activity and are reusable for the learning of the whole class (with the exceptions just mentioned) and there is no need to resort to conventional examinations.

THE MANAGEMENT LAB

At the end of the first year of the experience, students that were about to "graduate" from the subject approached the professor asking how they could, in the next year, continue to organize activities and improve their management skills and knowledge, apart from their continuing participation in the thematic mailing list.

This stimulated the professor to propose to the Scientific Committee of the Department the creation of a Management Lab where:
- all the professors and students of the Management subject are automatically subscribed as members, but any other professors and ex-students of the Department can apply for membership;
- the Lab has its own regulation and elected representatives;
- the Lab is responsible for the coordination of the activities of the second term and allows for the ex-students to be close to the activities of the Department, acting as consultants, invited speakers, sources of information and contacts with the outside world;
- the Lab contributes to further integrate the students (specially in the second term) in a new organizational setting.

CONCLUSION

In the experience reported we have applied modern conceptions from both the managerial field (leadership, empowerment, learning organizations, open space technology, self-directed teams, communities of practice) and the field of learning (student centred learning, cooperative learning, learning by doing, learning by reflecting in action, e-learning). The emphasis has been put in the creation of a learning environment where the students learn to work and learn to learn together, preparing them for genuine lifelong learning.

We are convinced that this experience is innovative in Portugal and that the students that graduate from the Department have acquired remarkable management skills and an experience of organizational work that could not be obtained with more traditional lecturing. This is, actually, confirmed by a growing number of employers that prize our students for the management skills and social awareness they are capable of harmoniously associate with their technical competencies (computer science and computer network).

We would be glad to share our experience and would like to know of similar experiences in teaching Management to engineering students around the world. We would also like to engage in a regular form of international collaboration aimed at interchanging experiences in this domain and creating an overall interactive community of practice. This might even lead to the creation of a web resource on Management for Engineering Students to be used by all interested universities worldwide.

REFERENCES

[1]   Argyris, C, and Schön, D, Theory in Practice, Jossey-Bass, 1974.

[2] Blair, G, "The Need for Project Management Skills in Newly Graduated Electrical Engineers", **http://www.ee.ed.ac.uk/~gerard/Teaching/index.html**, 1991.

[3] Blair, G, "Basic Management Skills", **http://www.ee.ed.ac.uk/~gerard/Management**, 1996.

[4] de Geus, A, "Planning as Learning", *Harvard Business Review*, Vol. 66, No 2., 1988, pp. 70.

[5] de Geus, A, *The Living Company – Growth, Learning and Longevity in Business*, Harvard Business School Press, 1997.

[6] Owen, H, *Open Space Technology – a User's Guide*, Berrett-Koehler, 1997.

[7] Schön, D, *The Reflective Practitioner – How Professionals Think in Action*, Basic Books, 1983.

[8] Schön, D, *Educating the Reflective Practitioner – Toward New Design for Teaching and Learning in the Professions*, Jossey-Bass, 1987.

[9] Senge, P, *The Fifth Discipline*, Doubleday, 1990.

[10] Wenger, E, *Communities of Practice – Learning, Meaning, and Identity*, Cambridge University Press, 1998.

[11] Wheatley, M, *Leadership and the New Science – Discovering Order in a Chaotic World*, Berrett-Koehler, 1999.