Fourth international workshop on Active Learning in Engineering Education. Nantes, France, June 6-9 2004 "*From activity to active learning, or how to learn to act with competence!*"

ACTIVE PEDAGOGY AS AN ESSENTIAL COMPLEMENT FOR PROJECT-BASED LEARNING

Siegfried ROUVRAIS, Jean-Marie GILLIOT, G. LANDRAC, D. DEGRUGILLIER, S. HOUCKE
ENST Bretagne
Technopole Brest-Iroise, CS 83818, 29238 Brest, France
e-mail : siegfried.rouvrais@enst-bretagne.fr

SUMMARY : *Our institution is a French "Grande Ecole" (MSc level) which trains numerous engineers. It has adopted, years ago, a project-based learning method (i.e. PBL), considering that it was essential to place our students in situations similar to those they will face in their professional careers. However, PBL is not ideally sufficient for our new incoming students. They lack autonomy in their learning process and are not used to working in groups or share knowledge. Therefore, they cannot collect the full benefits associated with PBL efficiently.*
A prior experience of active pedagogy is of great interest as it favors the students' autonomy in the learning process and stresses the members' importance in the project realization. Also, it allows students to develop a global view on their project and a better understanding of the combination of several disciplines. Active pedagogy was implemented in our curriculum in 2003. In our practice, active pedagogy relies on long-term project-based sessions. The project itself becomes the context for an active learning environment preparing for future large-scale projects during the rest of the curriculum. The competences highlighted in our new active learning project now induce a new competence referential in all the curricula.

KEY-WORDS : *engineering education, PBL, competences, large-scale projects, groups, self-analysis.*

1. INTRODUCTION

Our institution is a French "*Grande Ecole*" (i.e. graduate Engineering School equivalent to MSc engineering level) which trains numerous engineers in the fields of science, information technologies and communication technologies. It is a member of a leading body, the GET (i.e. "*Groupe des Ecoles des Telecommunications*"), which is the largest French training center for engineers in telecommunications, with over 1000 graduates per year. Our institution has a clear focus on the industrial and professional world and possesses incubator units as well as start-up companies. It has already adopted the Socrates/Erasmus ECTS credit systems which very much resemble that of the North American universities.

Our students join the institution after two years of selective preparatory schools where they merely acquire a high level theoretical scientific knowledge. Since French preparatory schools do not prepare students to the actual engineering practice which require know-how-to-do as well as know-how-to-be, our institution has adopted, years ago, a project-based learning method involving large practical workshops focused on engineering activities and group practice. Project-based learning (i.e. PBL) is essential as it places our students in situations similar to those they will face in their professional careers and gives them a global view on engineering activities constraints (cf. 2001 and 2003 French colloquia on project-based pedagogy organized by ENSIETA and our institution, cf. ENST Bretagne and ENSIETA, 2003).

However, PBL is not ideally sufficient for our new incoming students. Those new students lack autonomy in their learning process (i.e. they are more familiar with knowledge restitution) and are not used to working in groups or share knowledge. Therefore, they cannot collect the full benefits associated with PBL efficiently. PBL requires previously developed competences. Therefore, we investigated the introduction of active pedagogy in the first year long project (cf. Landrac et al., 2004), merely focusing on groups working with associated tutors, in order to provide, students with the specific basic competences to be developed through further large scale projects during the curriculum.

This paper presents our approach of using active pedagogy in the first year project as a complement for further large projects under the PBL paradigm. It is structured as follows. Section 2 presents the basic background of our new incoming students after their "preparatory schools". Section 3 addresses the PBL

experiences of our institution, and their benefits for our students. Section 4 briefly discusses the difficulty for students to pass from a classical learning paradigm to PBL. Then, Section 5 presents our first experience with active pedagogy to facilitate the development of new competences by those incoming students. Finally, Section 6 concludes by providing some perspectives for our next academic year.

2. STUDENTS BACKGROUND

2.1. Preparatory schools

Students who wish to pursue their study in our selective institution must prior complete a French "preparatory school". After at least two years, those schools give access to the national competitive entry into the elite "*Grandes Ecoles*" of which our institution is a member. In the preparatory schools, the education follows a relatively formal approach based on "absorption" and "restitution" of knowledge. French preparatory schools programs are deliberately very intensive and sometimes emotionally harsh. They are designed to prepare students to take the brutal examinations for entry into the "*Grandes Ecoles*". There, students acquire a solid theoretical scientific knowledge delivered through a strict academic teaching method, mostly based on individual learning using classical teaching paradigms. Students primarily work alone and their capacity of cooperation is rarely solicited. They are used to integrate any new information into existing classical cognitive structures.

2.2. Luggage when arriving

Accordingly, those students arrives in our institution with their "luggage" including knowledge, know-how-to-do and know-how-to-be. Those three dimensions are the basis to develop future competences.

However, due to their prior education, the knowledge dimension takes a large part of their luggage. The know-how-to-do dimension is relatively poor due to few weekly laboratories or practicals in preparatory schools. The know-how-to-be dimension can be considered as "empty" as regards group working and engineering competences. Due to this lack of know-how, students are not fully prepared to the professional practical world.

3. PBL BENEFITS FOR ENGINEERING EDUCATION

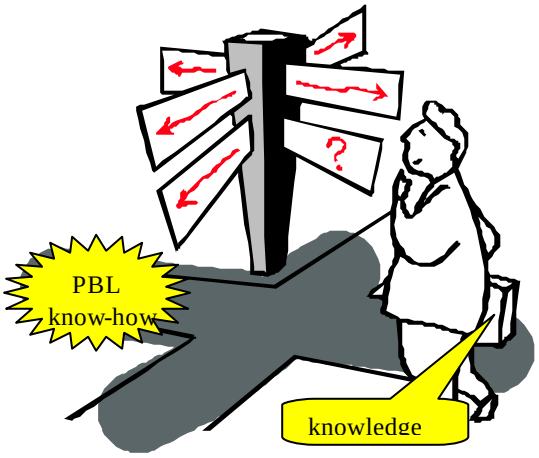
In light of this problem, our institution has adopted, years ago, a project-based learning method. Our projects mostly consist in practicals focused on engineering activities and group practices and rely more and more on large-scale projects (i.e. one day per weak during the entire curriculum). ENST Bretagne is now a leading actor of project-pedagogy in France (cf. Delisle, 1997), even if it still maintains a large place (i.e. around 75%) for traditional classrooms with courses (i.e. formal education), exercises and practicals.

3.1. Projects for engineering education

PBL is designed to place our students in "authentic" situations which they are likely to encounter in their professional careers and to give them a global view on engineering activities constraints (e.g. several domains, competence requirements). Projects also aim at stimulating the learning capacity of students and have a pervasive influence on their motivations. In order to achieve this, PBL confront the students to a practical engineering problem, involving several disciplines, which they have to solve as a group. Students, in groups, come into the projects only equipped with their prior theoretical knowledge and basic know-how abilities. Thanks to a real contextualization within their future professional activities, PBL conduct students to develop theories around practical problems and their solutions (cf. Brooks and Brooks, 2002). It also permits students to increase their decision-making skills concerning engineering problems, often combining several scientific disciplines (e.g. computer science, telecommunications, electronics) and a variety of informational resources. Finally, PBL offers students an opportunity to work within a group, showing them the importance of inter-personal skills (allocation of tasks, solution to disagreements, etc.). Overall, our experience in PBL proves that learning in engineering is favored by active manipulation, and that this teaching method improves the preparation of our students to their professional careers.

3.2. Learn to act with competences

Acting with competences means knowing how to react in a professional or training work situation, when confronted to a practical problem. Practical cases never raise clean-cut theoretical principles. With PBL, competences are put into context. In PBL, students have to determine how to find a global solution, by using their acquired knowledge, increasing such knowledge through alternative sources of information, and combining all this for a solution. In addition, they have to collaborate and reach an agreement in order to specify or solve projects. This way, they improve or acquire new competences such as conceptualization, auto-regulation and reflexivity (cf. Shön, 1983). In PBL, tutors should be more preoccupied with pedagogical issues, i.e. teaching how to find a solution by applying competences, than with production issues, i.e. finding the actual solution to the problem. Unfortunately, it is not always the case and students have often a hard time realizing by themselves that passing from a classical paradigm to PBL requires new competences from students and that it is essential to learn to act with competences.



4. FROM THEORITICAL SKILLS TO EFFICIENT PBL PRACTICE

When students arrive in our institution their luggage is quite empty as regards know-how. With only knowledge in their luggage, discovering large-scale projects is complicated for students as it mixes the different pedagogical objectives regarding each project. In practice, students do not really know how to work in groups (e.g. animation, decision, scheduling), nor how to find their place in such groups. Moreover, they are familiar with "absorbing" knowledge delivered in traditional classrooms and often do not know where to find additional information by themselves. Finally, they are more used to "restituting" their theoretical knowledge, than to adjust it to practical situations after an analysis of the problem submitted to them. Consequently, their first PBL experience is rarely conclusive and we can clearly notice that they are not fully prepared for further projects. In light of these difficulties, we believe that students clearly need an easier first step, less focused on technical and engineering issues, so as to fill their luggage with primary know-how and benefit from further PBL projects to the greatest extent possible.

5. ACTIVE LEARNING AS A FIRST STEP

A prior experience of active pedagogy (cf. Johnson, Johnson and Smith, 1991) is of great interest as it favors the autonomy of the students in the learning process (e.g. self-analysis of the work achieved within the group, autonomous discovery of alternative information sources). It facilitates the work in group in stressing the members' importance in the project realization (e.g. analysis of behaviors, interactions and allocation of responsibilities). Finally, it allows students to develop a global view on a project and a better understanding of the combination of several disciplines. Students must actively learn to act with specific competences in order to use them for further projects. Accordingly, our previous experience of PBL has encouraged us to provide a preliminary competence framework in the first year of training through the use of active pedagogy.

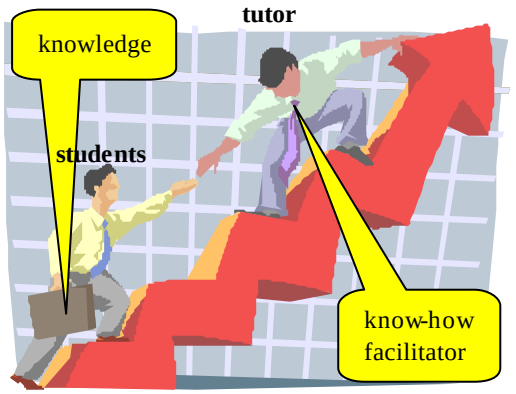
5.1. Facilitating group behaviors: know-how-to-be

The collaborative work on a project (cf. Jaques, 2000), with students sharing and helping each other, is a primary element for PBL. Active pedagogy is of great interest because it initiates

students to this cooperative approach where opinions and decisions need to be democratically shared. Students have different roles in a group and are rapidly confronted to decision making problems. During the entire first project (cf. Landrac et al., 2004), students have to monitor their own behaviors, including by drafting related synthetic notes. Those notes allow them to have a better view on their inter-personal skills and provide a follow up which is very helpful for finding solutions during the current project or further PBL projects (cf. De Grave, Boshuizen and Schmidt, 1996).

5.2. Approach: groups facilitated by a tutor

Active pedagogy was implemented in our curriculum in 2003. In our practice, active pedagogy relies on long-term project-based sessions (one day per week during 14 weeks) in order to achieve the above-mentioned goals for the first year project. Students can acquire 4 ECTS credits for this project with groups composed of 6 to 8 students.



In practice, we involve tutors (mainly as questioners and facilitators) whose mission is to trigger self-analysis among members of the group, promote adaptability and autonomy of students, and more generally help them identifying the learning process, e.g. what was learnt, how it was learnt, and how it can be applied again in another context (i.e. transfer). Overall, the role of a tutor is to demonstrate to students that, ultimately, they should be able to perform projects through self-training. The group of tutors, taken from the teacher's staff, has been greatly helped in its task by the experts of the "Université catholique de Louvain" (UCL, Belgium) which has now acquired a long-term practice in active pedagogy.

6. CONCLUSION AND PERSPECTIVES

Our theoretically-clever incoming students require a preliminary active learning of basic know-how-to-do and know-how-to-be for the rest of their curriculum. For relevance purposes, our engineering training based on PBL had to preserve coherence between its pedagogical objectives related to competences and the technical projects themselves. The first 14-day project introduces an active learning environment preparing for future large-scale projects for the rest of the curriculum. During this first project, the product to be created is the not the primary goal. This first project prepares students to group working and inter-disciplinary context with a view to further large-scale projects. It involves trained-tutors following groups as facilitators and mirrors.

Active pedagogy, for its first implementation in our institution this academic year, conceptualizes autonomy, reflexivity and collaboration in the work environment with a view to future large-scale projects. This first active pedagogy experience, used as a complement for PBL, could not be validated as of today, but considering the results achieved this year, we are clearly optimistic for the future.

The competences highlighted in our new active learning project induce now a new competence referential in all the curricula, and a formalization of our competence referential throughout our various semester projects has been engaged. The monitoring, by students, is still oriented on specific training and competence.

In addition, we are exploring pedagogical solutions to facilitate the transition from classical learning paradigms to more adequate ones by testing and integrating new solutions (e.g. Folios, cf. Danielson and L. Abrutyn, 1997, on-line simulations, cf. Gilliot and Rouvrais, 2004).

REFERENCES

J. G. Brooks and M. G. Brooks, 2002. In Search of Understanding: The Case for Constructivist Classrooms. Ed. Association for Supervision and Curriculum Development, ASCD, revised version.

C. Danielson and L. Abrutyn, 1997. An Introduction to Using Portfolios in the Classroom. Ed. Association for Supervision and

Curriculum Development, ASCD.

W. S. De Grave, H. P. A. Boshuizen and H. G. Schmidt, 1996. Problem-based Learning: Cognitive and Metacognitive Processes during Problem Analysis. Instructional Science, 24.

R. Delisle, 1997. How to Use Problem-Based Learning in the Classroom. Association for Supervision and Curriculum Development, ASCD.

ENST BRETAGNE and ENSIETA, 2003, 2001. Colloquium Acta, Project Pedagogy in Higher Education [1]; Questions of Pedagogy in Higher Education [2]. Ed. GLAT (Groupe de linguistique Appliquée des Télécoms).

J-M. Gilliot and S. Rouvrais, 2004. A Pedagogical Canvas for On-line Simulation-based Lessons. World Conference on Educational Multimedia, Hypermedia and Telecommunications, ED-MEDIA.

D. Jaques, 2000. Learning in Groups: A Handbook for Improving Group Learning. Ed. Kogan Page Ltd, 3rd Edition.

D. Johnson, R. Johnson and K. Smith, 1991. Active Learning: Cooperation in the College Classroom. Edina, Ed. Interaction Book Company.

G. Landrac, D. Degrugillier, J-M. Gilliot, S. Rouvrais and S. Houcke, 2004. The Project "Introduction to Complex System" at the ENST Bretagne. In Fourth international workshop on Active Learning in Engineering Education. Nantes, France, June 6-9.

D. Shön, 1983. The Reflexive Practitioner. Editor: Basic Books, New York.