Feedback on work based learning for engineers as a reply to industrial demands.

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Abstract
This paper deals with the presentation of the expertise of our department, Exploitation Engineers of Production Systems (IESP) from Polytech'Lille, who delivers a degree in engineering (speciality production). The specificity of our education program is work based learning as a reply to our strong partnership with industries. We present the historical setting up of our department created to answer the demands of industrials and its evolution: its strength relies on a 17 year of background experience. It's important to consider the whole French educational system and our legal framework that allows different ways of access to our diploma dealing with lifelong learning. Our learners are already employees with professional experiences (Long Life Learning) or young adults entering the professional system (apprenticeship). Our educational curriculum is composed of both academic periods in the school and industrial periods within a specific frequency (sandwich course). This approach gives priority to the development of the learner's skills. Our work based learning program is elaborated from a professional profile defined by our industrial partners. It is declined through an academic program that focuses on inductive pedagogy and a work placement training period with a dual tutoring by the school and the firm)that both evaluate the learner's skills. Our conclusion deals with the feedback of our practice and the key points: especially the importance of the involvement of the different partners (learners, teachers, tutors, mentors) and the training of the trainers. In addition the evolution of our industrial partners should be taken into account to adapt ourselves to the international context.

Keywords: work based learning, professional profile, work placement training period, professional skills, tutoring, inductive pedagogy, legal framework, lifelong learning, sandwich course

1. Introduction

Our department Exploitation Engineers of Production Systems (IESP) of Polytech'Lille is in charge of delivering a degree in engineering (speciality production). The school is part of the national Polytech network composed of 11 French Engineering schools covering 5 main domains (mechanics, computer science, electricity and electronics, civil engineering and food processing and biotechnology) within 50 scientific and technical fields taking advantages of research context. Each year 9 400 students are enrolled in the academic syllabus that lasts 5 years (2 years after high school degree+3 years) to get the French engineering diploma. This diploma is a Master degree which represents technical and management skills really valued in the labour market; the diploma allows access to a high social position. It is accredited by the Engineer Title Commission (CTI) that gives credit to the diploma and to the functioning of our structure. Four ways exist to get the diploma as shown on figure 1: general education, Initial Vocational education and Training (IVT), Continuing Vocational education and Training (CVT), and Accreditation of Prior Experiential Learning (APEL). Currently the legal framework reinforces the development of qualification and diploma within work based learning programs (developing a learner's proficiency and competency in the work place and because of the work place). Indeed the new law for social modernisation in 2002 (French Government, 2002) concerning higher education regulates recognition of prior and experience learning, formal, informal and non-formal learning with main changes: it's a right for individuals to claim the accreditation of their whole experiences (not only professional); in addition all types of qualifications are concerned. Such an interest from French policy is historical: since

1934 with State Engineer diploma (for people who have carried out engineering functions for at least five years) and the following laws in 1985 (that authorises access to all levels of higher education based on personal and professional experience) and its evolution in 1992. In 1992, our department was created as a reply to the demand of industrial companies (energy sector, metallurgy, food industry, automotive sector and chemical engineering as well as aeronautics) and 2 professional organisations (metallurgy and chemical). This demand was expressed as the need to reduce the lack of engineers with practical experience for production process management (young graduates preferring finance, research and development, methods and marketing sectors) and to promote technicians with recognised skill potential. The educational program was first created for employees with professional experience longer than 5 years (15 years as a mean value in fact). In 2004, the offer was completed with a vocational program for young adults with no expected experience to help the recruitment process of our partners. Both training programs are based on the same professional profile associated with inductive pedagogy. Our strong industrial partnership is effective thanks to our decision process of academic curriculum and its evolution relying on a board of management (both industrial and university members) but also within dual tutoring (school and firm) for work placement training period and the assessment of learner skills. Funds for our department come from learner fees (CVT) directly paid by companies like the salary of the learner, the costs of travelling and housing. Fees are free for apprentices (IVT) but the training is financed thanks to legal tax for apprenticeship. The company also pay the salary (work contract).

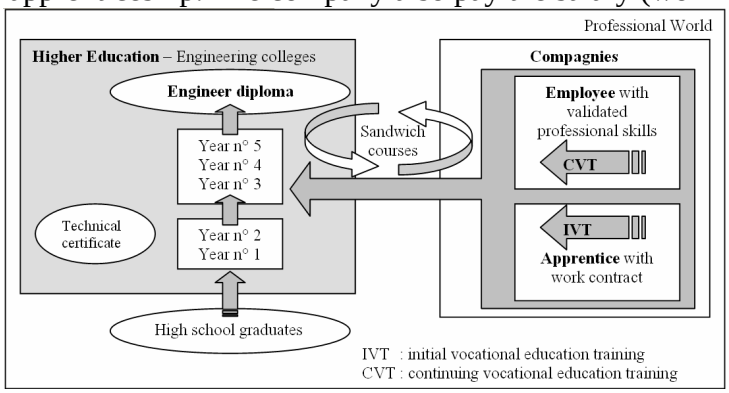

Figure 1: different ways of access to French diploma

2. Academic program and work based experience

The specificity of our educational program is to propose academic education periods that alternate with periods of training in the company (sandwich courses). Both ways of access (IVT and CVT) follow the same selection process and training path to the diploma all along the semesters of the engineer cycle (Armsby et al., 2006)(Boud et al., 2001). The department first validates the professional experience qualification of the learners enrolled in CVT. This public has a strong knowledge of professional life but often has forbidden lots of scientific tools and methodologies. So the first semester of the training is dedicated to the acquisition and reactivation of the learning mechanisms. This is the main difference with the young adults enrolled in IVT (apprentices) that has just graduated as technician or technical certificate (2 years after High school diploma). This public has a good scientific background but has a lack of knowledge about professional life. Therefore the first two semesters of the training are dedicated to the acquisition of a built guidance and of an Experimental and Reasoned Knowledge of Professional life (CERE). The first period is always a hard one due to high personal workload for CVT public: new life to lead (professional, educational and personal) with the constraint of alternated periods that implies living in different places. But this is also the clue to improve mobility and discover new ways of thinking. Indeed our promotions always present different social situations, different company cultures that are really a plus for our education program as experiences are transferred between learners, tutors,… The Engineering cycle ends with a two year period dedicated to the work based experience (engineer mission). All along the training, the learner is expected to become more and more autonomous and

evolve from his first working level as a technician to the status of engineer. The main difference is for him to integrate the criticism analysis faculty and management competencies. The training period evolves in an industrial work setting and constitutes a real investment for the company that provides an appropriate environment for the engineering training. The learner is put in an active position to reach his goal (formalisation and assessing his knowledge, skills and competencies acquired in the workplace) within learning (prior, experiential, formal, non formal... learning). The following table presents the academic and work based experience charge. It's important to note that the learner is expected to stand an important workload: both in the company to make his mission a success and at school to get the knowledge and the qualification.

Diploma access	**Duration of engineering cycle**	**Academic program**	**Period in the company**	**Estimated Personal workload**
Lifelong learning	Qualification + 5 semesters	1 200 h	1 800 h	2 100 h
Vocational learning	6 semesters	1 800 h	3 600 h	900 h
Formal learning	6 semesters	2 700 h	1 200 h	1 250 h

Table 1: curriculum workload (at school, in the industry, and estimated personal one)

The professional profile is linked to the expected competencies of an Exploitation Engineer of Production Systems who has to work in a state of mind dealing with: evolution, progress, adaptation in order to guarantee the everlastingness of the firm. Proof of this engineer attitude is given using the following set: Quality, Reactivity and Feedback, Profitability and Safety. In addition, the engineer's mission covers the application fields of the professional profile: Product, Process, Installation, Human, Organization and Environment. Indeed, as a production manager and an engineer, he has to use both specific skills (improvement, development, innovation) and cross skills (energising, anticipation and decision ability). Our professional profile, expressed by employers' associations and field organisations, was the outcomes from working groups including head of enterprises, excellent professionals, unions of professionals and universities experts. Our curriculum design was based on this professional profile and the pedagogy was adapted considering the co-operative education constraints: "Forming Engineer in a different way, thanks to learning in a different way".

The educational curriculum is implemented through vocational training and **sandwich courses** (Clénet, 2002): the learner spends periods at school for academic program and periods in the company in a real work setting. It is a real co-operative education between IESP team and the companies: all the learning support tools (exercise, project, work based experience and tutoring) are defined in accordance with the professional project of the learner and integrated in the strategy of companies (and therefore should present measurable objectives). The purpose is to reinforce what the learner is learning (prior, experiential, formal, non formal... learning) and also to formalize and assess the knowledge, skills and competencies he acquires at the workplace. The academic program covers the scientific knowledge but also the social sciences and the project methodology that will help the learner to reach his mission goal and acquire the required competencies. Whereas the academic knowledge is evaluated by the teachers, work based experience is evaluated by the couple: company tutor and school tutor. Benefits of the work based learning rely on the interactions and dialogues between actors from the Higher Education community and professional sector. It is an opportunity for knowledge and skill transfer under a formal or informal way.

Our Work Based Learning program develops learning in, at and for work. Indeed the competencies development of the learner is of interest for the learner as a personal goal, for the company to develop the firm skill potential (individual and collective), but also for the school with respect to the qualification and educational mission (Demol, 2002). Success of the learner in his mission integrated to the company policy is ensured within **double tutoring** and enforced steps: first a mission letter is given by the company tutors to remind the context and the target time, second the learner performs a framing letter to confirm his understanding of the mission integrated

into the actions plan and the general objectives of the company. Then engineering level of the mission is proved by the learner thanks to the covering fields of application of the professional profile: mission is expressed in terms of expected learning outcomes (measurable and surveyed), hierarchical position of the learner, percentage of time dedicated to the mission (complete or partial detachment), assigned resources (financial and human). Finally at the end of the mission, the learner will show his competencies through his results (skill and firm objectives). Thanks to the Work based learning triangle (see figure 2) the learners is accompanied and guided by a company tutor and a school tutor (member of the teaching staff with recognized competency in Lifelong Learning Program of partnership). They work together in guiding (Houssaye, 2000): the aim is to help the learner to achieve its goal. The tutors will transfer their skills on scientific, technological, economic, social and human fields. All the actors of WBL program are trained before and during the program in order to be efficient: focus is made on legal framework, required competencies, identification of tasks and activities, lists of professional competencies and tutors' functions and roles in WBL. Tutors listen, encourage, give advices but don't give solutions. Aim is to help the learner to discover his new identity as an engineer (Paul, 2004). Tutors should be familiar with operational tools: reference guidelines (professional profile, tutor's book of good practice), collaborative distance work platform and Learning Management System (Moodle), reference documents (for mission letter, framing report and final report), problem and project based pedagogy, tools for evaluation (assessment grids for report, oral presentation, competencies).

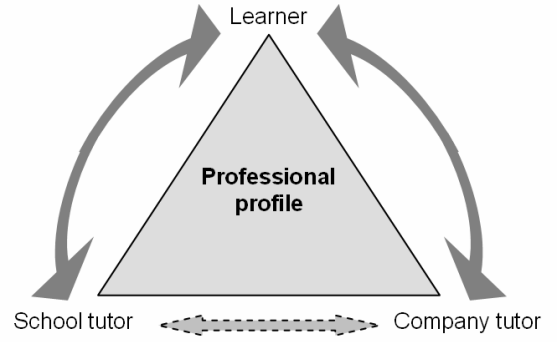

Figure 2: WBL triangle

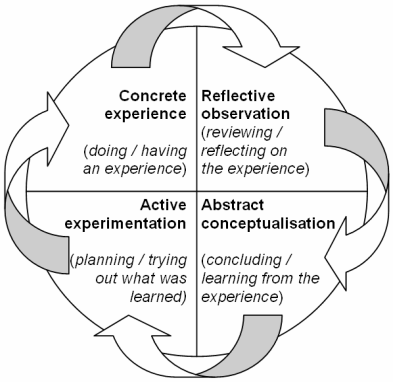

Figure 3: Kolb learning cycle (Kolb, 1984)

Due to the specificity of our groups already concerned by everyday industry constraints, **inductive pedagogy** (first learning the theory and then applying it) is not convenient for a quick and effective acquisition of knowledge and skill (Michel, 2005). Problem based pedagogy and inductive pedagogy (starting with real example that might lead to theory and solutions) are better ways however more complex methods to perform. The forwards and outwards experimental learning process (Kolb, 1984) has shown in figure 3 helps the learner to get the knowledge and abilities that will lead to skill within an active attitude and positive criticism and analysis: process starts with the observation step, followed by analysing and making assumption, then explaining with a local theory that might be generalised, and finally testing and validation that allows errors. During such activities and sessions, the learner or the group of learners is guided by the teachers team: to help them choose and define the study topic or problems, make it explicit and clarify the context, express the purpose, analyse and model, plan and define assessment criteria, learn and solve local problems, have a positive criticism of their approach, present their results and proofs and transfer their appraisement to others. Formative evaluation is therefore necessary to allow detection of competencies, positioning of the learner but also of the tutor, allowing errors of both (not possible with summation evaluation with notes like for inductive pedagogy).

3. Feeback after 15 years of practice

Today about 350 students get their degree in Polytech'Lille where 1 150 students are enrolled among which ones 160 are work based learners. Our first promotion passed the degree in 1995 and

today 186 IESP Engineers work in the industry (among which 17 apprentices). Academic program is made in Lille and Calais; two sites separated by 120 km in the region of Nord Pas de Calais but our learners come from any part of France. Until today we have worked with more than 40 different companies among which some we do have a strong partnership with: Renault, EDF, Safran, Rio Tinto, Danone… Work Based Learning education allows the same level of knowledge than any Polytech Engineer who has followed the conventional educational path but adds competencies that can be directly mobilised. As a consequence our engineers do have immediate employability and are well paid. Due to the success of our methodology and choices, the trend is to increase the number of apprentices and learners to prepare the renewal of generation: Work Based Learning is the right solution to transfer and keep individual skills and skills in the company. Work is recognised as a process of learning (Costley, 2000)(Dewblan, 2006). For our department and team the strong partnership allows us to keep in touch with the industrial reality (changes in technology and organisation structure) and keep on updating our competencies. Development of Lifelong learning process and legal possibilities for the accreditation of competences will help the social modernisation.

4. Conclusion

As a conclusion, we might say that our work based learning program is a good reply to our industrial partners. It takes into account adaptation to already employed public with inductive pedagogy. It allows the development of the learner's skill thanks to work experience. The companies are our clients and we do keep on adapting academic curriculum and methods with respect to their needs and our legal constraints linked to the conditions of delivering an accredited diploma of such level. The international evolution of companies urges us to open our recruitment to the international and to encourage the mobility of learners. Our success will rely on the strong partnership we will be able to develop with foreign actors: university, companies and finance resources; keeping on the development of our methods and practices.

5. References

Armsby, P., Costley, C. and Garnett,J. (2006) The Legitimation of knowledge : a work based learning perspective of appel, Journal of Lifelong Education, Vol 25 n°4

Boud, D., N. Solomon, Eds. (2001). Work Based Learning : a new higher Education, Buckingham, SRHE, and OU Press.

Costley, C. (2000), The boundaries and frontiers of Work Based Knowledge, in Portwood, D, Costley, C. (2000), WBL and the University, New Perspectives and practices, birmingham, SEDA Paper 109.

Clénet, J., (2002), L'ingénierie des formations en alternance, Paris, L'Harmattan

Demol, J.N., (2002), L'accompagnement en alternance : de l'université au travail, du travail à l'université, L'accompagnement dans tous ses états, Education permanente n°153, p 145

Dewblam Project (2006), The social and educational challenge of Work based Learning in European higher education and training: results of a pilot experience. Ed. Reinhard Schmidt, Firenze, December 2006, 352 p.

French Government (2002), Loi de modernisation sociale (social modernisation law), Loi n°2002-73 du 17.01.2002, et décret d'application du 24.04.2002, Version consolidée au 01 juillet 2007.

Houssaye, J., (2000), Le triangle pédagogique Edition Peter Lang, 2000

Kolb, D.A., (1984), Experimental learning experience as a source of learning and development, New Jersey, Prentice Hall.

Michel, M., (2005, 2002), La démarche inductive en pédagogie. Le Portique, n° 9 - La Nuit, [En ligne], URL : http://leportique.revues.org/document182.html, online 2005, march 8th, consulted 2009, january.

Le Moigne, J.-L (1995), Les Epistémologies constructivistes, Que sais-je?, Paris, PUF

Paul, M., (2004), L'accompagnement : une posture professionnelle spécifique, Paris, L'Harmattan