The dynamics of workplace learning in knowledge economy

Organizational Change, Knowledge Transfer and Learning
in the Pharmaceutical and Biotechnology Industry

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Abstract

This project on the dynamics of workplace learning in knowledge economy looks at processes of knowledge production and transfer among highly qualified personnel of four biopharmaceutical organisations. An empirical mapping of both formal learning activities and support to informal practices was produced to see how intensive are learning activities in these firms and how integrated they are in the daily action. Though present throughout the hierarchy, learning activities tend to be more diversified and undertaken with greater space for initiative at higher levels. Moreover, despite observed reality, official discourse of these organizations still refers to workplace learning mainly in terms of formal learning, with the exception of research and specialist staff. Six hypotheses are presented to analyze, at micro-level, the meanings and the implications of different patterns of formal and informal learning among these "knowledge workers". Organizational learning trends and contradictions evident in the bio-pharmaceutical sector are likely indicative of the future of workplace learning dynamics in most industrial sectors and of the ambiguities and challenges that will present themselves over the coming decades.

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The aim of this study on the pharmaceutical and biotechnology industry is to elucidate the different learning and inter-learning dynamics at play in the new knowledge economy. More specifically, our goal is to explore how, in different contexts of knowledge-intensive industries, highly trained workers acquire, produce and transfer new knowledge - the factors that facilitate or hinder the expression of individual and corporate learning demand, as well as the subsequent negotiation between the subjective and the organisational dimensions of this social demand. Our objective is also to see which workplace environments and policies favour or limit the deployment and recognition of informal learning. We are interested in patterns (cumulative, contradictory, or weak) that characterize the variety of relationships between structured and informal learning activities in these settings. Are they mediated by such variables as gender or immigrant status? What is the impact of the regional concentration of knowledge-based industries on inter-organizational mobility of workers and informal transfer of specialized knowledge through such « invisible college » (Crane, 1969, 1972)?

In order to study these questions empirically, we have selected work environments where an external researcher could observe, in context, informal and formal learning activities as they occurred. To that end, we chose to investigate Research and Development (R&D) teams in pharmaceutical firms because their visibility as concrete work units, their short-term mandate, the extended and close working relationships among members as well as their different mode of organisation and operation present an informative microcosm of workplace intensive learning practices.

What follows is a summary of the study design and a general description of the four firms selected. We then map their various structured learning practices and support for informal learning. Finally, we present six hypotheses that attempt to explain how professional workers from different backgrounds build and upgrade their professional knowledge and skills, how work environments influence and transform the dynamic between formal and informal learning, and why, under different workplace conditions, learning practices can vary substantially.

1. Research design and strategy

Research and development (R&D) units in the pharmaceutical and biotechnology industry (referred to as the "bio-pharm" industry forthwith) offer an ideal setting to capture the diffuse nature of informal learning because of their peculiar organization of work. R&D work is organized around a time-delimited project or mission assigned to a team of researchers and technicians. Within six or eight months, the team executes their objective with varying levels of autonomy and reliance on one another. Projects may involve the identification of molecules related to the treatment of an illness, development of a medication, clinical validation of a drug, or the design of a method of mass production. Teams are made up of project managers and both junior and senior researchers and technicians.

Because of intense competition, bio-pharm organisations must maintain tight schedules and function under confidentiality restrictions. As a result, it took months of dialogue to obtain the collaboration of two large private pharmaceutical firms (one

unionized), and two smaller enterprises, all situated in Montréal, Québec. A total of seven R&D teams, two within three firms and one in the third one, were selected for direct study.

Our study proceeded in two stages. First we developed, based on interviews and documentary research[1], a detailed portrait of the organization's formal learning practices and of organized support to informal learning Using this empirical mapping as a springboard, we then set out to examine and characterise the specific learning processes in each of the seven teams. Because the organizational cultures did not permit direct observation of teams, we relied on a research design used in anthropology studies of contextual learning[2] that reconstructs, at a micro level and *in situ*, the informal processes at work in such teams.

Through semi-structured interviews, we reconstructed the learning processes and relationships among team members by inquiring into the ways each member participated in project tasks[3]. For each of the seven teams, we identified typical project tasks of increasing difficulty and then reconstructed the ways new team members proceeded to master these tasks and engage their own knowledge and skills in the process. We believe that, through this indirect observation of informal learning, in context, we have been able to capture the often tacit nature of learning practices[4]. This data was intended to enrich and complement the Work and Lifelong Learning Survey findings on declared informal practices (WALL, 2003).

Utilizing the theory of peripheral legitimate participation (Lave & Wenger, 1991), our analysis proceeded at five levels, each level integrating the dual dimensions of participation in task-oriented R&D team action and development of professional identity (Dubar, 1998) (see Annex 1). The five levels are: (1) organisation of work in each team, (2) gradation of tasks according to their complexity and their chronological sequence, (3) the gradual

[1] Using a research design tested in previous studies (Bélanger, Larivière & Voyer, 2004).
[2] Lave, J., 1988. *Cognition in Practice, Mind, Mathematics and Culture in Everyday Life*, Cambridge: CUP; Lave, J. and Wenger, E., 1991, Situated learning: *Legitimate Peripheral Participation*, Cambridge: CUP; Wenger, E., 1998, *Communities of Practice: Learning, Meaning and Identity*, Cambridge: CUP)
[3] See, for example, the design of direct observation of people at work developed by the French school of "ergonomie du travail et de l'apprentissage" (Chatigny, 2001; Teiger, 1998)
[4] In each of the seven working teams, we conducted semi-structured interviews with four members (the leader, one "veteran" and two newcomers) and have administered a small questionnaire borrowing questions from the Survey (WALL, 2003). After a first analysis, some interviewees will be contacted several months later for further data collection.

mastering of these tasks through peripheral participation, (4) inter-personal and knowledge transfer dynamics, and finally, (5) the relationship (cumulative, substitutive, corrective, etc) between structured and informal learning in these different contexts. We examine how each team member relates to the tasks: integrating them on their own or with the assistance of other members, bringing their own input and initiatives to bear, involving themselves, in varying degrees, in different types of learning and knowledge transfer processes.

We combined this context-specific analysis on learning processes and relationships within the RnD teams, the mapping of education and training activities in each firm and classical data on individual formal adult learning participation in order to understand how each member, in different teamwork situations, relates their formal learning events to their informal learning activities, taking also in account whether and how these are supported by the organisation and/or the team.

2. Four participant organizations

As with many new high-tech industries, biotechnology and pharmaceutical firms, in the region of Montreal, have experienced remarkable growth since the early 1990s.[5] The surge in bio-pharm research and development activity of over 400% over the past fifteen years in Québec (Ouellet, 2003) confirms this domain as a highly knowledge intensive economic environment in rapid development, ideal for the study of workplace learning; many industry's corporate giants have research centres in Montreal[6], and are surrounded by hundreds of related medium and small businesses. This economic sector employs some 16,000 workers (in 2001) in approximately 170 companies. These workers have highly specialized education and training and enjoy a salary above the average of salaries of all other industries.[7]

This regional concentration of pharmaceutical firms did not occur by chance. The government of Quebec, building its strategy on an already existing federal

[5] Comité sectoriel de main d'œuvre des industries des produits pharmaceutiques et biotechnologiques du Québec, 1999.
[6] Aventis, Bristol Myers, Merck Frosst, Pfizer, Shering, Shire, Wyeth-Ayerst, etc.
[7] In fact, in 2000, the mean salary for bio-pharm staff was $877,17 per week compared to $584,53 in other fields (MIC, 2005 : www.mdeie.gouv.qc.ca).

measure extending to twenty years the protected period for "patent" and "licence", has developed an even more favourable economic environment through other measures[8]: guarantee for reimbursement on original (non generic) medicaments for a period of 15 years, corporate tax credits and public co-investment in risk capital for research and development. These industries are also benefiting from the presence on the island of Montreal of four universities,[9] some specialized research centers[10] and two important university hospitals.[11]

The bio-pharm industry has several unique characteristics. Firstly, many of these organizations engage in three specific activities: research and development, manufacturing and distribution. Secondly, this industry is strictly regulated. Companies must adhere to not only national quality control standards, but also to international norms in order to access foreign markets. Thirdly, there is a continual economic pressure to stay at the cutting edge of progress in the field; among bio-pharm firms, « continual innovation is critical for success » (Lam, 2002). A fourth characteristic is a highly qualified staff who are required to stay abreast of current and evolving trends in the development of new drugs. The four organizations were selected as typical of their industry. All are involved in research and development, one conducting R&D exclusively, and three engaging also in manufacturing of pharmaceutical products.

Company A is part of a multinational corporation involved in research, manufacturing and distribution of drugs, with 49 plants and 54 000 employees worldwide. Company A is part of the pharmaceutical arm of a multinational, with headquarters in USA. It has decided to invest in the region of Montreal because of its high concentration of similar companies and of related qualified manpower. Company **A** employs, in Montreal, a staff of 1200 involved in three activities: clinical research, manufacturing and distribution.

Company B is a small private enterprise conducting only highly specialized research. It is dedicated to the discovery of new treatments, at the molecular and antigen level, for cancer and infectious diseases. The majority of its staff of less than 60 possesses a post-

[8]See www.mdeie.gouv.qc.ca/page/web/portail/entreprises/nav/Secteurs_industriels/46968/46970.html?iddoc=46970
[9] Each year, Quebec universities confer diplomas on more than 10,000 students in pure and applied sciences and approximately 4500 in health sciences
[10] A federal National research Center and the Institut Armand Frappier.
[11] McGill and University of Montreal.

graduate degree, many a Ph D in science. It is also situated in the heart of the Montreal bio-pharm industrial park. This R&D firm operates within constant parameters of uncertainty; it relies on the expectation that potential discoveries will be bought by the large bio-pharm corporations for further development and production. Company **B** is currently involved in partnerships with neighbouring corporations co-investing in some of its research projects.

Company C, with a staff of 60, is active in two fields the industry: R&D and production. In their specialized industrial laboratories, they develop, test and produce active pharmaceutical ingredients and new organic and synthetic products for other bio-pharm firms. The researchers and technicians of Company **C**, developing new ingredient products as well as new means of production for exiting ones, maintain close contact with firms interested in purchasing these products and services.

Company D is active in development, manufacture and distribution of generic pharmaceutical products. Situated on the outskirts of Montreal, Company D has enjoyed a tripling of its profits in the past ten years. It employs a staff of 400 and has FDA approval to distribute to the United States. In 2002, this Canadian company was partially taken over by an American firm. This merger permitted Company **D** to expand its business to worldwide markets. The majority of their corporate activity is focused on clinical research to test and validate drugs and applied research to find new ways to produce generic drugs on large scale.

3. Portraits of formal learning and of support for informal learning

This section provides, firstly, a description of formal learning activities in each of the four organizations and, secondly, a picture of corporate efforts made by each firm to support informal learning, specifically for scientists and technology specialists.

3.1 Formal learning in the four organizations

Company A

Company **A** has in place five distinct types of structured learning activities: technical training for new positions, regular skills review and upgrading, continuing education of

management staff, education and training of scientists and other specialists, and training of internal trainers and coaches.

1. New position technical training

Traditionally trained on the job with no specific format, training of new staff or staff moving into a new position has become more systematic in the past few years. Currently, prepared education and training protocols, to be used by experienced staff in a peer training approach, have been developed and are managed by a central skills development (CSD) service. This basic technical training, lasting up to two months, is provided in the form of mentorship by certified staff trainers. It covers 'good manufacturing practices" (GMP), specific prescriptions relating to job tasks and equipment maintenance.

2. Annual and regular skills review and upgrading

Over the course of a job, the organization assures several scheduled training sessions on "good manufacturing practices" (GMP) and organizes an annual skills review session for all staff, specialized and management included. A requirement of the senior executive, this training takes the form of a general day-long session covering company values and GMP. In general, this training aims to reinforce conformity to quality norms and to correct any deviations noted by the Quality Control Bureau. Because of frequent modification in quality norms, the Quality Bureau also requires, at irregular intervals, that the CSD organizes training activities geared toward new developments in GMP.

3. Management continuing education and communication skills development for executive staff

Continuing education of management staff has intensified over the past few years in the hopes of maintaining and renewing their effectiveness. The human resources department, in collaboration with the Canadian head office and external consultants, organizes communication and other 'soft skills' programs on topics related to management issues. Company **A** has also a policy of reimbursement for continuing education that all staff can take advantage of in adult learning and post-secondary institutions.

4. Continuing education among specialists and scientists

Any skills training and further qualification required for specialists and scientists that does not fall into the management skills category is left to the discretion of the individual laboratory directors and team's leaders. Focused on professional development, continuing education of scientists takes the form of self-directed learning within research teams, participation in intensive external seminars, or university courses and programs at one of the four local universities, and attendance at conferences organized by relevant professional and scientific bodies. Participation in such courses, financially supported by the company, is also a result of a staff member's initiative. A specialist's immediate supervisor may also suggest skills upgrading learning opportunities.

5. Training of staff trainers and training specialists

In attempt to better systematize their internal training over the past several years, Company **A** designated technical trainers and training specialists from among its most experienced staff. Through the central skills development (CSD) function and with the assistance of external consultants, a formal trainer certification program was developed. Certified technical trainers, having successfully undergone the training, receive a training tool-kit approved by the Quality Bureau, as well as an increase in salary of 2% to 4%. Company **A** currently counts 100 certified technical trainers (more than one-tenth of staff) and 50 training specialists among their staff, all trained by the CSD function.

Company B

In this small firm entirely focused on applied research and development – of new molecules for eventual development into new treatments – learning activities and programs are geared to a highly qualified workforce requiring acquisition, production and sharing of the most up-to-date scientific and technological knowledge.

1. Continuing education

In company **B**, research oriented professional development of scientist staff, hence of the majority of personnel, is central to the objective of this organization. For example, every year, around a general review of research work, researchers at all levels are invited to report not only on the status of the company's projects in progress, but also on individual RnD projects that they are encouraged to work on in parallel to their work for the firm.

Continuing education throughout the year means for all researchers a participation in a variety of interdisciplinary (biology, chemistry etc.) meetings in order to gain a more global understanding and perspective on their work, of the evolution and resolution of projects currently underway. As well, meetings (on site or virtual) with corporate and international partners are called regularly for the purposes of discussing projects in development. Staff are also encouraged to participate in a variety of virtual information dissemination activities offered by international networks of scientific researchers. Representatives and specialized sales staff from the pharmaceutical industry also provide regular training sessions on the state of recent developments in their sector.

Outside of the company, researchers participate in intensive sessions at conferences and specialized seminars or other sessions provided by relevant professionally-affiliated groups. These provide the occasion for researchers to compare their work with that of their peers, or to present their work in order to obtain valuable peer feedback. Participation in these activities, often at the initiative of the staff member but also suggested by supervisors, is financially supported by the company.

2. Informal learning

Most informal learning among researchers at this company takes the form of intensive self-directed learning and inter-learning within research teams, during or outside paid work hours. For researchers, the company provides panoply of scientific journals that they are encouraged to consult regularly. Many also subscribe, with financial support form the firm, to electronic journals and bulletins. Staff find time during work hours, between periods of laboratory work, to review these for problem solving techniques and to learn about new procedures or recent discoveries in chemical combinations etc. It is assumed that staff also consults external resources such as university libraries and specialized centres of research

during work hours, particularly for concept development at the start of projects, as well as during evenings and weekends.

Knowledge sharing between peers tends to be continuous during work hours, at breaks or during the lunch hours, by which problems may be resolved in consultation with team members, readings may be recommended for concept development, or new insights from seminars attended may be shared. External networks also provide opportunities for knowledge transfer – scientific advances may be shared with colleagues or friends at university departments or opinions on project problems may be sought.

Publication of scientific articles in relevant journals is strongly encouraged by the company. Researchers can benefit from the expertise of project leaders on publication procedures in the form of an internal article review. Some are invited to prepare colloquia or seminars for professional colleagues. One of Company **B**'s directors is internationally renowned in his field and presents his research at several conferences each year.

In this small, flat organizational structure, the practice of 'mentoring' is common at all levels of research, between directors and senior researchers, and between senior and more junior research staff. Researchers supervise university students during their field placements, including a summer CO-OP program that provides paid work experience for students from across Canada. Finally, researchers are also encouraged to participate in the strategic planning activity of the company (in administration, licensing and patent issues etc.) and can thus acquire a global understanding of the company's evolving directio

Company C

Company **C**'s principle R&D and production activities are geared to the production of chemical and synthetic ingredients for other companies in the sector. Its education and training activities involve four very different types of interventions: training for new positions, technical training, management and specialist continuing education, and support of professional development.

1. Training for new positions

Orientation for new hired personnel is comprised of an introduction to the organization, the regulations that govern it, its different departments and health and safety rules – hygiene codes, paperwork requirements, and physical movement within the organization. This formal learning activity, conducted by supervisors or assistant supervisors, is followed by specific job-related training. The duration of this mentorship relationship varies depending on the position.

2. On-going technical training

Throughout the year, all staff are called to participate in technical training on quality norms and protocols for manufacturing (*Good Manufacturing Practices* <GMP>). Topics include industry GMP and international standards of operation (ISO). Linked to specific work posts, the learning activity is conducted by a supervisor or other senior staff, a quality assurance representative, or, because of schedule problem, is completed through self study of relevant documentation.

3. Continuing education of management and specialists

Continuing education of specialized staff (scientists), analysts and administrative staff takes place both inside and outside the organization. Internally, training related to procedures are planned and conducted by the quality assurance department. External training may be conducted by regulatory bodies, specialized institutions, post-secondary institutions or consultant firms.

In terms of seminars, colloquia and accredited education and training, the request usually comes from the interested individual. Supervisors may also propose upgrading activities and specialized sessions to assist in attaining R&D goals specific to active bio-pharm ingredients.

4. Individual professional development

This company also financially supports the pursuit of approved courses, requested by the employee or suggested by the supervisor, that relate to the work or that will allow career development. Reimbursement of course fees and expenses can be expected with an attestation of successful completion provided by the educational institution.

Company D

Company **D** is active in R&D, manufacturing and distribution of bio-pharmaceutical products. Its education and training activities must also address a variety of staff issues: training for new positions, education and training of management and specialists, and recurrent skills review or professional upgrading.

1. Training for new positions

At Company **D**, training for new positions involves four steps, the last three of which also apply to internal staff transfers. It begins with an orientation session on the organization and its different departments, an introduction to relevant best practices and health and safety information. The three other training topics refer to various sterile procedures, good manufacturing practices" (GMP) regulations specific to the handling of dangerous substances, and finally, hygiene and microbiological contamination issues. This training is comprised of both theory (e.g. sterile environments and bacteria) and practical elements (adherence to regulations during manufacturing). The practical training is provided by a co-worker using training materials that specify procedures, over a period of one day to several months, depending on the complexity of the task. Staff to serve as « floor trainers » are selected based on their technical competence and capacity to communicate information, but there is currently no quality assurance testing of these trainers and no provision of formal training of trainers.

Besides the training given to all staff, additional training is provided for specific positions[12] : supervisors take 10 additional courses, specialists seven and operators three,

[12] Topics such as the metric system, dangerous materials, best practice rules and procedures, appropriate clothing, sterilization processes, filtration, etc.

while packagers need not take any additional training beyond the general job-related procedures. In essence, « each post has a course curriculum ».

2. Continuing education and training of management and research specialists

Management staff and science personnel receive the general training mentioned above along with all other new employees. Beyond this, their education and training varies according to individual professional development plans and to « individual projects » acknowledged by the organization. Their education and training does not take the same course as that of production staff, as they are also assessed annually in a report provided by the human resources department. Training mainly takes place outside the organization at universities, CEGEPs and through professional organisations and regulatory bodies. Staff is assisted financially to participate in these various seminars, colloquia, distance education and credit courses. Initiative to undertake the training is usually the staff's, but at times comes at the suggestion of supervisors. The organization may offer its support in the form of work hours for the training and generally reimburses all related fees and expenses.

In this rapidly expanding organisation, an education and training policy for management and professionals remains a work in progress. Following a recent intensive initiative, the company is in the process of developing a series of structured training programs for its management staff on leadership, time and priority management, conflict resolution and project management. With the assistance of external resources, they are also preparing short courses for floor level managers on roles and responsibilities, communication skills, and project management software.

3. Annual and regular skills review and upgrading

All staff involved in manufacturing unit at Company **D** are required to participate in regularly scheduled skills upgrading for « quality assurance » (North American standards stipulate at least once per year).[13] Representatives of « continual improvement » from different departments must remain abreast of advances in techniques and methods of production; they may ask for or require upgrading training. These specific "theory"

[13] Selon le règlement de Santé Canada, sur les BPF, articles 2.8 - 2.11.

courses, lasting two or three hours each, and practical training, lasting from a day to a month, are tracked assiduously to ensure that all staff have been trained adequately.[14]

3.2 Support for informal learning in the four companies

These structured learning activities are only one part of the everyday reality of learning in organizations. Below this obvious 'tip of the iceberg' (Livingston, 1999; Livingston & Sawchuk, 2003), there exists another world of informal learning and self-directed learning behaviour in which employees participate either alone or in groups. How much do high technology and knowledge intensive businesses acknowledge this reality? How do they support and encourage such practices?

It is not a question of establishing the presence of informal learning in such organizations. On the contrary, individuals at work do structure, develop and mobilize their expertise whenever, in the tension between the prescribed and the real task, they participate in productive action and share responsibilities within work teams. The more appropriate and researchable question is whether or not organizations, in this case in the bio-pharm industry, support this tacit production and transfer of knowledge, acknowledge it and take it into consideration in their strategic plan and staff development programmes. Of interest to this study is how staff members interpret their company's attitude toward informal learning and knowledge transfer, what significance informal learning activities have to their condition of work and quality of life at workplace and to professional identity development, how participation in structured learning opportunities builds on and prolonged itself through informal learning, and, and in a broader perspective, how individuals recognize this possible synergy in their learning biographies. We will examine these concerns through the hypotheses and in the next phase of this project. Let us look, for the moment, to the kind of support organizations are providing for informal learning.

We have noted that the learning approach of scientific personnel is quite different from that provided to other staff in the companies under study. First, each of the four companies offer traditional support for professional development of specialist staff – time is freed up

[14] « Lorsqu'un employé entre, automatiquement il y a un registre de formation qui est remis à l'employé. C'est cumulé <…> il y a un fichier central où on va retrouver le registre de formation de tous les employés». (#1)

and expenses are defrayed for those interested in training at universities, colleges or other accredited organizations. This assistance[15] is primarily offered to young scientists who have not completed doctoral studies and who desire to become research investigators, principal researchers, and eventually, after several publications and special projects, team leaders or heads of laboratories.

All *Research and Development* staff is called upon, in a variety of ways, to constantly renew their knowledge and know-how to keep up with scientific advancements in disciplines relating to their work, continual upgrading of equipment and software, evolving corporate partnerships with specialists in other disciplines, modifications to experimental protocols etc.

This continuing development of skills and knowledge-base updating happens of course through participation in conferences, tele-conferences and seminars. But, more importantly and on a regular basis, the professional development of these knowledge workers takes somewhat guided self-directed form, similar to what Philippe Carré in France will call "auto-formation assistée" (Carré, 1992). In RnD project teams, it proceeds through contacts and informal exchanges with colleagues and more senior researchers, by assiduous review of scientific literature, by sharing experience, as well as through the pursuit of individual research « side projects » supported by the organization.

The four organizations assist this self-directed learning in different ways. From our interviews with management and employees, we have extracted seven practices that support informal learning (see Table 1).

[15] See hypotheses in the next sections.

Table 1.

Support for informal learning among participating bio-pharm organizations

Forms of support for informal learning activities	**Companies supplying This support**
1. Various access to relevant documentation	**A**, **B, C, D**
2. Mechanisms for integrated information exchange and consultation	**B**
3. Individual career development . plans	**A, D***
4. Environment facilitating inter-learning	**B>A + D>C**
5. High incidence of innovation creating a demand for self-learning	**B>**A> D>C
6. Encouragement of staff initiative to solve daily problems	**B, D****
7. Support to participate in external specialized formal and peer network	**B> A**

* **B** and **C,** smaller enterprises, tend to proceed, to that end, more informally.

** As explained later on, this encouragement in firm **D** came inadvertently through a crisis requiring urgently the "input" of personnel, but initiated, afterwards, a new movement.

The most common indication that organizations acknowledge informal learning is (see Form 1) through technical supports they all provide for access to information and documentation for their specialist staff – in the form of monographs, CD-ROMs or access to the Internet. Physical access to information is usually at a central distribution site, and staff are allowed time to visit it. As well, staff is reimbursed for costs associated with subscriptions to relevant journals and purchase of interactive instructional programs.

Though formalized mechanisms of information sharing, discussion and consultation with other staff have been put in place in each of the four companies, ranging from the traditional suggestion box and company newsletters to monthly information sessions at different levels of the organization, an ongoing consultation process integrated in the daily productive action is more seldom, except in firm **B**, which also organizes for all its staff annual company-wide review sessions (**B**).

Individual career development plans (Form 3) are in place in two companies (**A** and **D**), but mainly for professional and scientist staff.

The existence of an environment favouring knowledge sharing as well as space for inter-learning[16] constitutes a significant dimension of support for informal learning (Form 4). This is clearly the case in the special portrait of learning practices of firm **B**, but is also present with less intensity in firms **A** and **D**, and, to a lesser degree, in firm **C**. Participation in scientific conferences or seminars is followed up, particularly in firm **B**, with a report or presentation to colleagues in order to assure the dissemination of this new information. We can also see this type of support at the organizational level by the importance accorded to "coaching"[17] and, more critically, to training and support given to in-house mentors and trainers, and, at the micro level, by assessing how the organization of work in teams favours or inhibits cross-functional and interpersonal communication.

Another important feature of a corporate culture or climate for encouraging informal learning is the incidence of innovation creating a continuous demand for informal learning (Form 5). Though observed in all RnD teams, this indicator is again particularly evident in

[16] « Beyond the water bottle chatting »
[17] Where coaching and mentoring is in place, there is likely informal knowledge transfer and sharing of job skills, and the acknowledgement of knowledge transfer activity between peers on the "tricks of the trade".

firm **B**. At the cutting edge of applied research, this firm encourages its staff to seek new research approaches in use elsewhere and to play an active role in decision making about new applications back in their home departments.

A clear and sustained encouragement of staff initiative to solve problems (Form 6) is also a key feature of support for informal learning. Employees are encouraged to interact with others and bring new insights into a setting in order to 'troubleshoot' ways to integrate new systems or procedures. Integrated in the daily functioning of firm B, it occurred also in firm **D** through an unforeseen crisis. This company tried recently to introduce a new management software system. In the first stage, a consulting firm was contracted to conduct the integration of this new technology, but did not follow through appropriately before leaving. A crisis emerged. Some departments even reverted to their previous operation management system. Company **D** then decided to enlist the involvement of their internal personnel to ensure the transition to the new system, using staff who had already mastered the procedures. These later became known as the "super-users" and were mobilized as informal trainers and members of urgency teams as problem-solvers. Some even manoeuvred to adapt the system in ways that better integrate the specific needs and constraints of the different units. At first by necessity, firm **D** resorted to internal capacity for initiative but then modified its overall attitude and approach to rely more on internal capacity for initiative.

Finally, a seventh observed way to support informal learning is support to assist personnel in their voluntary participating to external specialized formal and peer network either of their scientific discipline or of informal scientific circles and professional associations. Staff is reimbursed for costs associated with membership in professional organizations and scientific networks. Firms **B** and **A** do that out of the belief that these informal genuine information and learning channels provide already a recognition to their professional staff and will ultimately benefit the organisation

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Conclusion

The four portraits of formal learning and of support to informal learning reveal common tendencies. First, learning has become a differentiated valued set of activities in each of these four firms with distinct organisational visibility both in human resource

department and, in the three enterprises involved in production, in their units responsible for quality control. Workplace formal learning and support to informal learning has become a new priority of knowledge intensive organizations[18]. We observe, in all firms, a trend toward more intensive participation in formal learning and greater accessibility to informal and self-learning among qualified staff. Secondly, the situation does vary from one firm to the other: besides Firm **B** that functions as an intensive integrated learning organisation, Company **A** appears to have a more sophisticated staff development strategy than either Company **C** or **D**. Thirdly, this gallery of portraits reflects diverse combinations of approaches to workplace learning; in these 'blended' strategies (Bersin, 2004), organizations mingle various types of interventions and services, from peer mentoring, just-in-time training, to assisted self-directed learning and regularly scheduled structured sessions, from access to self-directed learning resources available around work schedules to participation in external learning activities. Fourthly, the mapping of activities, even if interesting contradictions appear, reveals a hierarchical picture of workplace learning, both from a quantitative view (rate of participation) and a qualitative perspective (orientation and logics of action: conformity VS capacity for initiative). Finally, for the most part and despite concrete practices of support, official discourse of these organizations still refers to workplace learning chiefly in terms of formal learning contexts; support for informal learning in these organizations, though present at different levels, remains somewhat less distinctly defined, with, in some ways, the exception of the case of research and specialist staff.

Beyond this mapping of formal learning and of organizational support to informal learning, we will in the next phases of this study, undertake a micro-analysis of learning processes occurring within each research project teams; the series of interviews, already done in each of these seven teams, will provide the materials to observe more directly the less visible reality of informal learning.

[18] See Bélanger, Doray et al. 2005 and Statistics Canada, 2004.

4. Six hypotheses on the meaning and social implications of workplace learning in knowledge intensive organizations

The dynamics of workplace learning, so far observed in these four knowledge intensive organisational settings, lead us to propose hypotheses to grasp the meanings and social implications of various interaction patterns between formal and informal approaches to continuous expertise development. To pilot this future analysis, and out of a first exploratory review of the completed field work, we have developed six specific hypotheses:

Hypothesis 1: ***There is a direct relationship between knowledge intensive work context and organizational support of informal learning activities.***

In knowledge intensive organizations and, even more, in project teams with a knowledge building mandate, there is a built-in demand for informal learning and knowledge transfer activities among staff and, consequently for different support mechanisms as outlined in Table 1 presented earlier. The obvious strategic value of continual upgrading of knowledge and technology (Hendersen, 1999) leads high-tech enterprises, such as those in the bio-pharm industry, to recognize informal learning and sustain it. In this context, the provision of formal learning opportunities, far from opposing it, tends to emphasize the recognition of informal learning and to generate support to that end. A distinction is apparent, however, among different R&D teams, between informal learning and reciprocal knowledge transfer nourished by an interactive environment on the one hand, and, on the other, a pursuit of informal learning, as intensive, but more isolated and, even, more competitive, (see also Hypothesis 3).

Hypothesis 2: ***A geographic concentration of similar knowledge intensive enterprises favours informal practices of exchange and transfer of knowledge among personnel of different organisations and tends to create a veritable regional or local « invisible college ».***

One of the distinguishing characteristics of the bio-pharm industry in Montreal is the regional concentration of related firms. Significantly enhancing inter-company mobility, this context highlights the problem of maintaining staff loyalty, but also facilitates the emergence of horizontal informal networks and forums of communication. The bio-pharm sector in Quebec groups 15,600 jobs within 170 organizations, most of which are situated in the west end of the city. In fact, close to half of this industry's Canadian plants are there.

This geographic concentration of organisations continues to grow -- since 2000, more than 900 million dollars have been invested and 2000 new jobs were created.

This geographical grouping of similar organizations has forced companies to intensify strategies to ensure staff loyalty. But, at the same time, this local concentration of highly skilled workforce in need of continual professional development has also been a factor in the creation of an «invisible college » (Crane, 1972 and 1969; De Solla Price, 1963) where tacit knowledge is created, developed and distributed through informal interaction in regional meetings as well as in surrounding cafés and other casual meeting places (Lam 2002). In such an environment, favouring informal contacts outside the firm, a parallel "occupational model … of competence building favourable to learning and innovation" tends to compete with the more traditional "organisational model" centered on individual companies and their internal learning strategies.

Hypothesis 3: ***Organizational support to informal learning varies among companies as a result of factors such as work organisation, competition and production pressures, and the internal institutional policies and practices on formal learning .***

What are the factors and the contexts that favour recognition of informal learning in organizations and that give reason for support to these invisible practices of knowledge updating and professional development? From a social psychology perspective, some researchers have interpreted such development, in the workplace, of informal and self-directed learning "behaviours" as an interaction between personality factors specific to an individual itinerary on the one hand, and events or circumstances presented by the work environment at any given moment, on the other (Meignant, 2001). But, we need to go further and ask what, then, are the conditions or factors that predispose an individual to an active learning biography? What are the work and out-of-work contexts that are more inducing to self-directed learning practices and to a synergy between formal and informal learning?

Our preliminary data analysis indicates that the organization of the work itself, competition and other pressures to produce and types of institutional formal learning

policies and practices are factors that have a distinct impact on informal learning practices among staff. To begin with, certain skills and work experience do not, by their very nature, lend themselves to development and transfer by formal means or capture in course content, but require self study, observation and experience. Facility manipulating laboratory equipment, acquisition of know-how from repeated experimentation with procedures, cumulative experience from intuitive problem solving are but some examples of intangible expertise that cannot be transmitted through formal training programs. These kinds of skills, though comprised of non institutionalized knowledge, are strategically vital for any organisation.

In terms of the nature of work organisation, the demand to innovate and solve problems within groups, teams that require rotation of members and continual revision of tasks provide a favourable context to enhance and acknowledge the reflexive dimension of work. As specialists of "ergonomy of workplace learning" will put it (Teiger 1988), in such production post-fordist context, organisations tends to recognize more the critical distance, in all job posts, between the prescribed task and its real execution, a space where the intelligence of the subject and its idiosyncratic contribution inevitably come in. However, the constraint of the pressure to produce at high speed has a negative effect on this opportunity. Some companies put such intense pressure on work teams that, despite policies of support for self-directed learning, spare time for this is at a premium.

At the micro-sociological level, the organization of work in R&D teams, where members are collectively responsible for the expected output as a new molecule, clinical analysis of a new drug, or the design of a new industry procedure, can influence the dynamic of knowledge transfer and potential for "legitimate peripheral participation" (Lave & Wenger, 2001). For example, a division of work isolating the experts and delegating the repetitive task to new comers will seriously hinder the inter-learning process. Similarly, an authoritarian or democratic climate – either holding back or facilitating cross-functional communication and horizontal exchange of ideas – influences not only the development of informal learning, but also its orientation: more solitary versus more interactive. Indeed, in a work context of high competition for professional recognition, self-learning will tend to become an individual strategy to survive and compete; reciprocal knowledge transfer becomes then risky.

Initial education also affects accessibility to services supportive of informal learning. Employees' education level and professional status influence not only likelihood of participation in formal learning, but also propensity and capacity to access support offered by the organization for self-directed learning – and hence the possible synergy the individual can build between the two. Organizational formal learning practices and, more so, the learning culture they reflect[19] may also shape informal learning practices and their endorsement within the organization.

Hypothesis 4: ***The context of ease of inter-organizational mobility – made possible by the regional concentration of related firms – provides extra leverage to certain groups to change the gender or linguistic social relation within organisation.***

The R&D personnel of the four firms represent already a particular demographic, because of the special gender balance of its workforce (52% women) and of the significant presence of immigrant employees. We hypothesize that the formation of a first cluster of women or immigrant personnel will tend, through interpersonal contact, to enlarge itself – a type of informal affirmative action practice. Viewed from another angle, these subgroup networks, professionally and interpersonally based, constitute substantial social capital and therefore wield considerable influence in a highly competitive industry. Such subgroups could bring about positive change in discriminatory human resource policies that, for example, hinder career development for women at the critical biographical period (age 25-35) where reproductive momentum conflicts with opportunities for active formal learning and advancement within the company. Similarly, the social capital of members of a cohesive cultural minority both at the workplace and in the community can be mobilized to advocate for their learning needs and preferences, particularly in this segment of the labour market where certain immigrant groups enjoy a reputation as highly competent and innovative (Cohen, S.S. and Field, G., 1999).

Hypothesis 5: ***The increasing call for self learning as a method of professional development among knowledge workers has the dubious potential to open door to a legitimized expectation that this work be done outside of work hours without remuneration***

The conditions of R&D personnel in the bio-pharm industry may be similar to those of other knowledge workers. While enjoying certain autonomy of organization of work and

[19] Active or passive, adaptative or empowering ("autonomisante").

profiting from support to pursue learning throughout their careers, they experience a sense of ambivalence toward informal learning. As is the case of teachers, the amount of self-directed learning required has the potential to become an employer's expectation for unpaid work outside of work hours (Smaler, et al., 2005.) Opportunities for informal learning, in these contexts, may become a Trojan horse of quietly accumulating workload. Intellectual work outside of paid work hours tends to be reconstructed as an elevated symbol of professionalism and part of the "researcher" identity, much as it has been for teaching staff, and thus legitimizing its abuse.

Hypothesis 6: ***The ambiguity of the diverse rationales ("logiques d'action") at work in the domain of education and training in industry drives their on-going transformation.***

Current rationales governing workplace learning include (Belanger et al. 2002): *conformity to imposed production quality norms, * sustaining staff loyalty in a regional marketplace where demand for workers is high, * income tax -free provision of non-monetary rewards, * mechanisms for career development for management staff or self-directed professional development of expertise among science staff, and (Doray, 2001) as a * method for managing internal staff mobility based on formal level of qualification

The evolution of work organisation – in ways that increasingly engage employee capacity for initiative and collective intelligence – coupled the volatility of occupational life course may transform each of these logics or rationales in a more reflexive orientation, and may produce a substantial shift in policies flexibility of labour management.[20] This emerging logic of internal flexibility and reflexive learning policy, paradoxically, leads organisations, having precisely in mind the necessity to keep up with quality norms, to take distance with a linear approach of conformity training centered on inculcation of the 'prescribed' dimension of work tasks. Instead, because intolerance for latitude between prescribed process and real practice can discourage self and informal learning in subtle but significant ways (Teiger, 1998),[21] organisations tend to resort to more reflexive practices. Taking into account the idiosyncrasies in ways of proceeding and acknowledging a variety

[20] Organisations relying then more on the comprehensive ("polyvalente") competency of their personnel than on in and out recruitment and dismissal of workers according to short term requirements.

[21] See also the special edition of *Relations industrielles : «* Ergonomie, formation et transformation des milieux de travail", volume 56, numéro 3, 2001.

of approaches to executing a particular protocol or job task tend, indeed, to translate into encouragement for informal learning and inter-learning (Chatigny, 2001).

4. Épilogue

Finally, we submit a more general hypothesis that the organizational learning trends and contradictions evident in the bio-pharmaceutical sector are likely indicative of the future of workplace learning dynamics in most industrial sectors. Our on-going analysis of the four organisations in this study and our related research on learning in industries with labour markets of varying levels of expertise (Bélanger et al. 2002, 2004, 2005) have led us to view this sector, particularly its highly qualified R&D divisions, as prototypical of the evolution of education and learning in organizations and of the ambiguities and challenges that will present themselves over the coming decades.

Definitively, workplace learning is becoming a strategic instrument of productivity and hence of survival and growth for organisations in reflexive production sectors (Brown and Lauder 2001). Learning, in its mix of formal and informal practices, is no more a marginal reality in the prototypal industry of the future. There, we rediscover the producer-subject whose capacity to act is coming at the heart of the process (Bélanger and Federighi 2000). But the instrumental objective of productivity, that drives the new social demand for reflexive learning practices, may, though not necessarily, lead to a dominant logic of productivism. The weak social construction of skill development as a collective good (Streeck 1989) and the weak public regulation of this growing factor crucial both for a wider regulation of flexibility in the labour market and as a tool for individual to protect her or his right to work may, indeed, reinforce the individualist and productivist learning market pattern.

Yet the ambiguity of this knowledge driven neo liberalism is that it requires inescapably the individual and collective intelligence of all. The imperative need to draw on subjects' capacity for initiative and their empowerment in the most advanced economic sector may very well create new ground for a transformation of industrial relations conditions, if not for a broader process of liberating the productive and creative forces. Moreover, this dynamics of intensive "legitimate peripheric participation," now more

evident in the knowledge intensive sectors of the economic world, may soon become as powerful in the health and ecological domain.

Annexe 1

Analytical Framework on informal learning in RnD teams

Level 1 - Analysis of the organization of work in research teams		
Dimensions	***Sub-dimensions***	Indicators
Complexity	Description of the situation and of the different tasks involved (team work and its overt interrelation pattern)	• Description of the situation in terms of tasks (the most typical in order of progression and complexity, of roles, of specific practices and of responsibility. • Indication of duration of tasks and of their visibility
Identity *(Profile of most competent team members)*	Status	• Indications of status attached to each or group of positions in the team, in particular of most recognized competent members (and when appropriate, professional title)
	Relations	• Hierarchical relations • Relationships between colleagues (individual tasks and relational patterns in the team)
	Values	• Identification of legitimate authority (according to expertise, to recognized decision-making power, to speak on behalf of the team, rules keepers, group work coordination, informal leadership, …) • Identification of mandates and of prescribed tasks • Identification of organisation's different goals
Level 2 – Complexity and chronology of tasks		
Dimensions	***Sub-dimensions***	Indicators
Intensity	Types of activities	• Different implemented tasks and roles, their characteristics in chronological and "complexity" ranking order
	Types of participation in the team	• The dynamics involved in the peripheral incrementing participation in relation to the complexity of the tasks and roles involved • Indicators of progression through the tasks according to their complexity

		• Degree of peers' support (information, advice, observation, joint work, etc.)
	Degree of involvement	• Increasing degree of intensity in the implementation of the group's mandate • Various levels of involvement according to different tasks
	Degree of approval and recognition	• Acknowledgement (positive or negative) by leaders and peers of task performed
Identity *(manifestation of initial and progressive professional identity on the part of newcomers)*	Nominal categories	• Mention of formal and professional accreditation and title
	Relation to hierarchy	• Reference to relations with superiors in term of recognition and non recognition. • Relation to an informal leader (professional and non professional)
	Access to power	• Indications of potential to gain influence and power positions in the team (sharing decision-making, access to information, transmission of information, vertical mobility, etc.)
	Significant professional (model)	• Indications about (« significant others ») members who are source of admiration and professional referenced
	Trajectory	• Identity in terms of professional project.
Level 3 - The gradual mastering of tasks: peripheral participation		
Dimensions	***Sub-dimensions***	Indicators
Intensity (How tasks and roles are progressively mastered <peripheral participation>)	Ways of progressive acquisition of knowledge and skills, according to levels of complexity	• General and technical knowledge and skills • Learning (self and otherwise) practices • team support to master complex tasks and roles • Contribution or non contribution of structured learning activities (see level 5)
	Ways and means to acquire information and skills	• Progressive mastering of tasks • Means of acquisition according to levels of complexity • Ways of getting access to information and learning and documentation

Identity *(meaning given by new members to the progressive mastering of roles and acquisition of professional identity)*	Meaning given to being in control of new tasks and roles, to progression in expertise and recognized expertise.	• Access • Legitimacy • Participation
	Meaning given to acquisition of new identity in the team.	• Development of identity • Contribution to and position in the team
Level 4 - Interpersonal and knowledge transfer dynamics		
Dimensions	***Sub-dimensions***	Indicators
Identity *(position, roles in the group hierarchy; interactions; circulation of information; collaboration-conflicts; access-participation for each and all members)*	Access and participation; reproduction functions	• Access to information et resources • Legitimacy of action • Participation • Types of functioning • Modes of cooperation / conflict
	Patterns of interaction, types of exchanges, mapping of information and power (and leadership) inter-relationships (socio-gram)	• Relation of influence and power • Interactions • Types of exchanges • Role and autonomy of action of different members • Hierarchy • Cooperation and conflicts
	Climate, culture, team codes, legitimacy	• Identity • Legitimacy • Team culture, codes
Level 5 – Relationship between structured and informal learning		
Dimensions	***Sub-dimensions***	Indicators
Relationship between structured and informal learning	Contribution of informal learning to the team and the fulfilment of its mandate	• Retracing and going back to the various forms of informal learning of the above mentioned tasks
	Contribution of structured learning to the team and the fulfilment its mandate	• Contribution of structured learning activities to the mastering of tasks
	Complementarity / substitution / inconsistency	• Relationship between informal learning and participation in structured learning activities

Annexe 2

Biography

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