Epitech: from project-based teaching to sustainable learning.

Training future business managers: EPITECH, an innovative project-based teaching methodology

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I. Introduction

At times, the misfit between the traditional education system and the potentialities and needs of today's world are brought home to us more sharply.

Most of the time, the traditional education system is based on the teacher-student model: a certain number of students gather in a certain place, facing a teacher who 'delivers' his or her knowledge to the students. As long as there were no other channels through which knowledge could arrive, this model remained the only one valid.

Today, however, numerous other channels, such as the new technologies for instance, can result in knowledge creation and input.

The teacher's role remains crucial but its nature is changing. The teacher is now required to help structure the knowledge as well as disseminate it and this new role is at least as, and perhaps more, important.[1]

This means that decision-makers in education need to be prepared for major changes: in the coming century we are likely to see the development of a real 'school without walls' […]. As Michel Serres indicated in a government report published in 1992[2], "we need to imagine an entirely new way of reorganising how society gains access to knowledge in the next few decades."[3]

By presenting EPITECH's teaching system as an example, we have an opportunity to contribute to this debate.

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[1] Lelièvre C. ; Nique C., *Bâtisseurs d'école*, Nathan Pédagogie, 1994; p.431

[2] In 1991, Michel SERRES and Michel AUTHIER, in collaboration with Pierre LÉVY and others, led a project to combat exclusion. The then Prime Minister, Edith Cresson, believed that many people were excluded because their knowledge was not recognised by the systems in place (degrees, qualifications etc.) M. Authier put forward the idea of knowledge trees. Michel SERRES was quickly won over and decided that it should be a central feature of the project report.

[3] Ibid. p.432

The present education system

The French education system began with the coexistence of a few centres where the clerical elite offered the children of the wealthy lessons in values and behaviour in addition to the more traditional basic school subjects. The system gradually developed, becoming more diverse over the centuries to result in the education system as we know it today.[4]

But what exactly is an education system?

"In fact, it is a set of **institutions and agents** that **define which knowledge is to be acquired** by the population, **distribute it among the school publics**, **organise its transmission**, **deliver it** and **certify its acquisition**.

This complex system is run by a number of different cells (related to politics, administration, pedagogy, implementation, assessment, planning, etc.). The system's basic cell is **the classroom, the teacher and his/her students**, with the teacher transferring knowledge to the students who receive it. This basic cell is at the heart of the education system. The rest of the school system is organised and managed around it, for it, in accordance with it, etc."[5]

The education system founded on the class-cell worked well for many centuries "because there was general acceptance of the two conditions required for it to operate: firstly, that **knowledge can only be transmitted by a teacher with the help of books,** and secondly, that the public who receive this knowledge are in 'cultural connivance' with the teacher who addresses them. This situation is currently changing, however. On the one hand, **individuals today gain knowledge through a number of different channels in addition to teachers**; and on the other hand, a large section of the school public is no longer in 'cultural connivance' with the school culture."[6]

[4] This gave rise to one of the 4 dominant teaching methodologies: **individual mode:** successively, teacher - pupil. The 3 other forms are: **simultaneous mode**: teacher – group, at the same time; **mutual mode**: teacher – pupil (with monitors chosen from among the best pupils); **differentiated mode**: this is the simultaneous mode, but with the teacher dealing with each pupil in a different way according to individual needs.

[5] Ibid. p.433

[6] Ibid. p.433

If the two basic conditions for the existence of this education system cell are removed, what happens to the classroom-cell? Can the education system remain organised around it?
In short, believing that knowledge transmission from one generation to the next will continue to be organised in the same way as it has always been is to seriously misjudge the nature of social and technological evolutions.

True, the role of the teacher, the adult who helps, or the guiding reference, will always be crucial. But should such teacher-references continue to be considered as a depositary of knowledge to be transmitted, or should they instead be seen as guides who help to structure all the knowledge that arrives from every side?
And should this guide continue to group the students together in a given location?

In a world that will "increasingly be dominated by the brain economy, the school's role should be that of a […] driving force for the future because the competition in global brain power is going to get tougher […]. In France, the problem is not to decide if its education system is crumbling […] or wholly satisfactory […] but rather to energise it, improve it and adapt it to tomorrow's world."[7]

Where does that leave the future of the present-day education system?
New data increasingly needs to be taken into account in the organisation of knowledge transmission in an economy and a society that Europe has earmarked as driven by "knowledge".
In effect, the Ministers of Education in the EU member states wanted "to make the European Union the most competitive and dynamic knowledge-based economy in the world by 2010."[8]
In order to achieve this goal, the EU needs an education system that is able to provide **skills and competencies**.

[7] Allegre C., Dubet F., Meirieu Ph., *Pour l'école : Le rapport Langevin-Wallon*, Mille et Une Nuits, Barcelona, Spain, 2003. Preface by Claude Allègre; p.10
[8] During the European Council in the Portuguese capital, in spring 2000, the fifteen members of the European Union agreed on a highly ambitious objective: to make the EU the most competitive and dynamic knowledge-based economy in the world by 2010. This objective was later called the 'Lisbon Process'. Cf. The Lisbon process and education, 2000. Cf. the 2004 report concerning the roles advocated for Higher Education Institutions.

In short, the higher education system is at the heart of the new innovation-based knowledge economy, which includes breaking down university degrees into skills and competencies.[9]

Within this context and taking our previous definition of the education system into account, we explore three of the six aspects that define the education system through the example of EPITECH, namely **the intended knowledge input**, **the programme design** and **the implementation of knowledge transmission**.

We will do this by explaining how EPITECH:

- Breaks its programme down into skills and competencies defined in pedagogical terms:

  EPITECH is not only looking for the most effective way to use an internal 'on campus' teaching methodology but also, and above all, an external or 'out of class' pedagogy (concentric pedagogy that advocates field trips and outings, learning by objectives, project-based learning, mutual mode learning, etc.). Have such approaches to learning become one of the key success factors for certain higher education institutions, which depend more than ever on their capacity to produce, use and transmit knowledge effectively?

- Breaks its programme down into job-related skills:

  EPITECH has been exploring ways to adapt knowledge delivery to the constraints of the knowledge-based economy. This involves defining the learning objectives and then expressing the latter in terms of learning input as opposed to content. The final stage involves defining the intended knowledge input in terms of skills – the indispensable tools for applying and using knowledge in real life.[10] In other words,

[9] Michel Lussaut, « L'identification des compétences, un outil stratégique indispensable à la construction des parcours de formation » in «La déclinaison des diplômes LMD en compétences » CR of the Agence de Mutualisation des Universités et des Établissements. Seminar held on Tuesday July 6, 2004. Amue; p.6-7

[10] Michel Lussaut, « L'identification des compétences, un outil stratégique indispensable à la construction des parcours de formation » in «La déclinaison des diplômes LMD en compétences » CR de l'Agence de Mutualisation des Universités et des Établissements. Seminar held on Tuesday 6 July, 2004. Amue ; p.9.

numerous forms of Excellence become the foundation for a modern, fair and effective society as opposed to Academic Excellence exclusively.

Finally, these three defining aspects of the education system also lead us to question the **objectives,**[11] **the role** and the **place**[12] of higher education in today's society as well as, more generally, the underpinnings of education rather than simply its form, in other words, the concepts that lie behind teaching, learning and education.
Does this mean that teaching "is lagging behind cultural and social changes if we consider […] that educational humanism means providing students with programmes that will be useful to their professional and social integration" through "a new and active pedagogical method that requires diverse teaching approaches, enabling all students to have access to options and methods that bring out the best in them"?[13]

EPITECH's innovative project-based methodology also provides us with matter for reflection on this last question.

II. Context

Ministers are often blamed for taking measures too late with respect to needs and evolving situations, an illustration of its similarity with the world of higher education, which can be compared with Epimetheus (whose name means to think once it's too late), while the practical world of work would be that of Prometheus, the one who anticipates.[14]

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[11] Three distinct objectives that higher education "confuses to everyone's disadvantage are vocational training for the professions based mainly on intellectual know-how; contribution to the progress of science and the training of academic researchers; and dissemination of scientific, literary and artistic culture." Allegre C., Dubet F., Meirieu Ph., *Pour l'école : Le rapport Langevin-Wallon*, Mille et Une Nuits, Barcelona, Spain, 2003 ; p.37.
[12] "The main role of each society is to enable its members take part in the development of people, with each becoming what she/he has chosen to be thanks to the relationships that they build with others. This is called education. […] The education system is mistaken when it abusively, and often exclusively, lays emphasis on the acquisition of knowledge (considering it as an end in itself). […] Whatever the content, whether mathematics, physics, history or philosophy, the purpose of teaching is not to input knowledge but to use knowledge to create better ways of taking part in discussion (creating links with others)." Jacquard, Albert, *L'équation du nénuphar, Les plaisirs de la science*, ed. Calman-Lévy, Paris, 1998; p.51
[13] Dubet, F. « Que reste-t-il du Plan Langevin-Wallon ? » in Allegre C., Dubet F., Meirieu Ph., *Pour l'école : Le rapport Langevin-Wallon*, Mille et Une Nuits, Barcelona, Spain, 2003; p.118-119.
[14] I borrowed this image and some of the ideas that follow from De Peretti, « Ingénierie de la Formation », Conference paper, in Bourdoncle, R., Louvet, A., *Les tendances nouvelles dans la formation des enseignants : stratégies françaises et étrangères.* Conference paper, November 1990. INRP, Tours, 1991; p.17.

In other words, we have the impression that the academic world is trying to preserve precedence, integrity, and the purity of its theory and thinking, exclusive of practice. We believe that this is often also true with respect to its pedagogy.

We would therefore like to describe another form of pedagogy in higher education, one that focuses on reality, practical issues and the world of work. This is the project-based learning used at EPITECH, an example of another reality "that works". The idea is that opposites can balance rather than destroy one another. They can develop real dialogue as opposed to a dialogue that excludes. No teaching methodology provides the whole truth. We believe in variety rather than uniformity. Variety is another aspect of the modern world that allows diversity. Indeed, "It is not for nothing that Ashby's systemic theory highlighted the law of variety, essential as a possible regulator of metastable balance in an ultra-complex system: this is not only true for our societies but also for the ultra-complex system of **schools, classes** […]."[15]

In this paper, we try to present a combined whole that explores both the **principles** and the **practices,** acting as an intermediary between the two. We position ourselves at the interface between theory and practice, "promoting recognition of the dignity of the practitioner who is faced with the difficulties of on-the-field action, and who is supported rather than judged by the theoretician **who examines the practices**."[16]
Our underlying concern was to correlate the theory with reality, providing examples that are as much markers as benchmarks for a certain number of concrete actions. These examples, drawn from EPITECH's teaching methodology, can be found in the appendix.
We hope that the explanations for some of these concrete examples may later facilitate their conversion into re-usable actions, providing tools that have already proved their worth.

Finally, from the interface of the above-mentioned theory/practice tandem, we have positioned ourselves with respect to another tandem: i.e. **result/means**. This also needs to be taken into account "if we wish to remain on the side of Prometheus, which implies using

[15] Ibid. p.67
[16] Ibid. p.69

foresight, and not simply jumping in at the deep end."[17] As Mérieux pointed out, new solutions need to be explored in *project-locations*, in other words, concrete locations such as **institutions where attempts are being made to develop educational projects**. These *project-locations* where **other resources** can be developed might possibly provide responses to our questions and **point us in the direction of other solutions**, […]"[18]
Let us now turn to EPITECH.

III. Rapid overiew of EPITECH and its teaching methodology[19]

EPITECH is distinctly positioned as the generalist Computer Science *Grande Ecole*. Its focus is on the design and exploitation of IT systems, and its graduates are trained as Experts in Information Technology.
With a clearly project-focused teaching method based on the example of 'hands on' American institutions, EPITECH offers a multidisciplinary IT science programme. The students complete 150 projects during the 5-year programme. 90% of the assessment system is therefore based on real-life or simulated professional situations, with minimal assessment of theoretical input. EPITECH's programme sets out to train students to use all their knowledge and know-how in order to attain a concrete goal. If the project is successful, it is because the students have full control over the entire range of skills and can mobilise all their know-how and competencies.
This objective provides a logical backdrop to EPITECH's determination to embrace the Accreditation of Prior Experience and Learning (APEL) certification process, based uniquely on proof of the candidates' ability to master 'know-how' in their various activities.

EPITECH has also developed an original programme that gives the 3rd year students hands-on experience outside the school for 2 days a week. This is extended to 3 days a week from the fourth year. The main professional openings for information technology experts are:

[17] Ibid. p.70
[18] Merieux Ph., « IUFM : Questions et enjeux », in *Le rayon vert*, a monthly newsletter from the Lumière University, Lyon II, n° 31, 5-10-90; cited by De Peretti; p. 70.
[19] Information from the CNCP factsheet at EPITECH.

- Engineer / Operating systems manager
- Business engineer
- Research and development engineer
- Design and project manager
- Consultant/auditor
- Management/company creation/IT company takeover
- Technical/ IT director
- Systems and networks architect
- Engineer responsible for IT systems security

The main activities of 'information technology experts' have been sorted into five fields of overarching skills linked to jobs:

- Project management linked to IT systems
- Design and development of IT systems
- Management of administration systems and security
- Consulting/auditing IT systems
- Managing/creating/taking over companies in the field of NITC

The main skills, aptitudes and know-how mobilised in the course of these activities are globally the same whatever the technologies.

Hence, the present reference system applies equally to:

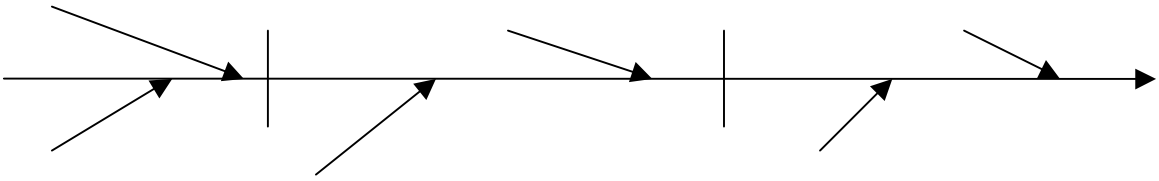
- telecommunications and network technologies (design, architecture and infrastructure, administration and exploitation, VoIP, VoD, multicast, etc.)
- Multimedia technologies (sound and image processing, interactive data flow transport, etc.)
- Internet-related technologies (design, development, online payment, e-banking, website exploitation, security management, etc.)
- databases (design, creation and operations, optimisation, decision support systems)
- security environments (cryptography, Windows, firewall, virus, risk management, quality and security contingency plan, etc.)
- software development technologies (software engineering, methodology, quality, programming: Perl, C, C#, dot.Net, etc.)
- cognitive technologies (AI., neural networks, genetic algorithms, agent-systems, etc.)

- man/machine interfaces (X-Windows, Motif, GTK, OpenGL, video drivers, voice recognition, virtual reality, etc.)
- design and management of information systems
- methods and project management
- business intelligence
- without forgetting closely related IT development disciplines that could be described as 'tertiary' (Management, Finance, Commercial, Law, Communication, Report writing, etc.)

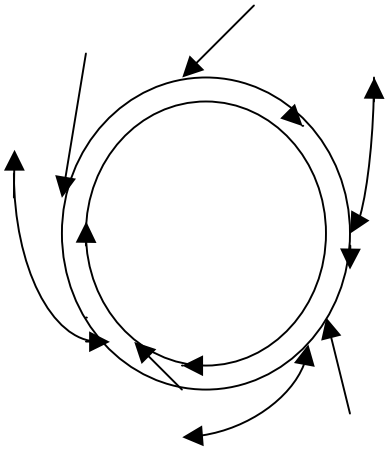
Finally, almost 94% of EPITECH students find jobs as soon as they finish their course, with starting salaries that are appreciably higher than the national engineering school average.

IV. Evolution of higher education institutions: innovative but not new teaching methods

As we saw in the brief description above, unlike traditional teaching which could be considered as more or less continuous and progressive,



EPITECH uses a concentric teaching methodology with a project-based approach, which consolidates and extends the programme, at the same fostering temporary experience outside the school (work placements, for example).



This highly innovative method is, in fact, not new. It was first propounded for vocational higher education in specialised schools in 1866. These schools, founded around 1880 under the aegis of the university, offered concentric 5-year study programmes, advocating practical experience for the students found outside the traditional school circuit. The programmes were divided into two cycles: 3+2 years. A board of perfection and patronage, made up of leading industrialists and businessmen, under the chairmanship of the mayor, sat side by side with serious remits. These schools were undeniably successful and were different from the so-called traditional education system in that they delivered the knowledge "demanded by the professions."[20]

[20] Duruy V. *Notes et souvenirs*, 1966, Hachette, cited by Lelièvre C & Nique C., *Bâtisseurs d'école*, Nathan pédagogie, 1994; p.316-7. At this time, higher education was called secondary education and depended on the university. It was divided into 'classic' and 'special'. These specialised schools only retained the original idea between 1880 and 1886, after which traditional teaching methods 'won the day' (based on the traditional system, this type of special education became continuous and progressive, the two cycles disappeared and the whole structure became identical to that of traditional teaching. This meant that they lost all their specific 'aura'). René Goblet, defender of this style of teaching, in a speech published in *Le Progrès de la Somme*, in which he tried to retain the dual distinction of special and traditional which he considered as equally important, said: "the new teaching methodology should differ from traditional teaching by providing knowledge that is required by the professions and it should be recognised as being just as distinguished" […] "We have to wrest the so-called special education from the mortal stranglehold of academics who have only ever seen the newcomer as an enemy […]. The coalition of traditional institutions [referring to so-called traditional education where Latin and Greek were obligatory for everyone, and which trained men of letters, lawyers, doctors, etc.] stopped at nothing to remove the utilitarian and practical nature of special education, in other words, everything which gave it its *raison d'être* […]." (Duruy V. *Notes et souvenirs*, 1966, Hachette). Cited by Lelièvre C, Nique C., *Bâtisseurs d'école*, Nathan pédagogie, 1994; p.316-7.

Victor Duruy, Minister of Public Instruction, believed them to be better able to "respond to specific and localised technico-economic demands in a situation of free exchange and in developing the applications of scientific discoveries to industry."[21]

Duruy added: "In the peaceful but powerful struggle that took place between the industrial nations, the winner was not the nation with the most manpower or capital, but the one with the best-educated and most intelligent working classes. Every day, science puts new agents at the service of industry to provide it with the support it requires. That is why industrial progress is so closely linked to educational progress today."[22]

This text is extraordinarily modern in spirit. Even if some technical points no longer correspond to present-day reality, we believe that the issues raised remain highly topical.

Today, we find the same mindset in the so-called vocational education institutions. EPITECH is just one example.

These higher education institutions are also, to a large extent, upgraded or revamped heirs to the old 'polytechnics', especially with the apparition of new forms of vocational practice (communications or IT careers, for example). Others attract a public who want to work in professions that are highly popular with young people today (media, etc.)[23]

"Vocational education institutes were set up to run alongside traditional and well-established schools, universities and training programmes for senior technicians. They found themselves competing on the education market to attract the best candidates and offer the best job opportunities. […]. There has been an increasing degree of state intervention in vocational education institutions and universities, whatever their speciality. The degrees delivered are examined in minute detail to ensure they match certain benchmarks, and this has led to greater formalisation of the teaching input and the teaching programmes."[24]

[21] Duruy Victor (Minister of Public Instruction under Napoleon III (report from 1966), (1811-1894), founder of the '*Ecoles spécialisées*'.

[22] Duruy V. Circular to Chief Education Officers, April 1866, on the organisation of special teaching. Cited by Lelièvre C. and Nique C., *Bâtisseurs d'école*, Nathan pédagogie, 1994 ; p.316-7.

[23] Vasconcellos, M., *L'Enseignement Supérieur en France*, 2006 ; p.47-8. I based the rest of this section on this book.

[24] Vasconcellos, M., *L'Enseignement Supérieur en France*, 2006 ; p.62

The new expectations voiced by society and the diversification of missions expected from higher education have been contributing factors in the new configuration of higher education. The ongoing expansion of vocational education institutes is just one example. They have benefited from the significant changes that have taken place in work organisation within the new economy, characterised by:

- a reduction in the sort of jobs where the workers simply execute, and a rise in the number of jobs for managers and technicians dealing with technological design, management and maintenance.
- the changed role of the hierarchical intermediary who now has a technical rather than a disciplinarian function.
- the introduction of sophisticated technological resources in the service sector, which promotes the arrival of young graduates equipped with new specialisations
- the change in the way middle management functions are accessed: rather than the traditional internal promotion, today's HR policies prefer to recruit young graduates with new technological and social skills.[25]

These degrees, based on programmes that combine technical and professional training, are highly appreciated by companies. They appear to be more open to company requirements in terms of learning content due to the presence of professional representatives in the decision-making bodies who draw up the programmes, and the way teaching is organised to include business organisations as a venue for training (internships) or for applied research opportunities.

It is difficult to classify them other than by their professional sector. Their general name of 'school' sets them apart to some extent from the rest of traditional higher education. This means they can stay outside the 'democratisation' process of the more academic forms of higher education which lays less emphasis on its students' concerns to enter the workforce.[26] They also differ in other ways, with **fewer formal knowledge input processes** in the programme design, and the introduction of new forms of knowledge, for example.

[25] Ibid p.42
[26] Ibid. p.61

In other words, these institutions, whatever their sectors, "appear, in particular, as **'counter-models'** to current thinking in higher education."[27]

The creation of vocational training programmes at the university has not drawn away the new student public as these institutions limit their intake anyway. They are also in the throes **of perpetual change**.

« Not only are we witnessing the creation of new tracks and disciplines, but the very framework of academic learning is changing. The style of teaching practices and relationships has led to new patterns of behaviour, new relationships between generations and between teachers and students, and new leisure opportunities and lifestyles […]."[28]

In addition, the students are taught subject matter that genuinely interests them.

Through their content, the new profile of teachers they attract, the less traditional teaching methods (fewer courses in lecture halls, etc.), and the inclusion of the concerns of everyday life, these new programmes attract students, assistants and lecturers alike.

Lastly, **the close fit with the world of work** and **the adaptation to professional concerns** gives these technical and vocational courses wide appeal. This also contributes to countering the centralisation of universities, the compartmentalisation of faculties and disciplines with fixed hierarchies, and the decision-making processes in teaching and research. Furthermore, in addition to their knowledge management autonomy, these institutions also manage their own teaching and research policies.

In other words, three key elements - autonomy, a multi-discipline approach, and partnerships, combined with two strong trends in the knowledge-based economy that Europe aims to make more competitive and more dynamic, namely the **professionalisation** of courses and **teaching innovation**, are increasingly visible in this type of higher education programme and, of course, at EPITECH .

[27] Galod G. et Michaut Ch., « Les études artistiques : hétérogénéité des écoles supérieures d'art, pratiques étudiantes et réussites scolaires » in Felouzis G. (dir.), *Les mutations actuelles de l'université*, Paris, PUF, 2003, cited by Vasconcellos M. *Le système éducatif*, Paris, La Découverte, « Repères », 4th ed. 1994; p.61.

[28] Ibid. p.66

V. New innovative teaching trends: professionalisation, skills and types of knowledge

In the **knowledge-driven economy** that Europe hopes to develop as the most competitive and dynamic in the world by 2010, "[…] **professionalisation** of learning programmes and the breakdown of courses into **skills and competencies** is considered to be at the basis of the **reorganisation** […] and **effectiveness** of academic programmes."[29]
This highlights the importance of introducing new pedagogic methods based on **fewer 'formal' and traditional forms of knowledge input** in programme design, and the introduction of **new types of knowledge**.

Since the pioneering work of Friedmann and Naville in 1962[30] - both work sociologists – we know that production activities are constantly changing and that any attempt to train **people within the education system in accordance with existing jobs will inevitably fail as such knowledge rapidly becomes obsolete**. Graduates find it difficult to transfer this type of knowledge to other work situations or to envisage promotional careers (**the training of IT specialists** is just one of many examples known to researchers). In addition, job descriptions depend on a configuration of activities, company policies and the relationships between different categories of staff faced with specific situations, while an activity's content depends on technical work organisation factors.
This makes it difficult to define fixed guidelines to use in programme design.

The idea behind the professionalisation of the teaching staff is to develop a better relationship with the job market.
In effect, "[…] the creation of specific new **vocational** degrees corresponds to the demand from new publics and developing their 'employability'. This trend has been noticeable in most European countries. Business organisations actively encourage this type of programme which corresponds to the credentials demanded by the professional sectors."[31]

[29] Vasconcellos, M., *L'Enseignement Supérieur en France*, 2006; p. 77.
[30] Friedmann G. ; Naville P. *Traité de sociologie du travail*, volumes 1 and 2, Armand Collin, Paris, 1962; cited by Vasconcellos, M., *L'Enseignement Supérieur en France*, 2006; p. 79.
[31] Vasconcellos, M., *L'Enseignement Supérieur en France*, 2006 ; p. 78

The design and purpose of learning content is thus based on 'feasibility' and effectiveness criteria arising from the business sector.

Today, the business sector is clearly operating in a knowledge-based economy.
This new economy has crystallised the unique articulation between:
- a long-term trend towards more resources devoted to **knowledge** production and transfer (in other words, knowledge whose main property is to generate new knowledge in its own right) and
- the introduction of **new information and communication technologies**.

This has led to various outcomes, one of the most significant being the increasing importance of change and **innovation**.[32]
Consequently, the success of business organisations depends more than ever on the capacity **to produce and to use knowledge**.

The impact of the knowledge-based economy has affected numerous activities, in particular science, industry, services and **education,** which depend more than ever on the growing emphasis placed on change and **innovation**.[33]

We believe that the same is true for higher education institutions, particularly when the learning processes and content are based on **information and communication technologies** as is the case at EPITECH.

Hatchuel and Weil[34] clearly demonstrated that the **skills** needed by individuals to cope with continual change **involve developing competencies that go way beyond mastering NITC tools**. Understanding, memorisation and inference are central to these learning capacities. Their development enables individuals to implement effective strategies when faced with the

[32] Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p.114. (much of the following section is based on Foray's work).
[33] Ibid. p.113.
[34] Hatchuel A. et Weil B., *L'expert et le système*, Economica, Paris, 1992.; cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000 p.108.

unexpected or with change. A key objective in the knowledge-based economy is therefore the acquisition of lifelong learning skills.[35]

In effect, "fields of competence are highly prone to change, reflecting the social evolutions of the past few decades: technological advances and diversification of know-how, market restructuring and changing demand, the repositioning of **individual and social intelligence** at the heart of production activities […] thus the players taking part in **'team-projects'** pull out all the stops to integrate the demands of customers with respect to deadlines and quality, bringing mobilisation skills and the ability to adapt their know-how into play in complex situations that demand a high level of personal commitment […]. In this case, competency could be defined as the capacity to adapt […]. Consequently, competency is a differentiating factor between two people with the same qualifications. Qualifications are appreciated beforehand and skills or competency are appreciated after."[36]

"A**ctivity and skills benchmarks** are often used as **learning goals**. The distinction has been made between the field and the level of competence. The field of competence constitutes the list of actions that an individual is able to achieve in a given domain. The level of competence defines the qualities or capacity to achieve, and helps classify individuals […]. Competency that is aligned with goals and results is frequently assimilated with performance. Performance is defined as an outcome in terms of realisation of actions, and competency is defined as a means in terms of the capacity to achieve them. If the individual undertakes an action and obtains the result, he or she has the necessary competency."[37] This underscores the importance of project-based learning which facilitates the implementation and assessment of processes and results, as well as activity and skills benchmarks.

Academic and training institutions are thus **central elements in adjusting skills and competencies to the constraints of the knowledge-based economy**.

[35] Favereau, *L'Economie de l'information*, La Découverte, Paris, 1998 cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p.108
[36] Denieuil P-N, « Entreprise et compétences » in *Education permanente*, N° 133, 1997. p.36
[37] Ibid p.42

Knowledge, however, is multi-faceted. Knowledge is firstly a **cognitive capacity**, distinguishing it from 'information'. Generally speaking, cognitive and interactive skills are those which need to be targeted for acquisition.
We are interested uniquely in the **mechanisms of knowledge acquisition and transfer.**

For many years, the concepts of knowledge and information have been assimilated with one another.
Knowledge, however, is more than information. It reflects the capacity that knowledge has to **generate, extrapolate and infer** (deduce a consequence of) new knowledge and information.[38]
An individual who possesses theoretical OR practical knowledge (or both) in a given field will be able to produce both new knowledge and new information relative to this field without help.

Thus, knowledge is first and foremost a learning capacity and a **cognitive capacity,** while information remains a set of structured and formatted data, to some extent inert, and at times, inactive, which can be learnt but cannot easily generate new knowledge on its own.[39]

Knowledge may be **cognitive** (mobilisation of known and memorisable processes, resolution of an enigma, definition of a tactic, etc.) but it can also **interactive** (dialogue, supervision, autonomy) and **automatic** (gesture, manipulation).[40]

It is easy to see why the pedagogical processes of knowledge reproduction and information reproduction are generally very different even though both are necessary. To put it simply, while the first occurs through learning (learning a learning capacity), the second occurs through duplication. We always have to mobilise a cognitive resource to reproduce

[38] Steinmueller W.E., *Networked knowledge and knowledge-based economies*, Telematica Institut, Delft, February, 1999, cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p. 9
[39] Or even prevent it. In some cases, an inert piece of information may at times block the learning of new knowledge.
[40] Hatchuel and Weil, *L'expert et le système*, Economica, Paris, 1992, cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p.9

knowledge, while the process involved in reproducing information is closer to the concept of photocopying.

Differentiating between the two concepts leads us to distinguish between **the learning processes** relative to the two notions.
The main problem with respect to knowledge concerns reproduction (problem of learning), while the reproduction of information is less problematic with respect to transmission.
Many professions are witnessing a crisis in both vertical and horizontal knowledge transmission (between student-teacher, between professionals, etc.).[41] This could be partly resolved if a clear distinction was made between the issues involved in knowledge reproduction and those involved in information input. Weaknesses in the **social networks** - which we will speak about later – explain the problems of knowledge reproduction in all the professional sectors.

Thus, in the frame of a knowledge-based economy, we will now focus uniquely on the **various and innovative project-based learning processes that have been developed at EPITECH in order to transmit and produce knowledge** (in other words, knowledge whose main property is the capacity to generate new knowledge) **based on NICT tools**.

VI. Project-based learning and examples at EPITECH

(http://www.epitech.eu/v4/epitech-english-documentation-art126-lang-en.html)

Learning at EPITECH is considered as:

1. A practice and experience-based activity (cf. EPITECH PFE project):

In addition to developing the production of knowledge in a deliberate and systematic manner in order to increase stock of knowledge, something that is mainly produced through the transmission of information, we could say that:

[41] *Knowledge management in the learning society*, Centre for Education Research and Innovation, OCDE, 1999. (Examples concerning health and education) cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p.10

"Every activity in which a good (or a service) is produced or used can give rise to learning and thus to knowledge production. In other words, in many activities, knowledge production is not a prime objective but it nonetheless exists […]. These forms of learning are known as *learning by doing* and *learning by using* […]."[42]

These learning processes are crucial in a knowledge-based economy and take us beyond the simple outcome of improved task completion through repetition of an action, even if "it is difficult to measure knowledge produced by learning."[43]

A great deal of knowledge cannot be boiled down to codified instructions but is, in fact, tacit. Mastering a new technology or new knowledge is a highly complex process that each company is more or less successful in achieving depending on its organisation, its forms of management and its strategy.

2. A collective effort (cf. EPITECH ZIA HTTP server project):

« [..] knowledge creation is increasingly acknowledged as the result of a collective effort. This may be internal […] or external, explicitly set up and organised (as in the case of a consortium) or much more informal and spontaneous as in the case of exchange of know-how between engineers belonging to rival firms). NICT, and the specific class of 'collaboration technologies' in particular, once again play a significant support role. Thus, new industrial and innovative organisations are created around this form of network, largely supported by the NICT."[44]

Added to this, there are short periods of construction of new capacities and longer periods of exploitation of these capacities creating a new order of continual innovation which requires higher levels of education and specific competencies based on adaptability, mobility, flexibility, investment in access to information systems, and complex coordination processes.

This process could be divided into two forms. The first form uses abstract and spontaneous exchange mechanisms and sharing of knowledge and know-how while the second form uses formal co-operation and collective training processes."[45]

[42] Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000. p14.
[43] Ibid. p. 15
[44] Ibid. p.28
[45] Ibid.p.44

In the first form, already available knowledge is pooled (not as a coordinated research project but as an exchange of existing data, with knowledge creation resulting from the dissemination and reuse of available knowledge).
In the second form, the players engage in knowledge production operations, that requires explicit coordination mechanisms as well as formalised agreements with respect to both division of labour and attribution of the results.

3. Joint production and utilisation activity (cf. EPITECH RUSH project):
At the heart of technological teaching, the learning process "is in fact made up of a succession of non planned experiences. These experiences themselves arise from the appearance of problems that are not anticipated at the time of the programme design, nor from anticipated but unresolved problems."[46]
Within this very general framework, we can separate routine-type learning, dependent on the repetition of one action linked to another that consists of conducting experiments which lead to the generation of new options. This form of learning relies on the development of an experimental concept that enables data to be collected and, on this basis, the best strategy to be selected for future activities. (This type of learning depends on the nature of the activity. Surgeons cannot learn in this way, for example).

4. A recognised combined and integrated activity (cf. EPITECH GOMOKU project):
"When an organisation has understood that it has several sources of knowledge and that learning processes take place throughout its structure, all that remains is to identify, collect and deploy the knowledge which is developed ‘on the job'. […] Certain companies succeed in recognising the dimensions of learning, collect the knowledge which arises as a result and promote links and feedback between the learning processes and the formal knowledge production and acquisition processes."[47]

6. Competency-codified knowledge (cf. monitoring and coaching activities at EPITECH):

[46] Ibid. p 44
[47] Ibid. p. 42

Knowledge may be codified to become readily reproducible and transferable. "Coding is not simply a question of transfer but is also one of creation, involving breaking down and rearranging the knowledge."[48]

If we follow this breaking down process into factual knowledge (know-what), procedural-type knowledge (know-how), and knowledge that gives access to other knowledge (know-who),[49] we can see that the most difficult aspect to codify is the knowledge related to the third group (the "yellow pages" enables information to be structured but does not codify the "knowing-how-to-find" information, for example). As it is difficult to codify this, it cannot be transmitted in the same way as basic information. Breaking it down into skills goes some way towards resolving this problem to a certain extent. As we already noted, the ability to understand, memorize and infer are central learning skills in the knowledge-based economy.

Regular monitoring is therefore necessary. This enables individuals to develop strategies in the face of change and the unknown, and to acquire improved "knowing-how-to-learn" skills[50] which become the key learning and training goals in knowledge-based economies.

These different innovative learning processes have been developed at EPITECH in order to professionalise learning, breaking it down into competencies to be transmitted so asr to produce new forms of knowledge adapted to the knowledge-based economy. They highlight a final characteristic of EPITECH's teaching methodology, namely a fairly marked **'non-academic' approach** combined with a strong emphasis on **"social knowledge networks**."[51]

VII. The importance of the 'non academic'

As already mentioned, the demands of the new economic order underpinned by a so-called knowledge-based economy, are now the acknowledged reality.

[48] Ibid. p. 50

[49] Foray D. and Lundvall B.A., "The knowledge-based economy: from the economics of knowledge to the learning economy," in *Employment and growth in the knowledge-based economy*, OECD, Paris, 1996, cited by Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p.55

[50] Foray D., *L'Economie de la connaissance*, La Découverte, Paris, 2000; p. 108

[51] Illich I., *Une société sans école*, Seuil, Paris, 1971

The European Union needs an education system that can provide **skills and competencies** in order to transmit and produce new forms of knowledge adapted to this economy.[52]

Teaching therefore needs to be designed according to a skills-based concept.

Firstly, when skills are assessed, evaluative moral judgements need to be avoided: a student may not have the necessary skills during an assessment but he or she is nonetheless a human being with a future. Secondly, when reasoning is based on the premise of skills, we reason in terms of individuals who are able to act, or the individual-stakeholder.

In other words, the students are players in the learning situation. They are part of a process which is not simply receptive and this means we need to mobilise the capacities of these stakeholders.

They must be able to master and activate knowledge (i.e. knowledge whose essential property, as we said beforehand, is the capacity to generate new knowledge). Lastly, the capacity to master knowledge goes hand in hand with the ability to master procedural skills such as attitudes or behaviours.

In short, thanks to this general skills-based approach, the individual becomes an active player in the development of knowledge, attitudes and procedures. This is very different from the ideology of knowledge transmission in a traditional teaching relationship, with so-called **'linear'** learning.

However, there is more than one way to approach skills, teaching methods and didactic transposition. Everything depends on what the students are expected to learn, based on the stated programme objectives. All teaching is preparatory and we can choose the best adapted teaching method according to the stated objectives.

In other words, with a critical pooling of practices and the joint construction of courses, progress and programming, the students will be able to develop **"a problem-oriented autonomy: because a successful teacher is one who disappears."**[53]

[52] Lussaut M., « L'identification des compétences, un outil stratégique indispensable à la construction des parcours de formation » in CR de l'Agence de Mutualisation des Universités et des Établissements from the seminar held on Tuesday 6 July, 2004: « La déclinaison des diplômes LMD en compétences ». Amue, 2004. The rest of this section is based on this text.

[53] Ibid. p. 7

This leads us to a last factor and one which is characteristic of EPITECH's teaching methodology, namely a fairly marked **'non-academic' approach** combined with a strong emphasis on **'social knowledge networks'**.

Indeed, for several decades and according to several reports (i.e. the Carnegie report) "with respect to schools and universities" we "are now wondering whether it might be possible to view education differently." [54]

Already in 1971, Illich put forward a strong case when he explained his concept of non **academic** learning. He advocated that teaching should also provide for "those who want to learn new ways of coming into contact with the world around them, instead of continuing to have **recourse uniquely to the traditional distribution channels of teaching programmes**."[55]

This text is incredibly modern in spirit, and even though many points are taken to the extreme in the book, we believe that some of the issues raised and the solutions put forward continue to be valid for EPITECH. **(cf. EPITECH RATP Project)**

Illich proposed separating the concept of academic teaching from that of education by focusing on **three factors** (access to existing resources, access to the people who wish to share their knowledge, and the possibility for those with new ideas to be heard) **and four sources of learning** (the objectives, the models proposed, the assistance of elders, and meetings with peers). He believed this would improve the way the education system worked and provide a better "framework of educational possibilities", in other words "an educational framework or fabric" that would produce new **knowledge networks**, giving everyone more and better opportunities for learning and teaching.

In order to function well, these networks need administrative support, technical equipment and legal protection. The institution must therefore:

1. provide the learner with access to "educational objects." Very often, schools force their students to live in an environment where the objects are extrapolated from the

[54] Illich I, *Une société sans école*, Seuil, 1971; p.123. The rest of the paper is based on this text.
[55] Ibid. p. 125

everyday environment which gives them their true sense. This means that they lose the ability to impact on reflection. We need to begin by reversing this situation.

2. contribute to an exchange of knowledge with older colleagues (and not only those who reflect the school's brand image.) through manipulating, examining, etc.
3. facilitate pairing up with equals: facilitate meetings between peers who share the same specific interests. "Modern technology easily lends itself to the introduction of peer networking."[56]
4. facilitate contact with 'reference' people in the field, whether they are from the institution or not.

This can be done via a pedagogical method which:

- Enables students to discover that reasoning systems are based on interchangeable axioms, and that conceptual mechanisms can be applied in a transverse manner.
- Enables the concepts of knowing how to learn, which methods to use, and sources of information to be differentiated.

In short, Illich's examination of education institutions incites us to reassess the way academic institutions work, as well as our image of education and human beings.

VIII. Advocating a project-based learning approach: "knowledge as development" and the evaluation of learning input

There is complex interweaving between **economic and technological points in time**, **modes of learning**, and **knowledge content** at every period in history, and it is continually evolving, promoting one form of intelligence or another[57] and the subsequent **assessment of learning input**.[58]

We have already spoken about the first three concepts. We are now going to turn our attention to the last.

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[56] Ibid, p. 155

[57] ` 'Intelligence' according to the definition by Berthelot J-M : « L'intelligence est la capacité d'établir des liens et de saisir les relations ». L'intelligence du social, Puf, 2nd ed.1998; p.9

[58] Padoani-David G. « La formation de futurs cadres en entreprise : Un dispositif pédagogique innovant en partenariat. » ACCES Doctoral School, Research Master in Education, 2002; p.8. The following section is based on this text

"**The field of education**, as an environment for exercising the right to individual promotion, has gradually become a space for achieving a certain obligation, **that of adaptation**."[59]

A training programme designed for future executives that is shaped through an innovative, **multi-field project with 'internal' and/or 'external' partnerships**,[60] like the previously-mentioned examples from EPITECH, reflects Jobert's "learning as development" in which he refers to three metaphors for speaking and thinking about **institutionalised educational action** in adult education. "In this model, personal learning is not simply achieved by the accumulation of learning input supplied from outside, […] nor by adaptation to the demands of a reality external to the subject."[61]

Once learning programmes are developed in this sense, it is no longer possible to just single out the mode of learning which promotes theoretical knowledge and whose main and most commonly used metaphor is that of "knowledge as stock", a capitalist vision borrowed from the industrial era and based on accumulation.

The learner is a memory, the teacher a supplier of data, and the goal is to amass conceptual knowledge to fulfil a function.

No attempt is made to develop innate or previously acquired skills, and "the creative potential of our intelligence" is not taken into account.[62]

Assessment is easy, as it discloses a kind of inventory of accumulated knowledge (classification/qualification).

This means we cannot discern simply the mode of learning that promotes practical knowledge either. The commonest metaphor for this form of learning (Jobert's second) is that of knowledge as an instrument for action, leading to "action learning." This metaphor attempts to

[59] Correia J. A., « Formation et travail : contribution à une épistémologique de la médiation », », in Apprentissages et évaluations, Education permanente, N° 143, 2000-2; cited by Padoani-David G; p.16

[60] Bautier E., Gonnin-Bolo A. and Zay D.,« La problématique et les thèmes du colloque, Compte rendu du séminaire préparatoire » in Zay D. and Gonnin-Bolo A. Institutions and strategic partnerships for joint projets. Conference papers of 14,15 and 16 January 1993. INRP, 1995; cited by Padoani David, 2002; p. 8

[61] Jobert G., « Dire, penser, faire. A propos de trois métaphores agissantes en formation des adultes », in Apprentissages et évaluations, Education permanente, N° 143, 2000-2, cited by Padoani David G., 2002. The first metaphor given is 'knowledge as stock', the second is 'knowledge as action' and the third is 'learning as development'; p.9

[62] Glass N., *Management : les 10 défis*. Editions d'organisation, 1998, Chapitre « Une nouvelle façon d'appréhender l' intelligence », cited by Padoani David G., 2002; p.9

integrate realities that are left out of the preceding accountancy concept, as it asserts that memory, conscience and action cannot be separated from the total psychic machine, relationships with others, or the physical reality which surrounds us. "Knowledge as action" emphasises practical intelligence over conceptual intelligence. It appears at the moment when production systems and the increase in economic competition become more complex.

Without ignoring the importance of scientific and technological knowledge, we assess the concrete, **the competency benchmarks** and the know-how needed to carry out an activity. "Teachers are no longer mediators between available knowledge and potential customers […]. […] Instead, their know-how becomes that of an analyst in terms of working situations and a consultant able to support collective changes." [63]

The fast-developing technological complexity of the world of work is increasingly dependent on human development, a long way from the conceptual knowledge/know-how dichotomy. This in turn fosters the construction and deployment **of all the skills and competencies that an individual possesses.**

These competencies are "knowing-how-to-mobilise", "knowing-how-to-integrate" and "knowing-how-to combine"[64] the diverse resources that are the outcome of basic education, higher education, the individual's personal background, professional experience, knowledge networks, etc.

In short, today's world now calls upon teaching oriented towards "development education", and underpinned by both the metaphors mentioned previously, as well as **the new concepts of learning and development, particularly in adult learning programmes (notably vocational learning programmes**) **and the accreditation of prior learning concept introduced by the OECD in 2001.**

"Indeed, there is always a twofold and, we might say, retroactive, aspect to the general project of adult education, particularly when it concerns vocational learning programmes: the process

[63] Jobert G., « Dire, penser, faire. A propos de trois métaphores agissantes en formation des adultes », in Apprentissages et évaluations, Education permanente, N° 143, 2000-2., cited by Padoani David G., 2002; p10-12
[64] Aubert S., « Transformer la formation par l'analyse du travail » in *Apprentissages et évaluations*, Education permanente, N° 143, 2000-2.cited by Padoani David G., 2002; p.10

which aims to transform the learners is extended through the aim of these learners to transform the world, thereby acting within the external world which, in return, contributes to triggering an internal subjective realisation. Work and learning thus maintain complex relations of reciprocal production in which all interactions must be taken into account: those of the subjects with the instruments that they use to act on the objective world (the tools), on others and on themselves (the signs); those they maintain with reality and with other people involved in the learning or production situations; those that the others maintain with the objects of the learner's activity." Development is then considered as "[…] a conflictual relationship between the internal and the external. Development is driven by the tension that is established between the state of the subject's capacities when acting alone at any given moment, and the requirements demanded by the environment. This internal tension, generated by the subject's state of inferiority, is compensated by the mobilisation of external resources (objects or people) which the social environment offers, a mobilisation which constitutes learning-generated development."

This development offers the teacher numerous opportunities because:

"[…] it signifies the unpredictability of the trajectory in which the subject is engaged, the permeability of this to the ongoing, surrounding history, its openness to original creations from the association between the learner's internal sources and the external resources they have access to. This development lability is based not only on the historical character but also on the fact that it takes place within permanent social interactions" [65]

The teaching of future managers also focuses on "learning as development", which brings into play conceptual intelligence, practical intelligence, and 'emotional intelligence' (control of the profound ego + perception of others + interaction with others).[66] These competencies which concentrate on human development are also known as "third dimension competencies."[67]

[65] Jobert G., « Dire, penser, faire. A propos de trois métaphores agissantes en formation des adultes », in Apprentissages et évaluations, Education permanente, N° 143, 2000-2, cited by Padoani David G., 2002. pp10/12

[66] Glass N., *Management : les 10 défis.* Editions d'organisation, 1998, chap. « Une nouvelle façon d'appréhender l'intelligence », cited by Padoani David G., 2000. pp12

[67] Barbier J-M., « Tendances d'évolution de la formation et place du partenariat » in Zay D. and Gonnin-Bolo A. *Etablissements et partenariats Stratégies pour des projets commun.* Conference papers of 14, 15 and 16 January 1993. INRP, 1995, cited by Padoani David G., 2002. p12

This third major metaphor is particularly apt in adult learning programmes, especially in **vocational training** and the **accreditation of prior experiential learning (APEL)**. Frederic de Coninck highlights this point when he discusses the last three modes of learning linked to three types of knowledge: "traditional knowledge", "collection of know-how" and "exploratory reasoning."[68]

In short, today's teaching of future executives has borrowed its logic and methodology from the business world to help them to develop a closer fit with their environment. These new modes of teaching demand effectiveness, efficiency and so on, but they continue to retain the logic and methods found in 'traditional' teaching.

In this still relatively recent cognitive revolution, the greater the advances of cutting edge technologies and, consequently, the greater the quantity of rapidly-changing knowledge, the more the gap between them closes. The more dispersed the networks are (in a world now characterised by centrifugal forces), the greater the need for **teamwork**. We also need to consider the importance now attached to developing immaterial cognitive and relational productions and to the individual performance of innate and prior learning that we already mentioned.

Project-based learning facilitates the adaptation of two key elements as working methods, namely a project-specific pedagogy and an approach based on partnerships. Jean-Marie Barbier,[69] among others, mentions these two elements used by EPITECH to enhance the programmes of future managers. He also identifies **various aspects of** evolutions, trends and changes which affect the world of education and training, **and which reflect a major change in the production and mobilisation of identities in Western societies:**

- **the development of project-based learning**, where real-life actions and situations concerning the production of goods and services by students or graduates are used as a starting point and a focal point for teaching purposes;

[68] De Coninck F.,« Des nouvelles « postures cognitives » dans le travail aux nouveaux processus sociaux d'apprentissage », in *Apprentissages et évaluations*, Education permanente, N° 143, 2000-2, cited by Padoani David G., 2002; p. 13

[69] Barbier J-M., « Tendances d'évolution de la formation et place du partenariat » in *Apprentissages et évaluations*, Education permanente, N° 143, 2000-2, cited by Padoani David G., 2002; p16-7

- interest in pinpointing and using **situation-problems** whose completion provides opportunities for finalising cognitive learning sequences;
- more generally, the creation of situations in which new competencies are developed through concrete activities involving goods and service production.

EPITECH's project-based learning includes all three aspects. A general analysis of this mode of teaching, and consequently EPITECH's pedagogic method, would appear to indicate that the act of teaching or learning increases coherence with its praxeologic environment, as if an explicitly managed articulation developed between the act of teaching or learning and the context which explains and justifies it.

This might be designated as the development of a project management-type function with respect to the learning context. The concept of the project would cover all the issues, stakeholders and operations that explain both the recourse to a particular activity and the transfer of its results.

The author mentions three other evolutions which also relate to the teaching measures that concern us:

"1) using research for training purposes: This is particularly common practice in various higher education programmes […], particularly for teachers […] and even engineers, whereby study and research activities, project development and report writing about real-life situations developed directly by the student are used explicitly as teaching tools […]. These learning practices appear to revolve around […] developing the ability to take the specificity of situations into account, to solve new problems and to imagine new solutions, in other words, developing capacities of expression or complex competencies.

2) using professional situations for learning purposes: Tin fact there are many approaches currently in use, but their characteristic feature is […] the desire to obtain at the same time and in the same place, in other words, during work times and in work locations, both the transformation of the learning produced and the transformation of the agents involved. This applies to […] action-learning and also the development of the tutorial system. […]

3) setting up methods that combine three facets simultaneously: an action facet, a research facet and a learning facet: This can be seen in many innovative methods today […] **where the group is simultaneously in a situation of action, research and learning.** These

approaches are often introduced to promote the social integration and professional qualifications of young people.

All these approaches […] comprise a moment of reflection, analysis, verbalization, formalisation of the action or work by the practitioners themselves and […] this moment ensures the learning impact […]. **The moment the act of work gives rise to reflection or research in whatever form, it consequently becomes an act of learning**."

Another evolution mentioned by the author concerns personalised management, not of learning paths but of paths of evolution, which he believes to be wider than what we tend to call 'development'.
This refers to **personalised project management** which highlights the importance of personalised assistance in project development and the personalised management of the acquisition methods themselves, as well as practices that encompass various teaching methods including **opportunities** for **self-assessment**. These practices are also embedded in EPITECH's teaching approach.
"These practices remain profoundly linked to learning paths. Nonetheless, they probably play a more profound role than we might describe as an element in identity flexibility, in other words the production of individual behaviours and capacities to adapt to changes in the environment and to transform these environmental changes into opportunities for individual change. Their function is not so much to facilitate the acquisition of such or such an identity as to impact on the potential or dynamics of identity transformation itself."[70]

Lastly, we want to highlight a last remark concerning teaching trends fostered by EPITECH's teaching approach, namely the general harnessing of the cognitive and emotional resources of both the students and **all the other stakeholders**.
All those concerned with the exercise of teaching (in our case stakeholders/partners/teachers) are called on through discussion, reports, communication and data management, to play an active role in the entire teaching process for which they are individually and collectively

[70] Barbier J-M., « Tendances d'évolution de la formation et place du partenariat » in *Apprentissages et évaluations*, Education permanente, N° 143, 2000-2, cited by Padoani David G., 2002; p19

responsible, in other words, to create collaborative links in order to set up joint actions (minimal definition of partnership)[71] that are essential to good project-based teaching methods. **(cf. "Le Bocal" at EPITECH)**

IX. Conclusion: between new knowledge and experience

Innovative channels that lead to the creation and transmission of knowledge, modes of access to knowledge, 'schools without walls' and non academic learning situations;

The brain economy, the knowledge-based economy and society, the Europe of knowledge, new forms of knowledge codified in terms of competencies, professionalisation;

Breaking down learning into competencies defined as the bases of employability. Breaking down learning into competencies defined as the bases of pedagogy, knowledge to be acquired, organisation and implementation of its transmission;

Less 'formal' forms of knowledge transmission, learning and knowledge transfer mechanisms, 'out-of-school learning' and social knowledge networks, project-based learning.

All four aspects can be found both in EPITECH's pedagogic methods and in its validation of skills and competencies.
Indeed, inspired by the principle of lifelong learning developed by the OECD, accreditation of prior experiential learning (APEL) is now included in the views expressed by European countries about education, in particular higher education. The concept was introduced in France with the "Law of Social Modernisation" in 2001.

APEL is based on the principle that **an individual's own unique experience** is equivalent to **the learning consolidated by professional practice** and **so-called 'academic' knowledge**.

[71] Bautier E., A.Gonnin-Bolo and Zay D. « La problématique et les thèmes du colloque, Compte rendu du séminaire préparatoire » in Zay D. and Gonnin-Bolo A. *Etablissements et partenariats Stratégies pour des projets communs.* Conference papers, 14,15 and 16 January 1993. INRP, 1995, cited by Padoani David G., 2002; p.20

In other words, tacit knowledge acquired in the professional sphere (including various unusual peripheral activities such as trade-unions, politics, voluntary work, etc.) is valued in the same way as knowledge acquired in an academic setting, without calling into question the importance of discipline-specific cognitive and social learning.
It is now possible to obtain a complete degree or diploma in this way.
The greatest demand is for so-called 'vocational' degrees. 'General' degrees are less well-adapted to the breakdown of learning benchmarks that underpin the assessment process to identify the past experience which is equivalent to 'academic' knowledge.[72]

Validated by a 'vocational' diploma, EPITECH's innovative project-based learning presented above takes of all these elements into account and raises questions about the future of higher formation.
Perhaps one of the avenues for the modernisation, energising or improvement[73] to vocational-oriented higher education in tomorrow's world is to adapt its pedagogy, as is already the case at EPITECH, to the underlying principles of APEL.

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[72] Rope F, 2005, cited by VASCONCELLOS Mr., 2006); p. 102
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