Themes and research approaches **in learning, education and training**

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1. Introduction

The project PREA 2K30, launched in April 2010 for one year, is a *prospective workshop* funded by the French National Research Agency. (ANR). It aimed at identifying and clarifying the major issues for the next 20 years in relation to knowledge and key tools for learning and teaching, taking into account their social, economic and industrial dimensions.

The following text aims at presenting the research themes that have emerged as priorities. It is complementary to a series of other documents available in French on the project site: http://prea2k30.risc.cnrs.fr/. See also section 6.4.

The method has been based on the mobilization of diverse perspectives (research, business, actors) and of multiple and complementary disciplinary expertise (cognitive science, psychology, ergonomics, philosophy, sociology, educational sciences, didactics, design of learning environments, virtual reality, etc.)..

Thematic working groups (WGs) were organized around the following fundamental themes:

- Cognition, learning process, evaluation of learning;
- Curricula, formal and informal learning contexts, teaching modalities;
- New resources, new instruments ;
- Changes in the constraints of work or learning and modalities for taking account of diversity.

We have mainly based ourselves on a method of scenario construction (De Jouvenel, 1999[2]). Twenty-two variables were defined in the 4 components of analysis considered as important (research, curricula, resources, social and political environment). Then, we studied their evolution over time and their relationships by seeking to identify possible factors of *disruption.* For each variable, assumptions of evolution for the next 20 years were developed[3]. Micro-scenarios peculiar to each component were constructed and discussed in the Steering Committee. Then macro-scenarios were developed by combining those sectorial scenarios.

More than 60 interviews were conducted with a highly contrasted panel of experts and two symposium were held in June 2010 and March 2011.

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[1]. Until September 1, 2011: Université Paris Descartes, Laboratory LATI.

[2]. De Jouvenel, H. (1999). The prospective approach. A brief methodological guide. Futuribles (No. 247, November 1999), updated in 2002. Consulted on: http://www.futuribles.com/pdf/guide.pdf

[3]. http://prea2k30.risc.cnrs.fr/contribs/afficher/77

2.   Context

2.1   Economic considerations

In France, in 2008, the expenditure for education amounted to 132.1 billion euros, or 6.9% of GDP. In terms of training and learning, spending totalized 28.4 billion of euros in 2007, representing 1.5% of GDP[4] . As far as we know, no reliable data are available on the share of these budgets possibly devoted to research activities.

Research and development performed on the national territory represented an expenditure of 41.1 billion euros. The three largest areas of research spending in the private sector were the automobile industry (17% of BERD), the pharmaceutical industry (13% of BERD) and aircraft construction (11% of BERD). There does not seem to exist data on the amount of research expenditures specifically dedicated to education, training and learning. One possible reason is the transverse nature of this theme in light of the main branches of research.

2.2   Global trends and uncertainties

In the next twenty years, three trends are strong in terms of demography:
- Aging population
- Development of large urban centers
- Upholding of territorial inequalities,

Regarding the active population, we may expect the following phenomena:
- Increase in precarious work,
- Increase in the level of qualification of people employed
- Increase of female employment

Moreover, quite radical changes are expected in the trades and professions of the major sectors of society. These changes have already begun in some areas such as medicine and the health professions. Socio-technical changes are going on very quickly ("infra-generational") and affect the skills, values and self-image of people. In addition, these changes impact both the work life and the life outside of work. The ability to act on these changes remains essentially heterogeneous, some actors having a significant capacity of influence - directly or indirectly. A question is therefore to know which actor(s) will be "the winners" in 2030?

However, forthcoming crises (energetics, social, ecological, technological, etc.) can significantly alter the major trends so far identified.

2.3   Trends related to Information and communication technologies

Technological innovation is the subject of high expectations with regard to the various challenges brought forward by the different stakeholders (politicians, business people, citizens ...). This occurs in a context of disaffection for scientific studies in France, of mistrust toward science in the name of a generalized principle of precaution, which leads to increase the importance given to the experts recognized by the political power.

The information and communication technologies - and more broadly emerging technologies - are now one of the first areas in terms of human and financial resources for research, particularly for research in businesses. Global trends identified regarding the evolution of these technologies are as follows:

a. Technologies are ever more performing in terms of capacity, processing and connectivity

The main trends we identified are:
- Small electronic components are having growing computing capacity.
- A high-speed Internet connectivity at lessening costs is developing, especially in large cities.
- There is a trivialization of mobile communication devices.

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[4]. These amounts are for example to compare to the health expenditures amounting to 11.2% of GDP in 2008.

- IP networks is coming at reduced costs.
- Solutions of cloud computing (perhaps the main innovation since Internet) are spreading.

b. Research is likely to renew issues of technology applied to the society

- Increasingly ICT interfaces interact with other technologies: robotics, Internet of objects, rendering and 3D interaction.
- In the longer term technology coupled with biology will bring new techniques and solution leading to a possible technologization of the living.
- Instrument monitoring individual behaviors will develop, not only in the work place
- There is going to be an increased diffusion of tools for manufacturing and prototyping, such as 3D printers, capable of renewing the problematic of information and communication technologies[5]
- An increasing energetic optimization of the systems is probable.

c. Users and customers increasingly involved in work and the production of values.

A trend in the current economy is the increasing involvement of users in the work and/ or the value of services and products, in many sectors related to new technologies. Examples are numerous, and may differ according to the free or paid aspect of the contribution, and the private or collective result of the contribution. Mention may be made of supermarket customers who themselves the items they buy. In the specific field of new communication technologies, we can mention the conception of free software, and the development of platforms of "crowd sourcing" ("open outsourcing"). In education, we can mention the development and the sharing of common resources for the classroom, as shows the example of the Sésamath association[6].

2.4   Stakes related to education and vocational training

Regarding education and training, many uncertainties exist, posing potential challenges to the vitality of democracy.

Education and training have long been associated with the stakes contained in their first objectives[7]: to support the integration and reintegration of workers, to allow their continued employment, to promote skills development and the access to the different levels of professional qualification, to contribute to the economic and cultural development and their social advancement. The 2004 Act operates some refocusing on the stakes related to access, maintaining and return to work, and reaffirms the need for training throughout life.

Other stakes also appear today, according to the different points of view of actors, such as:

- Help to educate enlightened citizens able to participate in discussions and decisions in the city, endowed with a certain mastery of the technologized and complex environment in which they bathe;
- Maintain the presence of skills and critical expertise for businesses and the country;
- Conquer and develop markets directly or indirectly related to education, training and learning;
- Promote the acceptance of technological innovations by citizens, the social acceptability of technologies (e.g. genome as a tool for selection, nuclear energy), barriers to this acceptance and the means to remove them constitutes a major stakes for businesses and the other actors in these areas.

Another strong question is about the dominant values in the society with the uncertainty, often expressed in international works, of a possible disruption of current models of school education, leading to a decrease in the role of the school public for the benefit of customized solutions organized in a market serving utilitarian views.

Other evolutions are uncertain in the state of our knowledge: for example, to what extent hybrid formations, that appear to be developing, will see the living labor of trainers replaced with digital resources managed by software platforms? To what extent, on the contrary, these resources will be additional assets, opened to the learners by teachers and trainers?

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[5]. See the establishment of laboratories manufacturing Fab-labs: http://fr.wikipedia.org/wiki/Fab_lab and in France, for example http://www.artilect.fr/.

[6]. http://www.sesamath.net/

[7]. See Act of July 16, 1971, Article 1

3. Research

3.1 Researchers

a. Researchers are mainly in the business and industry area, they are rather engineers, with a low representation of disciplines related to humanities and social sciences.

In 2010, researchers in industry (137,000) were representing 56.7% of researchers in France, and were therefore more numerous than those in the public sector (99,000). While the first diploma in public institutions is the doctoral degree, the engineering degree dominates in the private sector (52.5% of staff declared as researchers in the private sector had as highest diploma a degree in engineering), while only 13% had a doctorate (including health disciplines). Another specificity of business researchers is that they are relatively young, in their early career, and 12% of them had a degree level below the license.

According to the state of scientific employment in France (2009), researchers in business, for the two-thirds, were coming from the engineering sciences, the humanities and social sciences were very weakly represented (less than 1%).

b. Fewer researchers in the public sector, rather PhDs, with a quarter in the disciplines related to humanities and the social sciences.

Concerning researchers in the public sector, the proportions for disciplines in 2009 were slightly rebalanced with one quarter of researchers in social sciences (about 26%) and nearly 30% in the disciplines of Mathematics and Computer, sciences engineering and ICT.

c. What capacity(ies) of the population of researchers for answering questions of education, training and learning?

Given the growing wave of baby-boomer retirement and political choices related to public service and the distribution of researchers by field and discipline, one may question the ability of the population of active researchers in the coming years to meet the needs in terms of disciplines and themes that can be mobilized in the research, particularly in terms of human and social sciences.

3.2 Towards an integrated consideration of social issues?

As can be read in many syntheses and in the strategic display of political and research institutions, the different fields of research are increasingly moving towards an integrated consideration of social stakes of sustainable development and public health: food security, health and well-being at work, climate and environment, citizenship, emerging knowledge and knowledge that have not been stabilized etc.

Several uncertainties exist on critical problems for the effective consideration of these stakes and their translation into researches:

- The place and the scope of risk-taking deemed acceptable by research backers, the frame and deadlines imposed.
- The place and the scope attributed to multi- or interdisciplinary research in general, at the global and French levels, and more specifically in the field of education, training and learning.
- The incomplete coverage of societal, human and organizational dimensions of research on technologies and innovation, while, at the same moment, there is a rise of projects linking closely research and design of devices for subjects/ human users.
- The growing volume of scientific publications, due to two combined factors: the productivity of researchers increasing the number of publications, on the one hand, and on the other hand an increased perimeter of disciplines involved in research on education, training and learning.

3.3   The actors of research funding

A number of facts have a particularly prominent characteristic in the field of French research funding. The national agency for research (ANR) is probably the most central institution in the landscape. But two other points are worth noting. On the one hand, through its Framework Programs, Europe is an important actor,, probably favoring action research more than national bodies and attaching great importance to the promotion of research and its direct applications in the educational world. On the other hand, local authorities are also committed, although unevenly, in the financing of actions that are often at the interface between research and study. They sometimes seek a university label, perhaps sometimes in the hope of endorsing choices already made.

3.4   The case of research on education and training

One of the most salient conclusions of our study, which joins the findings of the Prost report of 2001[8] is to maintain a wide range of research on education and training, both in terms of the disciplines and methododology convened and of the research purposes (predict, understand, explain, act ...). This dispersion is manifest in different ways.

Disciplines that make reference in their name, to a special interest in matters of learning, education and training are numerous and easily include a dozen areas (see below) with their own identity, that is to say with the attributes of a scientific specialty that has a complete or partial institutional recognition labels by institutions in charge of piloting research.

- Didactics of subject matters
- Professional didactics[9]
- Right to education
- Technology for Human Learning (TEL)
- ergonomics school
- Neuro-Education
- Educational Psychology
- Developmental Psychology
- Psychology and Ergonomics Training
- Learning Sciences
- Educational Sciences
- Sociology of Education

Such a fragmented and heterogeneous research is primarily due to the scale and the multiple dimensions of the objects of research that focus on learning, education and training. There is also a need to build the relationship and integration of multidisciplinary research on these objects in relation to learning, education and training. Otherwise, one of the risks is the dominance of a paradigm and a unique way to address and define the purpose of research on education, training and learning. Moreover, the consensus is strong and unanimous to explain the persistence of this dispersion by the difficulty to make interdisciplinarity exist in research and its structures otherwise than occasionally and in a transitory way. In recent years, evaluation systems and laboratory researchers have also preferred in an increased way monodisciplinarity, as it's the case for a great number of research journals. For example, there is such a large uncertainty on the effective support to multidisciplinary actions will be obtained from structures piloting research (CNRS, universities, research centers, private and public, and the rating agencies of research).

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[8]   Antoine Prost, *Pour un programme stratégique de recherche en éducation*, Rapport sur la recherche en éducation, 2001, http://acces.inrp.fr/eedd/climat/recherche/plonearticle.2007-03-144187775276/.

[9]   Professional didactics may be defined as the discipline analyzing relationships between work activities and learning and training activities.

Moreover, if it is difficult to accurately assess the relative importance of funding related to research in education, training and learning, it is possible to estimate that the investment in this area is, in proportion, relatively modest.

There has also been a persistent misunderstanding between political actors, civil society and the world of research. A number of issues co-exist:

- Training and / or awareness effective in search of these actors;
- Citizen access to data and methods of investigation and analysis of such data. At a time when more and more data is available to citizens (health, academic achievement, household income, working time, etc.). As soon as any quantization is seen as a final argument, an important issue is the understanding of the influence of the choice concerning construction methods and data.

In counterpoint to the previous observation, an additional difficulty is the lack of tools and / or places for developing consistent and operational views of research on learning, education and training.

Another challenge for creating an accurate image depends on the plurality and diversity of models and theories, especially on the side of psychology, as well as in work on learning disabilities, the characteristics of knowledge areas in terms of learning, work on situations of teaching and education. Learning, education and training, indeed affect many spheres of human activity: economic, political, social and cultural, mental and psychological.

A number of themes have appeared as so far poorly covered:

- Adult learning at all ages apart from studies investigating the impacts of aging.
- End-user needs and contexts of genuine use of ICT, effectiveness of implementation at stake
- The study of learners with special needs, particularly in relation to technology (ICT and other emerging technologies);
- The acquisition of high-level skills and higher cognitive functions (in addition to the primary learning and executive functions or simulation).
- The activity of the trainers, even if there is a recent trend to develop research on the activity of teachers.

4.   Presentation of scenarios

Three main scenarios have been identified. Some have in common to stage the liberalization of education and training, as well as a dominant model based on individualization and customization of devices, resources and technology. Others, on the contrary, are assuming the construction of a knowledge society, where the central level has retained much of its prerogatives for strategic management and where research on education and learning has benefited sustainable investments. Three macro-scenarios have been developed, each capable of two types of changes according to changes in context variables. Here are, for each one of them, the main points.

4.1   Macro scenario 1. Market and customization, R & D, school and training à la carte

This scenario has been divided into two parts: 1a and 1b. They have in common to put forward the liberalization of education and training, as well as a dominant model based on individualization and customization of devices, resources and technology. They differ in the following items:

- **Scenario 1a** assumes a *status quo* in the field of research, with maintenance and coexistence of some related research on the fundamental mechanisms of learning, education and training, as well as the objectives of addressing the needs in the short end of the field. It assumes that the development offers, resources and technologies for learning, education and training are mediated primarily by the profitability of captive markets.
- The **scenario 1b** assumes a decline in the strict sense of the research on education and training, with a stronger intervention of digital technologies in the fields of education and training, developments taking place in collaboration with user, but without dedicated research.

In summary, features common to this scenario are:
- Learning, education and training: individual responsibility for the professional direction choices
- Disengagement of the state, competitive market and individualization of the offer
- Increased inequalities and disparities between actors
- Lower average levels of output of the training and qualification
- Two contrasting segments in learning technologies:
- High cost, high-end technologies, proprietary solutions
- Low cost, non-specific technologies available
- Varied and highly finalized researches, poor capitalization

4.2   Macro-Scenario 2. A divide between research & practice, education & training, a pre-eminence of technical experts

This scenario is also divided into two parts, 2a and 2b. It is marked by a **continuity** between the situation in 2011 and 2030, in terms of relations between the research and the education and training, organization of research and its piloting. The evolution of new technologies has no major impact in this configuration.

The differences between the two variants of the scenario are due to the fact that in the 2a the uses of information technology and communication mostly remain outside the field of education and training, while in 2b, economic profitability is a more important development criteria, especially on captive markets controlled by the authorities.
- The utility regarding employment: main criterion of legitimacy of the content taught
- Low or declining support for education research
- Growing inequalities between actors in terms of production, access and use of resources
- Educational resources developed by communities or by the publishing market
- Government of society on the basis of technical expertise
- Little research and some short-term competition, on a few topics related to innovation, maintain of a low basic research in connection with the practice and field requirements.

4.3   Macro scenario 3. Lifelong learning: a social project taken seriously

We might as well call this scenario optimistic (according to the researchers), utopian (in the sense that it assumes policy decisions which at the moment do not appear very likely). Its interest, in our point of view , is to draw the consequences of many trends identified whose conjunction is not impossible. It is also based on assumptions linked to the context variables, under which an improvement may occur in the economic sphere.

An open issue, often raised, is the recognition of multidisciplinary areas, which always tend to establish themselves as new disciplines and support with difficulty the prospect of being an area at the service of other disciplines, legitimized through their history.
- Education and training: a challenge, an investment and a strategy to move towards a society of knowledge
- Wide dissemination of various technologies and adapted on the basis of a human-centered approach
- Continued ownership of resources developed collectively within communities and widely accessible
- Reconciliations research, education and training
- Training and research of education stakeholders
- Direct links search / in various forms
- A learning center, education and training in the management of research

In all the cases, we have identified a number of research topics that we think important for exploring in depth. The following section synthetically presents these topics by classifying them according to thematic areas. These are large questions rather than specific issues.

5. Research themes

Five major research themes have emerged as priorities. Each one of them would benefit from being investigated in order to discover and learn about the facts that support the action.

5.1   Relations between the public, the sciences and technology

- How to reduce the gap between the skills taught and the state of current scientific knowledge, particularly regarding newly identified and listed knowledge? Curricular learning and changes in school subjects?
- The learning of science and higher-level skills (critical thinking, creativity, etc.): analysis, processes, challenges and tools;
- How to encourage, equip and improve the "enlightened" participation of citizens in discussions on non-stabilized knowledge?
- Which areas of knowledge seem necessary in terms of education and training throughout the life of citizens? Barriers and catalysts for their dissemination and appropriation?
- How to improve the coordination and integration between research and directly concerned fields?

5.2   Technology, education and training

- How to develop learning content taking into account the contributions recorded by the research? How to trace the requirements of educators and learners towards the world of research? How to ease the transition from research laboratory to research in the classroom?
- Understanding and improving the design process artifacts and technological systems for education, training and learning, taking into account the needs of end users and contexts of actual use of ICT, efficiency of implementation;
- Studies of existing practices in real situations, including empirical studies and evaluations of devices;
- Digital learning environments, Virtual Reality for Learning Technologies of mobility for learning and education;
- Barriers, opportunities and development of new modes of learning;
- Decision making for school choice and direction: accessibility of learners and their families to information, a tool for decision support, etc.;
- The study of populations of learners with special needs, particularly in relation to technology (ICT and other emerging technologies);

5.3   Assessment and decision making in education, training and learning

- Methods and evaluation procedures: range, reliability, validity and applicability;
- Understanding and evaluation of actions regarding the labor market and their effectiveness in improving the accessibility of training to everyone. The aim is to understand a paradoxical reality - to transform it - the more one gets older and the less one is formed at the outset, the less one has access to training;
- Analysis and Specification of human needs, organizational and technical education and training: which methods and efficiency in which conditions?
- Which theories mobilized to make the decisions of the design of systems, devices and educational resources for learning: nature, characteristics and outstanding operational contribution?
- Evaluation of public policies: which methods for which efficiency

5.4 Learning Interactions, Health and Environment

- Influence of the possibility (or not) to learn in the current situation on the health and well-being.
- Influence of health on learning: disability, sensitive populations, and modes of temporary schooling, link health, age and learning
- Education, training and learning to health and prevention
- Research of the training of caregivers
- Learning, education and training in daily practice for the environment and sustainable development

5.5 Socio-technical systems dynamics, Complexity and Cognition

- How do parents scaffold their children's learning activities in formal and non formal educational context? Which consequences in terms of parent-children relationship?
- Models, determinants of information processing for learning in situations of activities that do not explicitly aim at learning
- Activity-based models of learning, self regulated learning, learning in epistemic communities, organizational learning, collaborative learning
- Acquisition of higher order competences and higher order cognitive functions
- Learning, forgetting, re-learning (for example, factors linked with new modes of operation (for example, ecologic automobile driving)
- Learning at all ages, outside of formal study situations.

6. Appendix: organization and operation of the ARP Prea2K30

6.1 Partners

To achieve its objectives, PREA 2K30 has relied on a large consortium comprising:
- Recognized research laboratories working in multiple disciplines interested in learning technologies or practices;
- Firms, associations, actors and social world, education and training. PREA2K30 includes forty partners issued from research, business and voluntary sectors.

Among them, here are those who have had a responsibility to coordinate the project:
- Université Paris Descartes, EDA, LATI and Thematic Priority Theme "Submit, learn, learn"
- French Association of Virtual Reality, AFRV
- Association of Information Technology for Education and Training – ATIEF
- Centre for Research and Studies on the age and people to work, study center on employment, CREAPT – EEC
- Ecole Normale Superieure de Cachan, UMR STEF
- Institute of the Ecole Normale Supérieure, COMPAS Group
- University of Paris 8
- University of Toulouse 2

6.2 Project Steering Committee

Project leaders: GL Baron and JM Burkhardt (University of Paris Descartes)

Persons responsible for thematic groups
- Cognition, learning processes, assessment of learning (coordinators: E. & A. Pasquinelli knit).
- Curricula, formal and informal learning, teaching methods (coordinators: F.-X. Bernard E. & Bruillard).
- New resources, new instruments (Coordinators: P. & P. Leroux Chevaillier).
- Changes in work constraints or learning how to take into account the diversity (coordinators: Delgoulet C. & C. Vidal-Gomel).

6.3 Course of the project

1. Summary of prospective studies exist. Definition of relevant variables. Initial symposium in June 2010
2. Work in thematic groups. Hearing of persons over 60
3. Convergence process within the steering committee. Production of records and variables of draft scenarios
4. Symposium validation of the approach of 2 to 4 March 2011
5. Finalizing the development of scenarios and summaries

6.4 Online Resources
- First symposium: http://prea2k30.risc.cnrs.fr/colloque/premier-symposium
- Second Symposium: http://prea2k30.risc.cnrs.fr/colloque
- Fact variables: http://prea2k30.risc.cnrs.fr/contribs/afficher/77
- Scenarios: http://prea2k30.risc.cnrs.fr/contribs/afficher/75
- Analysis of foreign views: http://prea2k30.risc.cnrs.fr/contribs/afficher/78
- References: http://prea2k30.risc.cnrs.fr/biblio