

## Association for Information Systems AIS Electronic Library (AISeL)

---

CONF-IRM 2009 Proceedings

International Conference on Information Resources  
Management (CONF-IRM)

---

5-2009

# Understanding and Supporting the Creation of More Effective PLE

France Henri

*Télé-université/UQAM*, [henri.france@teluq.uqam.ca](mailto:henri.france@teluq.uqam.ca)

Bernadette Charlier

*Université de Fribourg*, [bernadette.charlier@unifr.ch](mailto:bernadette.charlier@unifr.ch)

Freddy Limpens

*Sophia-Antipolis*, [freddy.limpens@sophia.inria.fr](mailto:freddy.limpens@sophia.inria.fr)

Follow this and additional works at: <http://aisel.aisnet.org/confirm2009>

---

### Recommended Citation

Henri, France; Charlier, Bernadette; and Limpens, Freddy, "Understanding and Supporting the Creation of More Effective PLE" (2009). *CONF-IRM 2009 Proceedings*. 23.

<http://aisel.aisnet.org/confirm2009/23>

This material is brought to you by the International Conference on Information Resources Management (CONF-IRM) at AIS Electronic Library (AISeL). It has been accepted for inclusion in CONF-IRM 2009 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact [elibrary@aisnet.org](mailto:elibrary@aisnet.org).

## 23. UNDERSTANDING AND SUPPORTING THE CREATION OF MORE EFFECTIVE PLE

France Henri  
Centre de recherche LICEF, Télé-université/UQAM, Canada  
henri.france@teluq.uqam.ca

Bernadette Charlier  
Centre de didactique universitaire, Université de Fribourg, Switzerland  
bernadette.charlier@unifr.ch

Freddy Limpens  
Edelweiss, INRIA, Sophia-Antipolis, France  
freddy.limpens@sophia.inria.fr

### ***Abstract***

This paper reports on the results of the first stage of an exploratory research on the learning potential of Personal Learning Environment, not simply as a technological *artifact* but as an *instrument* to support the learning process. Firstly, we present PLE as an enriched concept. Secondly we identify the roles a PLE can play to improve the quality of the learning process. Thirdly, we explore ways for optimizing the learning potential of PLE from pedagogical, technological and institutional perspectives. Before concluding, we present very preliminary results that confirm the need for a better understanding of PLE.

### ***Keywords***

Personal Learning Environment, Self-directed Learning, Lifelong Learning, Collective Learning, Instrumental Approach, Instrumental Genesis.

## **1. Research background**

Research undertaken to help people creating more effective PLE is twofold. From a technological perspective, developers seek to offer *process* tools to support PLEs' creation process rather than imposing prefabricated PLEs that would challenge the essence of PLEs as individual and personal instruments created by users themselves. From an educational technology perspective, researchers try to build better understanding of the PLEs creation process and their role in the learning process. They try to grasp their potential and to suggest means to evaluate and improve them. Both research perspectives are essential and should be coordinated.

### **1.1 Supporting PLEs' creation process, a challenge for developers**

Most research agrees that PLE emerges from the learning experience of the learner. Mödritscher, Wild and Sigurdarson (2008) go further considering PLE to be the outcome of and not another pre-requisite to learning. From this perspective, significant efforts are currently undertaken by

developers using end-user development approach to support PLEs' creation process by designing PLE design language, PLE computer architecture, list of basic functions for PLE, and other technological tools (Wild, Kalz & Palmér, 2008). Developers of these technological artifacts are faced with a real challenge having to keep in mind the fact that the end-user is in reality the "end-designer". For that reason, we suggest that Rabardel's instrumental approach (Rabardel, 1995/2002; Rabardel & Pastré, 2005) could inspire and guide these developments. The instrumental approach is based on the distinction between *artifact* and *instrument*: artifacts, or tools, become instruments once they are incorporated into use through users' activities. An authentic instrument is an artifact associated with use schemas built by means of users' use. It is a *mixed entity, born of both the subject and object (in the philosophical sense of the term): the instrument is a composite entity made up of an artifact component (an artifact, a fraction of an artifact or a set of artifacts) and a scheme component (one or more utilization schemes, often linked to more general action schemes)*. (Rabardel, 2002, p. 86).

The instrument can thus be considered as the result of a process called *instrumental genesis*. Based on Rabardel (1995), Guin & Trouche (2007) explain that understanding the instrumental genesis means being able to grasp how two dual and simultaneous (sub) processes are articulated: the instrumentalization and instrumentation processes. The instrumentalization process is directed towards the artifact and pertains to the mobilized component of the artifact and its personalization. The instrumentation process is directed towards the subject, focusing on the emergence and evolution of the schemas developed to perform the tasks.

Rabardel's approach could not be considered as a final and complete solution to the developers' problem because like traditional design methods it maintains the idea that developers and users are different persons. Their challenge in that case is to overcome the gap between the design process and the process of appropriation of the artifact (separation of designers from users). With PLEs, we face a different situation where the end-user designs the technological artifact (create his PLE) and at the same time develops it into an instrument through its use.

From the developers' point of view, a change of paradigm is required to tackle such a new situation. This is why more research has to be undertaken to answer a series of questions that will allow the development of appropriate and adapted tools to support the creation of PLE by people. How do people create and use their PLE? How does it complement and interact with other learning environments? How could it contribute to collective learning? How could it be shared? The creativity of people in their way of learning with PLE has to be studied more deeply and results used to develop support resources to assist individuals in designing their own authentic learning environments.

## **1.2 Understanding PLEs' creation process from an educational technology perspective**

From an educational technology perspective, very few research results have been published on PLEs informing developers or institutions, teaching staff and learners themselves on what could be done to have more effective PLEs. The research project we are carrying out aims at developing a better understanding of PLEs' creation process and their use by tertiary education students. Results should enable us to better define and characterize PLEs, and to formulate hypothesis to answer the following questions. Under which conditions could PLEs support

learning? How do they transform students' learning experiences? How do they change students' relationship to knowledge? How can PLEs connect formal and informal learning?

### ***1.2.1 General description of our research project***

The goal of our research is to develop a better understanding of PLEs. That means getting better knowledge of the conditions under which they are created, of their uses and of their evolution over time. To address this goal, we are pursuing the following objectives.

- Identify and describe the various types of PLEs developed by students.
- Identify conscious and/or unconscious needs that induce students to develop PLEs.
- Identify and describe PLEs use patterns.
- Describe how PLEs evolve over time as technological as well as learning instruments.
- Identify factors that influence their evolution.

A theoretical and conceptual framework based on socio-cultural learning theories (Vygotsky, 1978; Lave and Wenger, 1991) and on Rabardel's (1995) instrumental genesis guides our research. We adopt a mixed research approach, quantitative and qualitative, and a longitudinal three stage methodology. The first stage consists in doing a speculative and exploratory analysis of the PLE concept from a pedagogical point of view. The second stage is descriptive allowing for a quantitative data collection on a large student sample from the Université de Fribourg (Switzerland) and the Université du Québec à Montréal to survey the creation processes and the uses of PLEs. This survey will provide information elements to answer to the following questions. How and why do students develop PLE? What needs are they trying to fulfil? What technological tools do they use? What are the factors (social, psychological, technological, etc.) influencing the creation processes and the uses of PLEs? Are PLEs connected to institutional virtual learning environments (VLE)? The third stage is explanatory with a qualitative study of the roles played by PLEs in students' learning processes. Longitudinal cases analysis will be conducted on a limited number of students from both universities. Cases analyses will be combined with observation of students using their PLE over 18 month's period. Semi-structured interviews will be conducted and think aloud protocol will be applied during observation.

In this paper we report on the speculative and exploratory analysis of the PLE concept, first stage of our project. Firstly, we present PLE as an enriched concept. Secondly we identify the roles a PLE can play to improve the quality of the learning process. Thirdly, we explore ways for optimizing the learning potential of PLE from pedagogical, technological and institutional perspectives. Finally, before concluding, we present very preliminary results obtained from answers to a questionnaire administered to 13 students to prepare the descriptive stage of our research.

## **2. PLE, an Enriched Concept**

The notion of Personal Learning Environment (PLE) as conceptualized by Attwell (2006, 2007) refers to a set of the different applications, services and various other types of learning resources gathered from different contexts. It is constructed by an individual and used in everyday life for learning. It is not an application or a system but a personal assemblage supporting new learning modalities induced by ubiquitous technologies and social software. From the technological point of view, ubiquitous computing allows learning to take place almost everywhere through wireless

and GSM networks and mobile communication devices enable access to the Internet. Because the same technologies are used in different contexts of our life (work, home, school) it becomes possible to support the learning process through time and space. Additionally, social software, predominant in PLEs, represents a technological development that allows people to connect and collaborate, and to create and share. All kinds of different and individual knowledge can then be generated and shared. New ways of learning could emerge from the use of PLEs. But as Lubensky (2006) has pointed out, the definition of the term PLE remains elusive. Conceptions of what constitute a PLE vary according to the profile and priorities individuals. Different people will make use of different types of PLE allowing for different types of learning. For example, university students with definite learning objectives enabling them to insert into the workplace or professionals eager to master competencies required for their work and career progression or adults pursuing eclectic paths of lifelong learning.

However, one has to recognize that PLE is not a fundamentally new concept. Before the current era of massive use of technology, learners always had to organise their own learning and develop some kind of PLE. For informal learning, on the one hand, PLEs might have been composed of individual learning resources such as magazines, books, CD, videos, etc., and social communication and sharing opportunities through membership of an association, participating in meetings, etc. For formal learning, on the other hand, PLEs were comprised of course notes, conceptual maps, summaries and other personal working/learning documents that students exchange. Face to face support from peers and friends, student meetings in cafeteria and tutoring were also part of more traditional PLEs. Now-a-days, PLEs are much richer in terms of volume of content, exchanged contents and technologies.

In fact, there is a strong idea underlying the PLE concept: the autonomy of the learner and what (Bandura, 2003) calls self-directed learning<sup>1</sup>. PLE is not something that is imposed on an individual but something that one builds autonomously to suit one's own needs and fulfill the type of learning one wants to pursue. Self-direction is recognized by the capacity to choose learning resources or learning providers, and the time, place and context of learning. It manifests also through the capacity to grasp opportunities to learn that could be supported by the PLE.

PLE can bring together seamlessly various types of learning: learning by personal interest or the desire to solve a problem, community learning, school learning, experiential learning, workplace learning, etc. In short, it can embrace all formal and informal learning. PLE has potential for more meaningful learning by facilitating reinvestment of knowledge in different contexts. Moreover, since lifelong learning is recognized as being crucial in our knowledge societies, it can easily be envisaged that everyone will develop ones own PLE. In this context, PLE should be considered as permanent, adaptable and evolving, enabling different types of learning, in different contexts and at different times in life.

Nevertheless, to obtain an authentic PLE from an assemblage of tools and from their use, some conditions have to be met. To trace these conditions, artifacts should not be assimilated with instruments according to the instrumental genesis approach (Rabardel, 1995; Béguin, &

---

<sup>1</sup> Self-direction includes competences to plan, organize and manage educational activities, to mobilize resources, to regulate ones motivation and to use metacognitive competences to evaluate the quality of one's own knowledge and strategies (p. 265). Authors' translation.

Rabardel, 2000). In other words, it means that when reflecting and conducting research on PLE, the focus should not be on technologies but rather on their uses and their potential for learning.

### **3. Roles of PLEs in the Learning Process**

PLEs can play a significant role to improve the quality of the learning processes by encouraging self-direction and reflexivity, bridging personal and collective learning, and empowering ownership of learning.

#### **3.1 Fostering Self-direction and Reflexivity**

Thanks to its reflexive functionalities such as goal setting, awareness and control over learning resources and results, PLE is not an alternative or parallel concept to VLE, it is an essential complement. The reflexive process, recognized as an essential part of authentic learning, is not usually supported by traditional VLE functionalities. Thus PLE can bridge the gap to completely fulfill integrity and integrality of learning. It has the potential to support the internalisation/externalisation of learning processes and results, and eventually, the full realisation of learning. But some conditions are required for the realization of this potential.

Reflexive tools should be available to the learner and easily integrated in his PLE. The decision of using reflexive tools implies that the learner has already developed metacognition competences, mainly his motivation to analyse, control and improve his learning. Thus reflexive tools should support cognition on the knowledge built and on the knowledge building process. They should be able to represent learner's knowledge (for example, using tags) and extract traces that represent his knowledge building process. The later implies that the learner is able to analyse traces and other information given on his learning.

#### **3.2 Bridging Personal and Collective Learning**

The interconnection of PLE is a crucial aspect and raises similar problems encountered by online communities when they want to exchange knowledge. In this respect, Web 2.0 applications represent a substantial advancement: the ability for users to contribute to collective databases combined with their ease of use and a focus on social exchange enable the creation of massive networks of knowledge and people. Many Web 2.0 services proposed users to organize this flow of data themselves with social tagging tools<sup>2</sup> where each user can tag the resources he posts or contributes to with keywords freely chosen. The resulting folksonomies (Vanderwal, 2005) consist of the collections of all the set of tags of each user (called "personomies" as an extension of the term folksonomy, but for one person) and can be seen as a way to bridge personal and collective knowledge bases. Social tagging brought a viral solution to annotation of content on the Web by allowing the mass of users to tag the mass of resources. Another aspect is that tagging is simpler because it allows classifying resources with multiple keywords as opposed to unique categories per item (Sinha, 2006). Moreover tagging benefits users first, for they tag for themselves to organize their own data, and second, it benefits the community when all these personomies are collected and made public. However, the exploitation of tools coming from the Web 2.0 culture and the folksonomies raises some issues. It is difficult to make these scattered sources of data communicate efficiently, since most of the data is contained in databases and is

---

<sup>[2]</sup> For instance : <http://del.icio.us>

thus not visible from the outside (the problem of "the deep Web"). Moreover, tags are sometimes ambiguous and folksonomies do not constitute a sound knowledge representation since they are, in essence, not structured.

### **3.3 Allowing the Change of Ownership**

The new generation of students who share the culture of Web 2.0 use blogs, wikis, RSS flux, podcasts and social software in their daily life. Building their own PLE, thanks to ubiquitous technologies and social software, becomes natural. By doing so, they gain control over their learning. Institutions must then recognize their lost of control over knowledge content, modes of transmission, learning processes and validation. They have to accept the fact that ownership of learning is moving to the students. Educational systems should not ignore this phenomenon but rather try to find ways to valorise learning that takes place outside the institution and recognize its contribution to personal and professional development. This entails that educational institutions have to develop a better knowledge and understanding of this new situation and learn how to exploit it in a constructive manner.

## **4. Enhancing the learning potential of PLE**

Optimizing the learning potential of PLE could be achieved from three perspectives: from a pedagogical perspective, by giving access to metacognitive resources; from a technological perspective, by allowing PLE to connect and interact; and from an institutional perspective, by offering a wider access to prior learning assessment and recognition.

### **4.1 Metacognitive Resources**

Resources to support metacognition, self-direction and reflexivity are currently used in formal education to improve learning, to learn competences and to stimulate learners' motivation. Such resources would have to be reconceptualized and redesigned for an attractive and autonomous use, inviting creators of PLEs to be more reflexive. For example, profile tools used to describe who one is when accessing a social networking website might be redesigned with a metacognitive approach. Resources to sustain social networking could help the construction of personomies or the development of portfolios. These are other cases where resources can become metacognitive tools to stimulate learning awareness and regulation of learning within PLE.

Experience has shown that only those who already have metacognitive competences can benefit from these types of resources. For others who lack of these competences, educational institution should try to reduce the divide by offering some type of subtle and appropriate metacognitive coaching, like peer coaching for instance.

### **4.2 Bridging Individual and Collective Learning**

As we have seen above, folksonomies are an easy way to obtain lots of annotations of resources, but they are heterogeneous and difficult to exploit. But the Semantic Web<sup>3</sup> offers a framework to integrate data from various origins and to relate them with real world objects via knowledge representations. To achieve this goal, applications need formal schemas, called "formal ontologies" (Gruber, 1993) which relate the different concepts within a given field of knowledge.

---

<sup>[3]</sup> <http://www.w3.org/2001/sw/>

Any resource can then be annotated according to one or several relevant formal ontologies. The problem of these structured representations is mostly the cost of their design and maintenance, which prevents applications based on ontology being widely used.

In order to bridge formal knowledge representations (ontologies) and informal knowledge representations (folksonomies), several directions are currently being investigated (Limpens *et al.*, 2008). Some researchers have tried to extract the semantics that underlie folksonomies. The hypothesis of this kind of approach is that between the personomies collected in folksonomies, there are some common ties which can be discovered thanks to statistical (Jäschke et al, 2008) or social network analysis (Mika, 2005). Using these methods, it is possible to organize the tags and to derive some relationships between the tags, allowing the suggestion of relevant tags when searching resources. Other approaches consist in using Semantic Web technologies to automatically generate annotations while creating or exchanging contents. For instance, when someone post on a blog, the system can create annotations stating the subject of the post according to its title, or the tags associated to it. Since the representations (ontologies) underlying this process follow the standard of the Semantic Web, resources are more easily available and can be connected to related resources (Breslin et al, 2005). Several works propose to bridge social tagging applications with ontologies: by automatically sorting out tags and linking them to ontologies (Specia & Motta, 2007); or by proposing users to connect, while tagging, their tags to concepts from ontologies (Passant, 2007); or finally by directly structuring folksonomies with the formalisms of ontologies (Gruber, 2005; Buffa et al, 2008). Thus, content of a collaborative knowledge base can be organized and structured thanks to the tool of the Semantic Web, while keeping the simplicity and sense of sharing of the Web 2.0 applications.

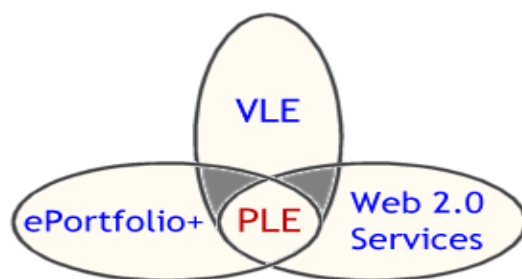
### **4.3 Institutional Resources**

It is important that institutions recognize and take advantage of learner empowerment. Teachers would be primary actors to be targeted. They should be accompanied in finding innovative ways for encouraging efficient use of PLE, easing the blending of learning from PLEs and VLEs.

Institutions should also offer a wider access to prior learning assessment and recognition. Most often, prior learning is recognized in programs offered to adults through continuing education. Research indicates that prior learning assessment improves learner confidence, self-esteem and motivation to learn. It helps learners develop clear educational goals and plans. Younger learners should also be able to demonstrate and obtain recognition for learning acquired outside of formal education settings. Consequently, flexible and adaptable study programs would have to be developed. Such an approach could be judged as too demanding for the educational system. The gain in educational efficiency by pinpointing learning needs more accurately should be evaluated.

Lubensky has indicated how PLEs are situated at the intersection of VLEs, Web 2.0 and ePortfolios (figure 1.) He indicates how we think PLE should be conceptualized by institutions.





**Figure 1. Interaction between PLE, VLE and ePortfolio**  
**Source: (Lubensky, 2006)**

## 5. Preliminary results

To get pragmatic information on PLEs to assist the design the methodological tools required for the descriptive stage of our research, 13 graduate students of the Université de Fribourg were asked to freely describe their PLE using an open ended questionnaire. Table 1 summarizes the main results. It points out that besides individual tools, social software is used by students to perform various types of activities. It also indicates that some students establish a conceptual link between their PLE and their institutional VLE. In table 1, activities are categorized in four domains according to four mediation types identified by Rabardel and Samurçay (2001) to describe the various roles undertaken by an artifact as part of the relation developed by a subject (student) with an object (a goal). Epistemic mediation is directed toward knowledge building; pragmatic mediation aims at the realization of a concrete task or a project; relational mediation supports relationship with others; and reflexive mediation is the relation established with oneself.

<i>Software used</i>	Google: Google books, google docs, google agenda (13) Facebook (1) Wikipédia (10) Bubble (1) MP3 (1)
<i>PLE's linked with a VLE (Moodle)</i>	(5)
<i>Epistemic mediation</i>	Collaborative writing (7) Researching information (4) Realizing conceptual maps (1) Note taking (1) Making summary (1) Studying (1) Writing in a foreign language (to update my language skills) (1)
<i>Pragmatic mediation</i>	Downloading documents (1) Planning courses and meetings (2) Recap and listen recorded lectures everywhere (1) Finding and using personal resources everywhere (1)
<i>Relational mediation</i>	Collaborative writing (7)

	Communicating with other students (3) Communicating with experts (1) Keeping in touch with others (3) Sharing references (1)
<b>Reflexive mediation</b>	Keep track of my learning path (1)

**Table 1. Social software, mediation and activities performed within PLEs**

This first exploration substantiates the fact that PLEs are composed of individual tools and social software used not only for formal individual learning, but also to communicate, share and collaborate. For seven students, Google docs is not only a collaborative instrument, it has also been made an instrument to support collaboration at a distance. Five students made explicit the connections they establish with their institutional virtual learning environment (Moodle) even though it is not technologically integrated with their PLEs. One student expressed the reflexive dimension of her PLE by stating that she uses it to keep a memory of her learning path.

## 5. Conclusion

The speculative and exploratory analysis of the PLE concept, first stage of our research, indicates that this type of environment could have a significant impact on the learning process not only during the schooling period but over a lifetime. Despite the fact that PLEs lie within the individual sphere of activity and that they could support informal and non institutionalised learning, educators and educational institutions should be concerned by their development and improvement, and by their best possible uses to support formal learning. We should be more aware that students are using them for formal learning as shown by the very preliminary results obtained while collecting data to prepare the methodological tools of the second descriptive stage of our research. These results along with our exploratory analysis confirm the learning potential of PLEs, not simply as a technological artifact but as an instrument of the learning process. It becomes more urgent to understand PLEs roles in the learning process and to develop means to improve their uses by students and by institutions.

## References

- Attwell, G. (2007). Personal Learning Environments - the future of eLearning? *eLearning Paper*, 2, (1) • ISSN 1887-1542. On line:  
<http://www.elearningeuropa.info/files/media/media11561.pdf>
- Attwell, G. (2006). *Personal Learning Environments*. Online:  
[http://www.knownet.com/writing/weblogs/Graham\\_Attwell/entries/6521819364](http://www.knownet.com/writing/weblogs/Graham_Attwell/entries/6521819364)
- Bandura, A. (2003). *L'auto-efficacité. Le sentiment d'efficacité personnelle*. Paris : De Boeck. (Translation of original american version, 1997).
- Béguin, P., & Rabardel, P. (2000). Designing for instrument-mediated activity. *Scandinavian Journal of Information Systems*, 12, 173-190.
- Breslin J., Harth A., Bojars U. & Decker S. (2005). Towards Semantically- Interlinked Online Communities. *European Semantic Web Conference 2005*, 500-514.
- Buffa M., Gandon F., Ereteo G., Sander P. & Faron C. (2008). SweetWiki : A semantic Wiki. *Journal of Web Semantics*, 6, (1), 84-97.

- Gruber T. (2005). Ontology of Folksonomy : A Mash-up of Apples and Oranges. *Metadata and Semantics Research Conference*. Online:  
<http://tomgruber.org/writing/mtsr05-ontology-of-folksonomy.htm>
- Guin, D. & Trouche, L. (2007). Une approche multidimensionnelle pour la conception collaborative de ressources pédagogiques. Dans M. Baron, D. Guin & L. Trouche (Eds.), *Environnements informatisés et ressources numériques pour l'apprentissage. Conception et usages, regards croisés* (pp. 197-228), Paris : Hermes-Lavoisier.
- Jäschke R., Hotho A., Schmitz C., Ganter B. & Stumme G. (2008). Discovering Shared Conceptualizations in Folksonomies. *Journal of Web Semantics*, 6, (1), 38–53.
- Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate and Peripheral Participation*. Cambridge, Cambridge University Press.
- Limpens, F., Gandon, F., & Buffa, M. (accepted). Rapprocher les ontologies et les folksonomies pour la gestion des connaissances partagées : un état de l'art. *Ingénierie des Connaissances*.
- Lubensky, R. (2006). *The present and future of Personal Learning Environments (PLE)*. Online:<http://members.optusnet.com.au/rlubensky/2006/12/present-and-future-of-personal-learning.html>
- Mödritscher, F., Wild, F. & Sigurdarson, S. (2008). Language Design for a Personal Learning Environment Design Language. Mash-Up Personal Learning Environments (MUPPLE'08). *Proceedings of the MUPPLE'08 Workshop in conjunction with the EC-TEL 2008*, Maastricht, The Netherlands, September 17. Online:  
<http://ftp.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-388/moedritscher.pdf>
- Passant A. (2007). Using Ontologies to Strengthen Folksonomies and Enrich Information Retrieval in Weblogs. *International Conference on Weblogs and Social Media*. Online:  
<http://www.icwsm.org/papers/2--Passant.pdf>
- Rabardel, P. (1995). *Les hommes et les technologies. Approche cognitive des instruments contemporains*. Paris: A. Colin.
- Rabardel, P. & Samurçay, R. (2001). From Artifact to Instrument-Mediated Learning. *Symposium on New challenges to research on Learning*, Helsinki, March 21-23.
- Rabardel, P. (2002). *People and technology : a cognitive approach to contemporary instruments*. English version of Rabardel, P. (1995) *Les Hommes et les Technologies, approche cognitive des instruments contemporains*. Online: <http://ergoserv.psy.univ-paris8.fr/>
- Rabardel P. & Pastré, P. (Eds.). (2005). *Modèles du sujet pour la conception : Dialectiques activités développement*. Toulouse: OCTARÈS Éditions.
- Vygotsky, L.S. (1978). *Mind in Society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wild, F., Kalz, M. & Palmér, M. (Eds.) (2008). Mash-Up Personal Learning Environments (MUPPLE'08). *Proceedings of the MUPPLE'08 Workshop in conjunction with the EC-TEL 2008*, Maastricht, The Netherlands, September 17. Online:<http://ftp.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-388/preface.pdf>