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PERCEPTION OF THE USEFULNESS AND USABILITY OF CMAPTOOLS IN A UNIVERSITY-LEVEL COLLABORATIVE REMOTE LEARNING ACTIVITY

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Abstract. Our work analyzes the way in which university-level students perceive CmapTools in a remote learning context. The activity they are to perform is done remotely and in collaboration to conceptualize the main features of a course in the human sciences.

1 Introduction

According to Novak (77), a concept map makes it possible to graphically represent and organize a conceptual field as it is perceived by a person. In a pedagogical context, concept maps can fulfill several functions (Quintin 99): learning facilitator, assessment facilitator, navigation and internet search aid, communication facilitator and finally analysis facilitator or aid for structuring learning material. This last function seems the most pertinent in terms of the conceptualization activities that we ask students to perform in lab exercises for a university course in the human sciences. In this learning situation, the role of the concept map is to enable students to approach the material in an easy-to-read and global manner. The learner thus has a canvas to build upon, enrich, specify or correct as he progresses in absorbing the material. The concept map is considered to be a tool that can lead the learner to make links among the concepts he is learning and also to establish a correspondence between the previous representations he held and the new ones that are being built in his mind. The creation of a concept map may cause a cognitive conflict that brings the subject to modify his initial conception through a process of cognitive self-regulation or equilibration of cognitive structures that allows him to refine his degree of understanding. We decided to use CmapTools because it meets another specific requirement of our learning mechanism: it is possible to use this particular tool for creating concept maps remotely and in collaboration.

We want the individual representations of each member of the group to be exposed freely, then to come together to end up in a common production that has been enriched by the contributions of each member. Pudelko & al. (03) highlighted that, even though concept map tools are generally rather user-friendly, some learners have to adapt to this new graphical mode of representing knowledge that is quite different from the textual and linear representations they are accustomed to. We focused on analyzing this activity of creating a concept map remotely and, with reference to the works of Tricot & al. (03) concerning the ergonomics of computer-based learning environments, more specifically on the way students perceive the tool (its capacity to help the student attain his objective) and its usability (its capacity to be used simply and easily by the learner). To help us think about the way to analyze the use of concept maps in pedagogy, we draw from the theoretical model developed by Depover, Karsenti & Komis (07). Their model is based on the idea put forth by the distributed cognition school (Pea, 1993; Perkins, 1995) that every individual belongs to a social and materiel environment that takes part in his learning. The cognitive functioning of a learner must be considered beyond his own individual cognitive system. If learning aids can be foreseen through interactions between individuals, they can also come from the technological tools in their environment that act as an extension of their cognitive capacities.

As Figure 1 shows, Depover, Karsenti and Komis (07) distinguish cognitive potential tools from cognitive tools used for specific purposes. For these authors, the cognitive potential tool corresponds to a computerized environment whose features are such that it can be integrated into learning situations and can at the same time bring about positive effects on the learners. The authors insist on the importance of the context in which the cognitive potential tool is

to be used. Depending on the relevance of this context, a tool may be able to meet the real needs of the learners and help them develop different types of skills (usefulness). On the level of context, two additional dimensions should be taken into consideration: elements related to the material context (usability) and those related to the human context. The material context mainly concerns the accessibility the learners have to the tool and the ease with which they can use it. The human context refers more to the pedagogical action of the instructor through the learning scenario he has developed and in which the chosen tool will be implemented. The human context also takes into account individual characteristics: information about the educational background is considered in this particular research project.

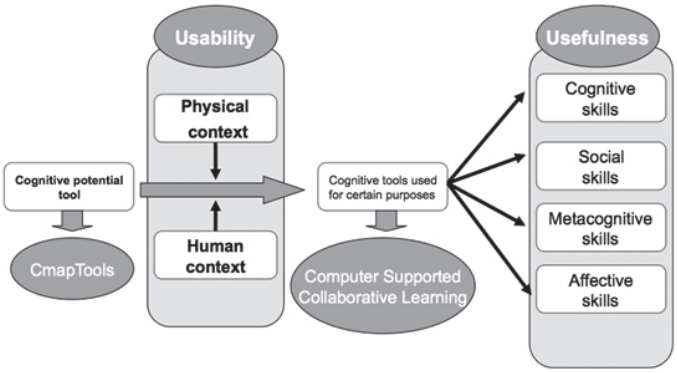

Figure 1. CmapTools in the model of the cognitive potential tool by Depover, Karsenti and Komis (2007)

2 The context of the study

The context is one of hybrid training (theoretical courses in a classroom setting and remote lab practica) for students in the 2nd year of the Bachelor in Psychology and Education. The course deals with models of teaching and learning. Concept maps are one of the means that allow students to show how they position the characteristics of the different models with respect to each other. Our work belongs to the fields of computer support for collaborative learning (CSCL) and computer-mediated communication (CMC) and our main reference model is the co-constructivist interaction model.

2.1 The teaching set-up

<table>
<tr><td>W1</td><td>W2</td><td>W3</td><td>W4</td><td>W5</td><td>W6</td><td>W7</td><td>W8</td><td>W9</td><td>W10</td></tr>
<tr><td colspan="2">Individual - Collaborative</td><td>Individual</td><td colspan="5">Collaborative</td><td colspan="2">Individual</td></tr>
<tr><td colspan="2">Phase 1</td><td>Phase 2</td><td colspan="5">Phase 3</td><td colspan="2">Phase 4</td></tr>
<tr><td>Activities 1 and 2
Profile of the learner and handling of the mechanism</td><td>Activities 3 and 4
Socialization</td><td>Activity 1
Comparison grid of families of models
Activity 2
Concept map Cmap Tools</td><td colspan="2">Activity 1
Comparative analysis of 6 families of models CmapTools</td><td colspan="3">Activity 2
Analysis of training situation</td><td>Activity 1 Assessment of knowledge</td><td>Activity 2
Self-assessment (optional)</td></tr>
</table>

Table 1. Progression of the activities by week and by phase (in grey: activities in which CmapTools is used)

Once the theoretical course is finished, the lab practica are comprised of four phases spread out over ten weeks (Table 1). Phase 1 (weeks 1 and 2) corresponds to (activity 1) handling the training mechanism and the e-learning platform that supports it (Esprit[1]), allowing learners to become familiar with the tools for remote communication and collaborative work. This is also the moment (activity 2) to collect information on the individual characteristics of the learners using various questionnaires: personal profile, learning style, motivation, feeling of personal efficiency.

[1]Esprit: http://ute3.umh.ac.be/esprit

During activities 3 and 4, the learners discover who their fellow team members are and use CmapTools to describe the team. This collective activity enables them to become familiar with its use.

Phase 2 (week 3) asks students individually to compare three families of pedagogical models from the six presented during the theoretical course (Behaviorism and neo-behaviorism, Socio-cultural approach and distributed intelligence, Constructivism and socio-constructivism, Mastery learning, Gestalt and information processing, Social learning). The comparison is made using a grid (activity 1) that contains a series of criteria to highlight their specificities. Then the students - still individually - represent the comparisons made in the grid in the form of a concept map edited by CmapTools (activity 2).

Phase 3 (weeks 4, 5, 6, 7 and 8) is collaborative. Groups of three students are formed based on their participative learning style (see description of experimental variables). Starting from their comparison of certain families of models, they must collectively design a map with CmapTools that summarizes all of the families of models from the course (activity 1). In an online forum set up to this effect, they discuss their choices and the way to proceed. Three steps are foreseen to carry out their analysis. The first is to compare the maps of the models that the members of the team have in common and to annotate the maps that they do not have in common. The second step is to identify relationships of similarity and opposition between the six families of models; at least four links must be made between the families of models. The third step is to write a team report, related to the concept map, in which the similarities and differences between the six families of models are highlighted. The teams must choose the ten links that they consider the most important for characterizing the models and they must support the choice of these links in their report. Activity 2 of this third phase asks learners to watch four video segments of spelling lessons, after which, in order to apply the theoretical aspects of the course in a real situation, the students must identify in these film segments the concepts from the pedagogical models that seem to them to be best represented.

Phase 4 (weeks 9 and 10) is individual and demands that learners carry out (activity 1) a certain number of compulsory assessments (knowledge test, opinion test,…) and invites them optionally (activity 2) to prepare for the final examination using a self-assessment questionnaire.

2.2 The experimental set-up

The dependent variable of our analysis is the opinion of learners on the usefulness and usability of CmapTools in the collaborative activity they are carrying out remotely. The independent variable of the experimental set-up (Table 2) is that the learners are first-time university students (N=126) or continuing education students (N=54) and are participating in the same remote training mechanism.

TYPE OF TRAINING:	*Teams*	*Subjects*
First-time university education	42	126
Continuing education	18	54
	60 teams	***180 subjects***

Table 2. Breakdown of the two experimental groups

3 Research questions and methodology

3.1 The research questions

Our intention, with the questions listed below, is to find out how students perceive the usefulness and usability of CmapTools. The main questions presented here are inspired by the works of Dillenbourg (02), which underline the effect of the structuring of interactions on the efficiency of collaborative learning.

Q1. What is the perception of the usefulness and usability of the CmapTools software for all of the students?

Q2. Do the first-time university students have a perception of the usefulness and usability of the CmapTools software that is different from that of students in continuing education?

3.2 The methodology

Information was gathered using various questionnaires filled out by the learners during the course of their training. To measure the perception that the learners have of the tool, we used the Davis questionnaire (89) composed of 12 questions spread out equally between usefulness and usability. This questionnaire has been translated from English into French and adapted for CmapTools. We felt it was useful to add three additional questions to the initial twelve: these cover the online use of the tool (Q6), the collaborative activity (Q7) and the interactions between team members (Q11). The students must indicate their opinion on a 5-level Likert scale ("totally disagree" to "totally agree").

4 Results of the experimental study

Our analyses cover two lines. The first deals with the overall perception that university students have of the usability and usefulness of CmapTools. The second deals with the difference in perception between our two groups of students with different educational backgrounds (first-time university students and students in continuing education). We will only present the items for which a significant difference was observed.

4.1 For all of the students

Table 3 reveals that the majority of learners have a positive opinion about the use of CmapTools. More specifically, when we look at the "totally agree" column, we see that the questions for which we obtain the best results (the only ones that are higher than 20%) are related to usability: CmapTools "is easy to use to design a concept map" (Q4: 28.8%), "is a tool that I find user-friendly" (Q1: 25.4%), "seemed easy to use" (Q2: 21.5%), "is a tool through which it was easy for me to become skillful" (Q5: 21.5%). This bears witness to the idea that, on the whole, learners agree that the tool is not only easy to learn and to use, but also that it does indeed enable them to attain one of the objectives - designing concept maps.

In terms of usability, we can thus say that the appreciation of the learners is rather positive. Figure 2, in which we have grouped the items according to their percentage of positive opinions (total of the "agree" and "totally agree" percentages), shows this and more: not only are the positive opinions quite high, but also relatively equal from one column to another.

As far as negative opinions are concerned, very few learners chose the level "totally disagree". The highest scores for these items are: "allowed me to work on a common map at the same time as my fellow team members" (Q7: 8.5%) and "makes it possible to interact with my fellow team members" (Q11: 5.1%). These two items are both linked to collaborative use. This could mean that the collaborative and online use of CmapTools is somewhat difficult and that it may not be easy to work at the same time as fellow team members on a single map. Answering the open questions on the questionnaire, the students say that it is difficult to work on a collective map without seeing each other and some think that the work would have been more interactive if it had been done face-to-face (in the library, for example) to discuss the various points.

In Figure 2, it is clear that these (Q6, Q7 and Q11) are indeed the three items that get the most negative (in bold) reactions. By testing the homogeneity of opinions using the χ^2 test, we can show that, for the items related to collaborative use, there is a significant difference observed for Q6 "online use seems easy to me"; $X^2 = 13.849$; TS = .008). The opinions given concern the tool's capacity to be used online easily, which is complex undoubtedly due to network problems rather than to problems with CmapTools itself. So it is the nature of the collaborative activity that appears to complicate the task and not necessarily the software. It seems important to take into account the difficulties associated with working in a team on a single task, which required more coordination and additional means of communication. Tools should not increase this difficulty but reduce it as much as possible. In light of this particular finding, CmapTools does not seem to help on this level - but at the same time it is not an impediment, as can be seen through various positive reactions.

		Totally disagree	Disagree	Neither agree nor disagree	Agree	Totally agree	χ^2 Test	
		Negative opinion			Positive opinion		χ^2 - sign	
Usefulness	Q8. That allows me to perform my tasks more quickly.	5.1 %	18.1 %	37.9 %	34.5 %	4.5 %	8.418	**.007**
	Q9. That improves the quality of my work.	1.1 %	9.6 %	31.1 %	46.9 %	11.3 %	8.090	.088
	Q10. That increases my productivity.	1.7 %	14.7 %	45.8 %	32.2 %	5.6 %	12.869	**.012**
	Q12. That makes it easier to do the task that has to be performed in this activity.	0.6 %	8.5 %	16.4 %	58.2 %	16.4 %	9.104	.059
	Q13. That improves the efficiency of my learning.	1.7 %	13.0 %	28.8 %	47.5 %	9.0 %	8.580	.073
	Q15. That will be useful to me in my education.	2.3 %	11.9 %	37.3 %	37.9 %	10.7 %	5.569	.234
Usability	Q1. That I find user-friendly.	1.7 %	15.8 %	15.3 %	41.8 %	25.4 %	7.479	.113
	Q2. That seemed to me to be easy to use.	1.1 %	13.0 %	16.4 %	48.0 %	21.5 %	2.955	.565
	Q3. With which interaction is clear and understandable.	1.1 %	9.0 %	26.0 %	46.3 %	17.5 %	1.416	.841
	Q4. That is easy to use to design a concept map.	0.0 %	2.8 %	10.2 %	58.2 %	28.8 %	3.297	.348
	Q5. Through which it was easy for me to become skillful.	0.6 %	7.9 %	17.5 %	52.5 %	21.5 %	2.796	.593
	Q14. With which I could interact with flexibility.	2.3 %	11.9 %	32.2 %	44.1 %	9.6 %	7.414	.116
Collaborative use	Q6. Whose online use seems easy to me.	3.4 %	19.2 %	28.2 %	35.0 %	14.1 %	13.849	**.008**
	Q7. That allowed me to work on a common map at the same time as my fellow team members.	8.5 %	19.8 %	22.6 %	30.5 %	18.6 %	5.805	.214
	Q11. That makes it possible to interact with my fellow team members.	5.1 %	18.1 %	37.9 %	34.5 %	4.5 %	7.085	.131

Table 3. Occurrence of the answers to the questionnaire related to the usefulness and usability of CmapTools –χ^2 value and degree of significance

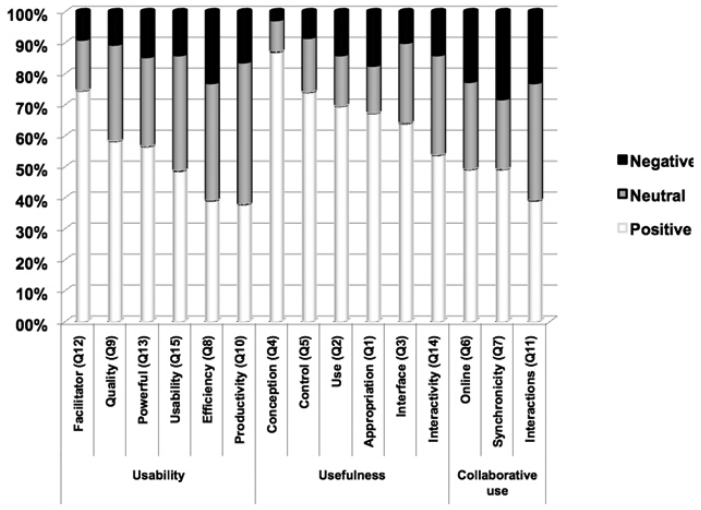

Figure 2. Hierarchy of the items according to positive and growing appreciation of the usefulness, usability and collaborative use of CmapTools

In terms of the usefulness of CmapTools, in their answers to the open questions, it is above all the cognitive and esthetic potential of the tool that students put forward: “I think this program is rather convincing. It lets us use our analytical skills while trying to tap into our artistic potential and eye for detail to produce a map that is both clear and pleasant to look at.” (Alain). In their opinion, making the concept map gives them the chance to organise, to establish a hierarchy and to assimilate the various notions brought up in the course: “I plan to print out the concept maps and use them to help me study for the Educational Psychology exam because they are a good summary of the material.” (Estelle).

As for the answers where students were to give their opinion using a Likert scale, we see in Table 3 that the degrees of significance yielded by the χ^2 test are almost all significant (Q8 “allows me to perform my tasks more quickly”; $X^2 = 8.418$; TS = .007) and (Q10 “increases my productivity”; $X^2 = 12.869$; TS = .012) or nearly significant (Q12 “makes it easier to do the task that has to be performed in this activity”; $X^2 = 9.104$; p: .059) ; (Q13 “improves the efficiency of my learning” ; $X^2 = 8.580$; p : .073) and (Q9 “improves the quality of my work”; $X^2 = 8.090$; p: .088). Hence we can say that overall the usefulness of CmapTools is considered differently by learners: some have a positive opinion of it (many “agree”), while others have a more mixed opinion (many “neither agree nor disagree”). Figure 2 clearly shows this contrast between positive opinions (in white) and mixed opinions (in grey). There seem to be divergent opinions among learners as to the effect of CmapTools on fulfilling tasks, whether in terms of productivity or efficiency or both together.

We can say then that, all in all, learners have a positive and unanimous opinion on the usefulness of CmapTools, but a contrasting opinion (positive or mixed) as to its usability, and a rather negative opinion of its collaborative use. We will see below that this disparity in opinions as to the pedagogical relevance of CmapTools can be better understood when the educational background of the learners is taken into consideration.

4.2 Depending on the educational background of the learners

The following analysis in Table 4 shows that students in continuing education express opinions that are significantly more positive than first-time university students in terms of the usability of CmapTools [Q1 – 101.21 >89.32; p: .039 (TS)] and its collaborative use [Q6 – 109.34 >81.21; p: .001 (TS), Q7 – 101.34 >84.05; p: .033 (TS) and Q11 – 102.68 >83.11; p: .022 (TS)]. On the other hand, in terms of usefulness (Q9 and Q13), the first-time university students have significantly more positive opinions [Q9 – 93.07 >76.81; p: .035 (TS) and Q13 – 93.95>76.08; p: .026 (TS)].

First-time university students appear to be more skeptical about the pertinence of CmapTools for favoring cognitive skills [improving the quality of work (Q9) and the efficiency of learning (Q13)]. Continuing education students are more focused on easy implementation from the perspective of general functioning (Q1) and online use (Q6) and on the facilitation of group work whether it is on the level of interactions (Q11) or on the level of simultaneous work on a common map (Q7). For this latter category of students, their focus on the material context (Depover & al., 2006) can be understood by their need for tools that simplify the task. These are adults who have taken up university studies later in life and who work during the day and study at night. This group of students needs tools that are easy to use and that favor remote communication and group work.

Cmap Tools is a tool:	Initial education	Continuing education	Significance	Item related to
Q1 - that I find user-friendly	89.32	**101.21**	**.039 (TS)**	usability
Q6 - whose online use seems easy to me	81.21	**109.34**	**.001 (TTS)**	collaborative use
Q7 - that allowed me to work on a common map at the same time as my fellow team members	84.05	**101.34**	**.033 (TS)**	collaborative use
Q9 - that improves the quality of my work	**93.07**	76.81	**.035 (TS)**	usefulness
Q11 - that makes it possible to establish interactions with my fellow team members	83.11	**102.68**	**.022 (TS)**	collaborative use
Q13 - that improves the efficiency of my learning	**93.95**	76.08	**.026 (TS)**	usefulness

Table 4. Values of the rank test (U-Mann-Whitney) according to the educational background of the learners

First-time university students seem to be less sensitive to these constraints: they are more concerned with finding tools that are efficient in making their learning easier. These learners are more focused on the pedagogical efficiency of the tools probably in part because they have more time to solve technical difficulties but also because they can carry out the collaborative aspects using means other than those provided by the tool itself. These first-time learners generally have more opportunities to meet each other in person whereas the learners in continuing education count on the proper functioning of the tool to enable them to carry out the collaborative activities. This could explain the importance they place on the proper functioning and the relevance of CmapTools in the pedagogical context that interests us.

5 Conclusions and perspectives

Overall, the usefulness of the tool is confirmed. Opinions on its usability are mixed and those related to the collaborative use of CmapTools are less positive. The learners find the tool easier to use than efficient for learning, but they also find it complicated to implement in groups remotely.

Depending on the educational background, the learners are more sensitive to the usability or to the collaborative use of the tool to the detriment of its usefulness when they are faced with a heavy organizational burden due to tight schedules. This is indeed the case of our students in continuing education. The first-time university students are concerned with the usefulness of the tool to the detriment of its collaborative use.

Usability seems to be important for all the students, especially for those who have the heaviest workload, like our continuing education students. In our research, students who are more sensitive to the usefulness of the tool for its relevance to learning are those with the lightest workload: the first-time university students. The collaborative use of CmapTools appears difficult to implement. However, it would seem that this is due to the inherent difficulties of group work rather than to the characteristics of the tool itself, which, incidentally, are perceived positively.

To further our research on the adequacy of CmapTools with respect to the needs of our learners with varying profiles and the type of remote collaborative scenario that we set up, it would be useful to refine our observations through a more qualitative analysis of the procedures used by learners in terms of designing concept maps. We should combine trace analysis with the analysis of the discussions in the forums, which would enable us to better understand the choices that were made. This could be enriched with semi-guided interviews of learners in view of an even deeper understanding of the pedagogical “added value” that they associate with this technological tool.

References

Davis, F. D. (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13, 3, 319-340. pdf: http://www.cba.hawaii.edu/chismar/ITM704/Davis-TAM1989.pdf

Decamps, S., François, N., Depover, C., De Lièvre, B. (2009), Style d’apprentissage, script collaboratif et forum de discussion,. In : E. DELOZANNE, A. TRICOT, P. LEROUX (Eds.). Environnements informatiques pour l’apprentissage humain 2009. INRP: Lyon. pp.173-180.

Depover, C., Karsenti, T. & Komis, V. (2007). Enseigner avec les technologies: Favoriser les apprentissages, développer des compétences. Ste Foy: Presses Universitaires du Québec.

Dillenbourg, P. (2002), Over-scripting CSCL: the risks of blending collaborative learning with instructional design, Centre for Research and Support of Training and its Technology, Swiss Federal Institute of Technology, Lausanne.

Grasha, F. (2002), Teaching with Style: A practical guide to enhancing learning by understanding teaching & learning styles, Alliance Publishers Eds., University of Cincinnati, 385 pages.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997), “Analysis of a Global On-line Debate and the Development of an Interaction Analysis Model for Examining Social Construction of Knowledge”, In Computer Conferencing.

Kreijns & al. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. Computers in Human Behavior. v19 i3. pp. 335-353.

Novak, J. D. (1977). A theory of education. Ithaca, NY, Cornell University Press.

Pea, R. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), Distributed cognitions (pp. 47-85). New York: Cambridge University Press.

Perkins, D.N. (1995). L'individu-plus. Une vision distribuée de la pensée et de l'apprentissage. Revue Française de Pédagogie, 111, 57-71.

Pudelko, B., Basque, J. & Legros, D. (2003). Une méthode d'évaluation des cartes conceptuelles fondée sur l'analyse en système. In C. Desmoulins (éd.), Actes de la conférence EIAH (Environnements Informatiques pour l'Apprentissage Humain). Strasbourg, Université L. Pasteur, 15-17 April 2003. pp. 555-558.

Quintin, J.-J., (1999). The use of conceptual map in education and training. In G.L. Baron, E. Bruillard, C. Dansac. Representation, models and modelling. Brussels: European Commission, Educational Multimedia Task Force.

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (2007). Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group, and task characteristics. Behaviour & Information Technology, 26, 55-71.

Tricot, A, Plégat-Soutjis, F. Camps., J.F. Amiel, A. Gladys, L. & Morcillo, A. (2003). Utilité et utilisabilité, acceptabilité: interpréter les relations entre trois dimensions de l'évaluation des EIAH, In Desmoulins C. & Marquet P. & Bouhineau D., éditeurs, Environnements Informatiques pour l'Apprentissage Humain, Strasbourg, Atief ULP INRP.