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WORKSHOP ON VIRTUAL LEARNING ENVIRONMENTS

VIRTUAL LEARNING ENVIRONMENTS

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This document aims to provide policy makers with synthetic information (one-page summaries) regarding what's going on in schools and research labs with respect to virtual learning environments. Some issues, namely teaching training and organisational change, are deliberately not addressed here because they pertain to other workshops of this conference.

1. What is a virtual learning environment?

Does a «virtual learning environment» refer to **any educational web site? No**. However, as many fashionable words, some authors use it in a very broad way, including for instance Web sites that simply include static Web pages. Is a «virtual learning environment» restricted to systems including some **3D / virtual reality technology? No**. Some environments include less sophisticated interfaces, namely text-based. Between these over-general and over-specific definitions, there is a range of environments, which vary along the criteria listed below. Our goal is not to decide which environments deserve the «virtual learning environment» label, but to provide an understanding of their specificity.

What is specific to virtual learning environments?	*see section*
The information space has been designed.	➡ **1.1**
Educational interactions occur in the environment, turning spaces into places.	➡ **1.2**
The information/social space is explicitly represented. The representation varies from text to 3D immersive worlds.	➡ **1.3**
Students are not only active, but also actors. They co-construct the virtual space.	➡ **1.4**
Virtual learning environments are not restricted to distance education. They also enrich classroom activities.	➡ **1.5**
Virtual learning environments integrate heterogeneous technologies and multiple pedagogical approaches.	➡ **1.6**
Most virtual environments overlap with physical environments.	➡ **1.7**

Is a "virtual learning environment" synonymous to a **«virtual campus»? No**.

- A "virtual campus" provides University courses, while the name «virtual learning environment» does not restrict the scope to any level. The former is hence a sub-category of the latter.

- A "virtual campus" covers a set of courses, often a whole diploma programme, while «virtual learning environment» can be used for smaller curricula.

1.1 A virtual learning environment is a <u>*designed*</u> *information space.*

Any Web site is a built information space. In many cases though, this information space is just spaghetti of HTML files. We refer to the 'architecture' of information instead of 'structure' or 'organisation' of information in order to emphasise the fact that the structure results from analysing the functional requirements of the environment. For learning environments, the functional requirements are numerous and have not been yet systematically studied. Here are a few examples:

- *Using information in educational interactions.* For answering simple questions such as "Give me an example of..." or "Give me an argument against...", information must be stored in tables (databases producing dynamically Web pages) or in HTML files enriched with meta-information[1].

- *Multi-authoring.* The information stored in a virtual learning environment is produced by many authors: several teachers, students, domain experts, ... Who is authoring what must be explicitly stored in the system for developing mechanisms for sharing objects (e.g. «locking» an object when somebody is editing it) and workflow techniques (e.g. the document produced by X must be sent for approval to Y and Z before to be displayed).

- *Indicating information source.* Web information without explicit information regarding to (the authority of) its author will soon have no more value

- *Maintaining information.* When Web sites grow, if information has not been carefully structured, maintenance becomes very heavy: maintaining links, removing obsolete information, ... The cost of maintaining a Web site may become higher that the costs of creating the site! And despite this, it is rarely included in the budget.

- *Following technical evolution.* The effort devoted to developing Web sites has to survive the current technology. Structuring information and adding meta-information increases the potential of reusability of information.

- *Sharing information with the world.* Education would benefit from richer possibilities to share information outside the environment. There are currently efforts to establish worldwide accepted 'resource description formats'[2] and to specialise them for educational purposes[3].

Today's use of 'virtual learning environment' is not restricted to well-structured information spaces, but I expect that this criterion will become more salient, as content management becomes a main issue for all teachers involved in virtual learning environments. Researchers have to develop a better understanding of the functional relationship between how information is structured and represented and how it can be used in learning activities and interactions.

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1   Meta-information is information on information. This includes the information stored in the header (meta-tags) of HTML documents, describing namely the content of the document. Meta-information is also provided by XML-tags describing what is included in a paragraph: an example, a case study, a product…
2   Http://www.w3.org/RDF/Overview.html
3   See the IMS Global Learning Consortium (http://www.imsproject.org/) or the ARIADNE Consortium (http://ariadne.unil.ch/)

These points illustrate the fact that developing a school Intranet is a bigger challenge than building on the Internet (Comment by U. Hoppe), but that, at the same time, the Intranet information should be made available for wider communities.

1.2 A virtual learning environment is a social space.

A book can hardly be described as a learning environment. But, reading a book in a seminar, discussing with other students, writing a summary for the tutor, ... do constitute a learning environment. Similarly, a set of Web pages does not constitute a virtual learning environment unless there is social interaction about or around the information. This includes synchronous (e.g. chat, MUDs...) versus asynchronous (e.g. electronic mail, forums,) communication, one-to-one versus one-to-many or many-to-many, text-based versus audio and video, ... (see section 2.3). This includes also indirect communication such as sharing objects.

What is specific to virtual environments compared to any information space is that it is *populated*[4]. The users are inside the information space and see a representation of themselves and/or others in the space. As soon as students see who else is interested by which information, the space becomes inherently social. Researchers have introduced the notion of «place[5]« to emphasise that space as a social impact. Places are "*settings in which people interact*[6]. "*While spaces take their sense from configuration of brick, mortar, wood and glass, places take their sense from configurations of social actions. Places provide what we call appropriate behavioural framing*"[7].

The notion of social space opens interesting possibilities that are only explored for a few years. Here are a few examples:

- If a student looks for a book, he/she may go to the library and use standard search techniques. A library is a well-structured information space. Besides the library, the set of university offices, in which each professor has its own books, does also constitute an information space, but socially structured. This type of information architecture may be more useful in some cases, for instance if the student does not know much what he/she is looking for.

- Social space can be represented explicitly. For instance, students may leave trace of their presence in a room or on a page. Viewing which area has been visited by other students is an indirect mode of interaction (see section 2.3.3).

- The social space can be represented per se, for instance by drawing a graph in which students are the nodes and the thickness of the link between two nodes represents the number of e-mail messages between two students[8]

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[4] Dieberger, A. (1999) Social connotations of space in the Design for Virtual Communities and Social Navigation. In Munro, A., Höök K. & Benyon D. (Eds), *Social Navigation of Information Space*, pp. 35-54. Springer: London.

[5] Dourish, P. & Chalmers, M (1994) Running out of space: Models of Information Navigation. In Human Computer Interaction conference HCI»94, Glasgow.

[6] Munro, A., Höök K. & Benyon D., (1999) Footprints in the snow. In Munro, A., Höök K. & Benyon D. (Eds), *Social Navigation of Information Space*, pp. 1-14. Springer: London.

[7] Dourish, P. (1999) Where the footprints Lead: Tracking down Other Roles for Social Navigation. In Munro, A., Höök K. & Benyon D. (Eds), *Social Navigation of Information Space*, pp. 15-34. Springer: London.

[8] Demo: http://www.kas.utu.fi/eu/ttfirma2.html. Nurmela, K., Lehtinen, E. & Palonen, T. (1999) Evaluating CSCL Log Files by Social Network Analysis. Proceedings of the CSCL Conference, Stanford, Dec. 1999, pp.434-444.

1.3 The virtual space is explicitly represented.

We do not restrict the definition of virtual learning environments to Web sites that look like a Nintendo game. The representation of the learning environment ranges from text-based interfaces to the most complex 3D graphical output. The key issue is not the representation per se, but what the students actually do with this representation. For instance, we observed that virtual space imparts on users behaviour even when space is only described by text[9].

Nevertheless, representations are not neutral; they do influence the students work. Most often, the rationale for using 3D-graphical representations is motivational. It is taken for granted that nice representations trigger positive attitudes towards the environment. Actually, as all extrinsic motivational tricks, its impact on students may not last very long. However, it would be hard to justify that the interface of learning environments is less appealing that those of other software! Nevertheless, representations of the space may have an impact on the learning process beyond motivational aspects. Here are some examples:

Virtual space may support navigation. This is of course not the case for any spatial organisation (e.g. not for a labyrinth). *«City of News»*[10] is an example of information space organised as a city, designed for exploiting people's ability to remember the surrounding three-dimensional spatial layout.

Let us imagine a virtual museum. If the virtual space aims to imitate physical rooms, the student would explore it, room by room. In a museum, the information space is structured by 'painting schools' (e.g. surrealism), or centuries, or countries... Instead, the information space could be represented by an «Europe 20th century painters map» (2D or 2D or more complex). On this map, distance between two painters names would be computed on the basis of a survey in which art experts have been asked to answer question such as «Is Folon closer to Delvaux or to Magritte?» Students would explore this virtual museum in a way that is different from real museums.

- Let us imagine a drill&practice environment in which 100 exercises are distributed over 10 virtual rooms. On the graphical representation of this course, students can see who else is in the same room[11]. Thereby, if Paul is in room 5, facing difficulties with exercise 5-3, and sees Suzanne in the same room, he talks more than her that with Sandra who is in room 3 and does not know anything about exercise 5.3. Reasoning on "who is where in virtual space" tells me about "who is (and has been) doing what".

These are simple examples, but there exist a variety of mechanisms by which virtual space has an impact on learning interactions[12]. Like other maps, the aesthetics and ease-of-use are important concerns, but the main design issue is which information has to be provided for

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[9]   Dillenbourg, P. Mendelsophn, P. & Jermann, P. (1999) Why spatial metaphors are relevant to virtual campuses. in Levonen, J. & Enkenberg, J. (Eds.)(1999). *Learning and instruction in multiple contexts and settings*. Bulletins of the Faculty of Education, 73. University of Joensuu, Finland, Faculty of Education.

[10] Http://ali.www.media.mit.edu/~flavia/CityOfNews.html

[11] Awareness tools inform users about what others are doing in the workspace. Gutwin, C. & Greenberg, S. (1998) The effects of workspace awareness on the usability of real-time distributed groupware. *Research report 98-632-23*, Dept. of Computer Science, Univ. of Calgary, Canada

[12] Dillenbourg et al. (1999) *op cit.*

which purposes, or what is the structural relationship between the spatial representation and the information space.

1.4 Students are not only active, but also actors.

In Web-based environments, learning activities range from multiple choice questionnaires to problem solving. Simulations are indeed virtual learning environments as well. While originally restricted to physical models, they cover now a broad spectrum of domains such as economics, politics, biology… However, what is more specific to virtual learning environments is the set of activities in which the students construct and share objects. Most often these objects are Web pages. Writing activities (producing syntheses, study reports, newspapers, ...) are very popular in schools. Students are not restricted to consuming Web information, they become information producers, they enter in the game. There is quite a difference between writing a critique of a novel which will be read only by the teacher or which can be read by potentially anybody.

Often the writing activity is per se the educational goal, but in many cases, it is just the end point which drives a variety of earlier activities such as site visits, observations, experiments, interviews, literature review, ... (see section 1.7). Up to several weeks of work are carried out upstream to move to the Web. This work can be integrated in the virtual learning environments. For instance by enabling students to share informal notes, enabling teachers to provide references, by adding scheduling tools, ... Many Web-based environments re-instantiate, in more recent technology, the founding principles of Freinet's project-based pedagogy, not only by their use of tools (for instance e-mail and web-page replace letters and printed newspapers used by Freinet), but also by their concern for multidisciplinarity. For instance, a condition for schools to participate into the «Young Reporters for Environment»[13] is that teachers from various disciplines (e.g. biology, physics, geography, …) agree to articulate their course around an environmental issue.

Texts and Web pages are not the only products that student teams build together. It can be computer programmes[14], graphical objects[15], ... and even the environment itself. For instance, in the Pangea[16] project, kids from various countries (and various languages) co-designed a virtual island, which required them to work out problems related to ecology, democracy, geography, and so forth.

In other words, the notion of a learning activity in virtual learning environments refers to something richer than in individual courseware, closer to the notion of project. The difference between other constructivist environments and what virtual environments potentially offer can be described as making students not only active, but also actors, i.e. members and contributors of the social and information space.

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[13] http://www.ac-grenoble.fr/yre/
[14] http://tecfa.unige.ch/campus/infospace/index.php?display=buildings&id=1609
[15] http://space.arch.ethz.ch/ws98/
[16] http://tecfa.unige.ch/proj/pangea/

1.5 Virtual leaning environments are not restricted to distance education.

Web-based education is often associated to distance education, while - in the practice- its is also widely used to support presential learning. Actually, the difference between distance education and presential education is fading for several reasons.

- Many distance education students do not live far away from the physical school but have tight time constraints (often they work). Asynchronous communication provides them with time flexibility, a growing concern in our society.

  Many Web-based courses combine distance and presence, which makes learning environments more robust. Whatever technology is used, all tools have intrinsic limitations. These limitations do, over time, become real obstacles to learning. Even a small amount of co-presence may solve some of the problems that can hardly be solved at distance. Examples are activities that require presence such as: launching a new project, complex technical assistance, repairing deep conceptual misunderstanding, negotiation.

These points are important for vocational training, university courses and lifelong learning. In primary and secondary schools, the opposite balance is found: so far, Internet-based activities are there to enrich presential learning activities, not to replace them. The enrichment can be just an add-on, for instance the teachers points to Web pages that the students should read. This is not the case for virtual learning environments. We argue in section 2.6 that they influence the way teachers teach and thereby contribute to renew teaching methods.

1.6 A virtual learning environment integrates multiple tools

A physical learning environment generally integrates courses, resources (libraries), formal communication (boards) and informal communication (cafeteria, ...), an administration, ... Similarly, a virtual learning environment integrates a variety of tools supporting multiple functions: information, communication, collaboration, learning and management[17]. The very idea of *environment* includes this notion of integration. This is clear in virtual campuses (see definition on page 3). Because of their broad scope, they have to fulfil administrative functions: managing who is registered to which courses, collecting assessment notes to count credits, ... Virtual places have to reproduce most functions which can be found on a real campus: registration, assistance, leisure & fun, ... The integration of technologies is also present in smaller learning environments, for instance when a teacher sets up a page for a course that includes key pointers, a chat, a QUIZZ, a space to share drafts, ...

The word *integrated* refers to fairly different realities. There is a technical and a pedagogical integration, and both of them may vary in degree. The WEB technology has increased technical integration. At the lowest degree of integration, different pieces of software can be placed on the same Web page. For instance, there is a small Authorware programme running in the upper part of the page and a synchronous communication frame in the bottom of the screen in which the student can ask questions. The integration is here restricted to the fact that the two applications appear in the same window (versus in two different windows). Nevertheless, it is already interesting to design such a structured interface and not simply to ask the user to start multiple applications and configure the screen.

A higher degree of integration is reached when applications share or exchange data structures. Examples:

- If the student press 'help' in the Authorware programme or if the programme itself finds out that the student needs help, it opens up the chat and automatically sends to the teacher a request for help and a summary of what the student has done so far in the environment.

- If the student enters an answer that the Authorware standard pattern matching techniques cannot parse, the message is passed to the mailer, which asks the teacher to provide feedback[18].

These examples show that the technical integration supports the pedagogical integration. For instance, the designer has not to choose between self-instruction and tutoring, but decides to use both, self-instruction as the basis and tutoring when it is necessary.[19] For instance, microworlds have often been criticised for a lack of coaching and information. We can now have a chat within the microworld plus a rich hypertext (local and/or with pointers to Internet). For many years, the field of educational technology wad divided into schools of thoughts, e.g. Logo versus CBT. Now, that the designers can select the best of

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[17]   Peraya, D., Piguet, A. & Joye, F. (1999) Rapport d'information sur les mondes virtuels. Rapport rédigé pour l»office fédéral de la formation professionnelle et le la technique, Berne, Suisse.

[18]   This example is inspired by the Think Tanx development environment. (http://www.viviance.com)

each approach, that using one technology does not exclude another one, the debate between these schools of thought will hopefully be re-centred to understanding which types of interactions are relevant for which learning objectives.

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[19]   De Lièvre, B., Une expérience d'encadrement en direct d'une formation pratique à distance, Actes du Colloque du Conseil Interinstitutionnel pour la technologie éducative, Montréal, Octobre 1997.

1.7 The virtual environment overlaps with the physical environment

Virtual learning environments do not only integrate a variety of software tools but also integrate all the physical tools that can be found in a classroom. Of course, there exist some 'pure' virtual environments, designed for curricula that are completely at distance (Students never go to the school, never meet, ...). But, most virtual learning environments include:

- A variety of non-computerised learning resources: concrete manipulation tools, instruments, books, ...

- A variety of interactions that are not computer-mediated: face-to-face discussion among students, lectures by the teacher, group discussions,..., plus traditional media such as letters, TV, phone and fax.

- A variety of activities that are not computer-based: field trips, role playing, ..

We will not enter here into the debate on what is virtual and what is not, on where the physical environment stops and where the virtual one starts. It is an interesting philosophical issue, more complex that the simple difference between computerised and non-computerised elements. In the practice however there is no need to draw a boundary between physical and virtual worlds, the key is to integrate them, not to separate them. The continuity between physical and virtual objects becomes clear now that hybrid tools[20] appear that connect computers with physical artefacts:

- Boards on which students move blocks whose positions are known by the computers (as in chess games)[21]. These are physical objects, but coupled with a representation in the virtual space that can be used for interactions which are not possible in the physical world: computing all combinations of the elements assembled on the table, recording all the steps in assembling pieces, detecting where the current state of the artefact has already been reached before, ...

- Single-display systems: several students interact live in front of same screen but with different mice[22]. While their actions are performed in the virtual space, most of their interactions occur in the physical world: the students not only talk to each other, but touch and even push each other.

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[20] See the European programme "the Disappearing computer"
[21] http://kn.cilt.org/cscl99/A40/A40.HTM
[22] http://www.cs.sfu.ca/~inkpen/Papers/CSCL99/S174_6.gif

2. Will virtual learning environments improve education?

Potentially yes, but probably not. It would not be honest to claim that virtual learning environments will improve the quality of education or reduce the costs of educational systems. These environments have some *potential* effects, described in this document. However, the past tells us that it is very difficult to set up the conditions that turn potential into actual effects. Anyway, even if there were no proof of superiority in terms of learning outcomes, the evolution would not stop. The question is not to prove but to understand.

Here is the structure of our argument:	***see section***
Media have no intrinsic effects, but include affordances.	➡ **2.1**
What are the affordances of virtual learning environments?	
Social interactions	➡ **2.2**
Access to information	➡ **2.3**
The integration of technology	➡ **1.6**
Collaborative learning	➡ **2.4**
Before "Is it more effective than?" , teachers ask "does it work?".	➡ **2.5**
The effect of virtual learning environments may be less a matter of effectiveness than as space for innovation	➡ **2.6**

2.1 Media have no intrinsic effectiveness, only affordances.

Since virtual learning environments are a new generation of computer-based educational systems, it is worth looking at whether computer-based learning is more effective than learning in a traditional classroom. The question is indeed *irrelevant* for those, the vast majority, who see technologies as tools for teachers and not as substitute. Let's however have a look at research results on these issues. In short, studies show a slight advantage for computers[23], especially when considering the time for learning. These results have been questioned, but even if they were granted, how could policy makers generalise from these studies? Could we conclude that any courseware, even badly designed, would outperform teachers, even the best of them? Of course not. When comparing a courseware and a teacher, we do not measure the intrinsic effectiveness of computers versus humans, but the quality of two learning methods as implemented by two devices. If, for the sake of comparison, we forced the computer and the teacher to apply the same method, we would observe the same lack of difference as if one compares a FiatUno and a Porsche on a road where the speed limit is 30 km per hour!

It may seem trivial to say that a medium has no effect in general, but the history of educational technology shows that every new technology (television, computers, hypertexts, multimedia, Internet, virtual reality, ...) raise a wave of naive expectations regarding to the intrinsic effects of these technologies. Still every medium has some specificity, but this specificity can only expressed in terms of potential effects. A medium affords specific types of interactions: computers enable individualised instruction but not all software is individualised, computers are able to analyse the learner behaviour, to manipulate interactive models, but most programmes don't do it. The effect is 'potential' in the sense that interesting types of interactions are available, but not used or not used for the right learning objectives and audience.

Now, can we establish that some educational programmes are effective, without comparison with teachers, simply by comparing what the learners know before and after ? We can, in some cases, especially for self-contained courseware. However, we observed that the effectiveness of courseware often depends upon the pedagogical context in which it is used. We observed[24] that, even with simple hypertexts, the way students navigate in very much influenced by the tasks that teachers assigned to them. As a simple example, let us imagine a drill&pactice software in arithmetic, which provide learners with incorrect answers. It would be is a very bad learning tool for the teacher who use this courseware in a normal way, but it could be turned into a very interesting tool if the teacher asks the students to find the mistakes in the programme. This example is not ridiculous since the Web contains a lot of incorrect information.

In summary, courseware effectiveness is bound to the pedagogical context of use: the pedagogical scenario in which the courseware is integrated, the degree of teacher involvement, the time frame, the technical infrastructure, and so forth. This is not specific

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[23] Kulik, J., Kulik, C.L.C., & Bangert-Drowns, R.L. (1985). Effectiveness of computer-based education in elementary schools. Computers in Human Behavior, 1, 59-74.

[24] Zeller, P. & Dillenbourg, P. (1997) Effet du type d'activité sur les stratégies d'exploration d'un hyperdocument. *Sciences et techniques éducatives*, 4 (4), p. 413-435.

to technology, all reforms of educational systems face the same difficulty in scaling up success stories.

2.2 Social interactions

The first obvious opportunity of virtual learning environments is that they support social interaction, in many ways: synchronous versus asynchronous, text-based versus audio or video, one-to-one versus one-to-many, ... Again, these affordances define potential effects, not actual ones. For instance, we often encounter teachers who believe that, since their students use e-mail, they will start to ask frequent and smart questions. In our experience of Web teaching, this is rarely the case. Most email conversation is about the management of learning (finding resources, negotiating deadlines, asking for an appointment, ...). Spontaneously, they send few content-rich e-mail messages. The same applies to educational forums, in which it is very difficult to sustain the flow of messages. The problem is not due to the technology, but to the educational context. Students will not start communicating with the teacher for the sake of communication

In the following sections, we argue that the pedagogical challenge is not to imitate face-to-face interactions, but to explore different new communication functionalities that are effective in virtual learning environments.

2.2.1 Virtual places define the conversation context and thereby implicitly convey the communication contract.

The social context in which interactions occur has a strong impact on the way students interact, sometimes even stronger than technological features. Virtual environments offer designers ways to specify implicitly this context to the students, namely the communication contract. We illustrate this point with the usual discrimination between synchronous (e.g. chat, MUDs, ...) versus asynchronous (e.g. electronic mail, forums, ...) communication. The technological difference is real and simple, but their usage is more complex. Synchronous systems (CHATs) are becoming very popular. They are however criticised for several reasons[25], one of them is the fact that students to do have or do not take the time necessary to reflect before to answer. However, we observed in a synchronous virtual space[26] that the delay of answer was often above several minutes, i.e. much more time that what students would need for sending an e-mail message. When does communication stop to be perceived as synchronous? After 1, 5 or 88 seconds? In voice conversation the single second of delay which occurs in some satellite communications disturbs quite a lot the conversation. In written communication, a longer delay is accepted since, in most systems[27], the delay includes the time necessary to type the answer. Indeed, synchronicity is less a matter of real time than a subjective feeling of doing a task concurrently with somebody. If two students solve equations together and use a chat, the synchronicity is less due to the tool itself than to the fact that one student says something like *«OK, now let's do exercise 5.2»*. In other words, the key variable is not synchronicity but the communication contract, often implicit, among interlocutors. Setting up implicit communication rules is one of the social affordances of virtual places (see section 1.2): Students do not expect the same conversation rules in a bar versus a shop, in the lecture room versus the professor's office.

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[25] Namely, synchronous communication is hard to use in virtual learning environments because they re-introduce the time constraints from which distance education attempts to escape. For instance, in our own virtual Campus it is almost impossible to organise a collective synchronous discussion with 20 students during distance learning phases, because these students are adults with many commitments. Teachers also face scheduling difficulties if their kids have to discuss live with kids from another school.

[26] Dillenbourg, P., Jermann, P. , Buiu C., Traum , D. & Schneider D. 1997) «The design of MOO agents: Implications from an empirical CSCW study. *Proceedings 8th World Conference on Artificial Intelligence in Education*, Kobbe, Japan.

[27] Some systems indicate to the partners that the emitter is typing something. Some other system show what the partner types when she types it (and not only when he hits the ENTER key

2.2.2 Virtual interactions do not have to imitate face-to-face communication in order to be effective.

Virtual space designers do not necessarily try to imitate physical space, they look for creating new affordances. In the same spirit, the most relevant mode of communication is not necessarily the one that imitates face-to-face conversations. The comparison is not the key issue. Shlager et al. Showed that, by about the 3rd meeting, online real-time meetings followed similar patterns as face-to-face meetings[28]. Of course, they are some situations for which no medium has been found as effective as physical co-presence. For instance, launching a project and negotiating goals is very hard to do by e-mail. Therefore empirical studies on computer-mediated communication are often expressed in terms of «what is loss»: for instance, moving from face-to-face to chat, students loose facial expressions, body gestures, voice intonation... Such comparisons underestimate the fact that groups of users and tools form distributed cognitive systems[29] and they self-organise to adapt to the context. For instance, as mentioned above, MUD[30] messages are only sent when the emitter hits the ENTER key. This is different from usual conversations and hence disturbs beginners. Often, the emitter repeats his question before the receiver has the time to answer. However, experienced users have developed ways to cope with this: before typing a long answer, they inform the partner by a short sentence such as «Let me answer...». Another trick is to type only the beginning of the answer, followed by the symbol [...] to indicate that the message will continue (implicitly asking to keep the floor). These meta-communicative acts become part of the specific culture of virtual environments.

Another example is the irregularity of turn taking in MUD conversations[31]: the utterance N+1 does not necessarily answer to utterance N, but to any of the recently uttered sentences. Again, this disturbs new users, but not experienced users who are used to look a few utterances back to understand what is being referred to. It is even turned into something positive: because MUDs are semi-persistent media (previous utterances remain displayed in the window which slowly scrolls up as new turns are added), users become very quickly able to participate in multiple conversations in parallel. This feature can be applied to create multiple individual tutoring, one tutor interacting semi-synchronously with several students located in different virtual places, each place maintaining its own conversational context

Our challenge is to understand these opportunities and integrate them where they are pedagogically relevant. This work still has to be done for multimedia interactions. The affordances of voice and video communication in virtual environments are largely unexplored. Video communication is often limited to displaying the speaker's face, which has a limited value compared to its technical cost. In general eye contact is not possible. Turning head to give the floor to another speaker is irrelevant since the speaker looks at his screen. So far, environments where students see the same objects enrich more interactions than that of those where they see each other (although these are not exclusive). I do not

[28] Schlager, M., Fusco, J., & Schank, P. (in press). Evolution of an On-line Education Community of Practice. To appear in K. A. Renninger and W. Shumar (Eds.), Building virtual communities: Learning and change in cyberspace. NY: Cambridge University Press. http://www.tappedin.org/info/papers/evol99/
[29] Hutchins, E. (1995). How a cockpit remembers its speeds. *Cognitive Science*, 19, 265-288.
[30] A MUD is a text-based virtual space, multi-user, supporting synchronous and asynchronous communication.
[31] Dillenbourg & Traum (1997), *op cit.*

question the future of video communication but points out that its current use (namely traditional lectures that are video recorded and broadcasted on the web) are not very innovative. We have to invent uses of video and audio communication that improve communication in virtual space.

2.2.3 'Non-verbal' communication

The specificity of virtual learning environments is that, beyond direct text/voice/video messages, users may communicate in other ways: exchanging objects, moving in the space. These are often called 'non-verbal' communication, but this term is slightly inappropriate when the commands are verbal (e.g. users have to type «move», «give object to Bill», «Smile»). These new forms of social interactions are less known but I view them as the main avenue for development.

Many virtual environments include a shared space, i.e. an interface where users see the same collection of objects, can add objects, take them in their private space, edit them, delete them, etc. Whiteboards[32] are typical examples of shared spaces. Because these objects are persistent, they support referencing in verbal communication. The set of objects constitutes a representation of the state of the problem, which play the role of a collective memory. Whiteboards are also used to support face-to-face meetings[33]. Researchers on computer-supported co-operative work are exploring the design of such innovative functionalities that do not necessarily exist in face-to-face interactions.

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[32] Type of software in which two or more users draw on the same page a set of objects, can see what the other does, edit and delete the objects drawn by the partners, etc.

[33] Schrage, M. (1990) *Shared Minds. The new technologies of collaboration*. New York: Random House, 1990.

2.2.4 Building virtual communities

When groups of users interact intensively through some medium, they progressively constitute a community. The community feeling does not automatically emerge because groups use electronic communication, it takes a lot of time, a lot of interactions. It requires sharing goals and, whatever that means, sharing experiences. How do feelings such as membership and group identity appear in virtual learning environments? These factors are not well known and more research is needed to understand how designers may favour the emergence of a community. Obviously, how a group of users design their (virtual) space is one of these factors: if you look by the window when the plane is landing over London versus over Napoli, you get an immediate appraisal of the relationship between culture and architecture/urbanism.

Since communities do emerge, we have to understand how they may enhance education. They key answer is culture, taken here in its cognitive dimension, i.e. the conceptual framework which mediates the way students interpret situations. In recent theories[34], learning is described as the process of entering a culture. Learning to be a physician is not only learning about medicine per se, it is also acquiring the physician language, their values, their biases, ... How to design environments in which the culture that will emerge closely matches the culture to be acquired? In vocational education, this can be achieved by connecting students with professionals outside schools, i.e. with a community that has already developed the target culture. The bottleneck is obviously the difficulty to find workers who can/want to take the time to interact with students. There are for instance exciting experiments[35] that can hardly be generalised since they rely upon the fact that Nobel Prize winners were available to discuss with students.

However, as C. Depover pointed out, we must be careful that the specific culture of a community does to prevent students to join the community. Virtual leaning environments should not be places where student absorb «the» culture, but places where they co-construct new culture(s) or at least find the opportunity to expanding[36] the existing culture.

There are further reasons to explore this community building process:

- *Building teacher communities*. Teaching has always been an individual work: teachers do not collaborate a lot, they rarely attend to each other lectures, do not much exchange teaching material and so forth. *The challenge is to turn teaching into a collective performance.* Some very large running experiments specifically foster the creation of communities for teacher professional development[37].

- *Building larger educational professional communities.* The improvement of educational systems should only rely on teachers. Many teachers reported (whether this is true or not) that one of their difficulties was the fact that schools directors or inspectors know much less than themselves regarding to how to use Internet. Some experiences start to integrate more parents in virtual communities.

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34   Lave J. (1991) Situating learning in communities of practice. In L. Resnick, J. Levine & S. Teasley (Eds.), Perspectives on Socially Shared Cognition (63 - 84). Hyattsville, MD: American Psychological Association.
35   See the 'CoVis' project. http://www.covis.nwu.edu/
36   Engestrom, Y. (1987). *Learning by Expanding*, Helsinki, Finland: Painetu Gummerus.

In other words, virtual communities may contribute to break the barreers around the schools.

2.3 Unlimited access to information

The WEB provides learners and teachers with access to an amount of information that has never been accessible before and is developing at an exponential rate. This statement is so trivial that many people only point out the negative aspects:

- The quality of information is uneven, there is often no validity check.

- There is an overflow of information, it is difficult to find what we are looking for.

- The information is not filtered. Hence students may encounter pages which contradict the teachers moral or ethical values.

- The information is not structured, the Web is a huge unorganised file repertory.

- There is a lack of meta-information (who produced this information, is this author a reliable source, how long will this information remain valid, ...)

All these critiques are valid. However, they should not hide the fact that this access to information still is a new opportunity, and as such, worth to be explored. Not only students have access to more information, but, more importantly, to a larger variety of information sources. Once again, this feature does not per se guarantee any effectiveness. Our point is that it is an affordance that clearly discriminates Web-based environments from previous systems. The effectiveness depends upon the way the designer exploits this opportunity, which raises two questions:

- How does the designer address the problems listed above? Concerning the issues of quality control and difficulty to find information, there are two strategies: either to pre-select information, i.e. to set up a page gathering the information considered as correct, relevant for the course, morally acceptable etc., or to provide unfiltered access to the Web but to teach students how to search for information on the Web, to train them to be critical, ...

- What role does the designer allocate to information access in the learning process? There is a risk that designers confuse setting up a learning environment and providing access to information. As a caricature, a teacher could say "Everything you need to know on this subject is on the Web, please read it and be back for the exam in 6 months." The risk of 'simple knowledge transmission' is quite high if one looks at University Web sites, but it is not present at primary school level.

We expect a rapid evolution of these issues, both with respect to the information itself and the leaner attitude towards information. More and more Web information will have no value if there is no explicit information regarding to the authority of its author. Teaching strategies for assessing the validity of Web information will become a critical mission for schools.

2.4 Collaborative learning is not a recipe

Virtual learning environments contain obvious affordances for collaborative learning. We hear many over-expectations regarding the benefits of collaborative learning, and over-expectations always have a counter effect. Is collaborative learning more effective than learning alone? Comparative experiments gave an advantage to collaborative learning in about two third of the studies[38]. This led to a second generation of studies which aimed to determine under which conditions collaborative learning is effective: which group size (2, 3, 5, more ...), which group composition (homogenous/heterogeneous, mixed gender or not, ...), which task, which communication media, and so forth. These factors interact with each other in way that it is impossible to control all conditions and to guarantee effective collaboration. Hence, the third generation of empirical studies analyse which interactions do indeed take place during collaborative learning. Simply stated, collaborative learning is effective if the group members engage in rich interactions: When they explain themselves in terms of conceptions and not simply answers, when they argue about the meaning of terms and representations, when they shift roles, ... One cannot a priori guarantee that rich interactions occur, but one can regulate the collaborative process to favour the emergence of these types of interactions. This can be performed in two ways:

- *Structuring collaboration*: The teacher does not simply ask the group members to do some task together, but specifies a scenario. A scenario includes several phases and, at each phase, the team has to produce something and the team members have some role to play. Roles such as criticising the partner's proposal, summarising what the partner has read, probing the partner for justifications, ... are expected to trigger productive interactions.

  Regulating interactions: Even if the efforts to structure collaboration increase the probability that productive interactions would occur, there is no guarantee that the interactions do actually occur. Therefore, collaborative learning would benefit from some external regulation, generally a tutor. The role of this tutor is not to intervene at the task level, but to make sure that all group members participate, to point out contradictions between group members which have not been noticed and so forth. Regulation is however difficult when interactions occur in the virtual space, a teacher cannot for instance regulate synchronous communication in 10 teams of 3 students. Researchers are now developing tools to help teachers to regulate groups and/or to help groups to regulate themselves[39].

Our issue is how virtual learning environments increase the probability that productive interactions emerge. Designers create environments which structure collaboration, namely interfaces which structure the task (specifies the different phases, who has to put which object at which phase etc[40]) or the communication. The latter are called 'semi-structured communication interfaces'. These are communication tools in which the users communicate through a predefined set of widgets. A widget can be a button such as "I disagree with you." or a sentence opener such as "Why do think about..." (the user has to

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[38] Slavin, R.E: (1983) *Cooperative learning*. New York: Longman.
[39] Jermann, P. & Schneider, D.K. (1997) Semi-structured interface in collaborative problem-solving. *Swiss workshop on collaborative and distributed systems*. Lausanne, May 1st 1997.
[40] See for instance http://tecfa.unige.ch/campus/infospace/index.php?display=buildings&id=1601 (connect as guest1, password=guest1)

complete it). The underlying hypothesis is that these interfaces will shape collaboration among subjects, as language shapes thought. Preliminary empirical findings suggest that these interfaces do for instance reduce the number of off-task interactions. However, this research is still in its infancy.

2.5 «Does it work» is what matters

The pedagogical effectiveness is an object of investigation for scientists, and a concern for policy makers, but teachers often have a primary concern: does it work? This question does not only refer to the fact that the software is easy to install and to use, and that it is bug free, but also to questions such as: Does it work with my students? Do the students 'play the game', i.e. feel engaged in the scenario and have a sustained interest along the software use? How long will I be able to keep the floor with this software, a few hours or a few months?

LOGO is good example of the difference between this practical efficiency and the above mentioned pedagogical effectiveness. It has never been proven that learners acquire the reasoning skills that Papert claimed they would acquire[41]. This lack of evidence did not stop many teachers from using LOGO: it was cheap and reliable (no bugs), could sustain the learners activities during long periods, activities could be set up in time periods which fitted with school schedules, ...(and moreover LOGO was accompanied by a well-received philosophy of education). This illustrates that teachers are – and this is very legitimate - sensitive to practical efficiency: does the courseware help them to do their job well and easily?

It is very hard to assess practicality in abstracto, but rather easy to observe in the field: only software that does work will emerge from bottom up. The 'practicality' has indeed social dimensions: how many colleagues are using the same tool (and can share resources, other help,...), how do I position myself in the teachers community if I use these tools, ... This social dimension was very clear in the LOGO story.

I emphasise this form of efficiency because it is under-emphasised in the literature: most experiments are run for a short period of time, with voluntary teachers, adequate equipment, etc. Although this is trivial, it is important to say that there is no chance that the effects observed in controlled experiments can be generalised if the system does not work - in its broad meaning - in the everyday school context.

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[41]   Pea, R. D., & Kurland, D. M. (1987). On the cognitive effects of learning computer programming. In R. D. Pea & K. Sheingold (Eds.), Mirrors of minds: Patterns of experience in educational computing (pp. 147-177). Norwood, NJ: Ablex Publishing.

2.6 Virtual space is a space for innovation

Although we cannot predict how virtual learning environments will influence learning effectiveness, an important point to consider is that, for teachers, a virtual space is an open space, a space where they can try new approaches. It striked me that most teachers who report how they use Internet in their teaching implicitly depict themselves as pioneers. In most cases, they are indeed pioneers in their school or district. They face technical and institutional adversities, they take risks, namely some distance with the curriculum, they escape from the established routines. These teachers spend many more hours on their teaching preparation than they are expected to. *Not only pioneers contribute to educational change, but, more importantly perhaps, they develop an ownership of change.*

In other words, the main effect of virtual learning environments on educational systems may be revitalising teaching outside the Web. Harasim (1999) reported that the teachers, who worked part-time for the VirtualUniversity, changed their teaching style even outside Internet, including more collaborative learning practices, viewing themselves less as knowledge providers and more as facilitators[42]. Indeed, if you set up two conferences, "How to teach via Internet?" and "How to improve teaching?", the former will attract more teachers than the latter, but it will be anyway about improving teaching.

This is the positive side of the coin, but there is also a negative side: teachers spending a lot of energy to find resources («Exhausted pioneers» as F. Verdejo call them), teachers reinventing the wheel, teachers devoting all their energy to technology instead of educational goals (C. Depover). Here, we touch here a difficult policy issue: how to support those who make one step without killing the "Robin Wood" effect (some teachers perceived Internet as a way of non-obeying).

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[42]   http://www.telelearn.ca/

3. Other Comments

- The technology questions are complex and important. Current development is sometimes too much driven by technology instead of by pedagogical goals. *We should not, as a reaction, disregard the technological issues.* Instead the challenge is to reach a deep understanding of the relationship between technological, or even technical, choices and teaching/learning processes. Especially, we want to emphasise here that there is still a need for developing new technology that supports specific pedagogical functions (e.g. group regulation).

- Social gaps can be larger than physical distance. In several EU countries, the educational system is still structured on historical distinctions, for instance between state schools and catholic schools, where religious freedom is mostly used as an alibi for social discrimination. In a similar way, the distinction between different forms of secondary schools (general, technical, professional,...) do less reflect career directions than social layers. On those days when Swedish teenagers may interact with Chinese children, *Internet should also serve as a medium to break the walls inside our society*, to smoothen the transition between clusters of educational systems. This move is already visible in practices where the Internet is used to bridge the gap between schools and workplaces and the gap between schools and families (e.g. offering the parents to use the school Net in the evenings).

- What distance education offers is not only the possibility of access for people located far away from any school, but, for those who live close to an University, *the possibility to choose - under legal and financial constraints - which school they want to attend to*. Several new companies that offer on-line university degrees have appeared on the market. Students are not any more a captive audience, a Geneva student will soon be able to pick up a course wherever he/she wants. This phenomenon appeared at the University level, but will influence sooner or later the school system upstream. This new form of competition opens a controversial political debate. It is however a matter of fact that this competition will increase and that teachers - and the school system- have to be prepared for it.

- Time is a critical factor. Space is a central concept in this document, but empirically speaking, time has a stronger impact on what works and what does not. If time is a critical factor in virtual learning environments, it has to be represented explicitly. We have already addressed two timing issues: synchronous versus asynchronous communication (cf. 2.3.1); increasing flexibility is often more crucial than decreasing distance (cf. 1.6) In our virtual campus, we see two other factors

  - *Time is the bottleneck.* Although traditional computer-based teaching has been proved to reduce the time for learning, this is - empirically - not true with Internet-based training. The ratio between the workload and our students' availability remains the most critical feature in designing curricula. Time is also a very rare resource for teachers who spend a huge amount of time to set up Internet-based activities.

  - *Activity timing is as critical as activity design.* When we move learning activities from presential to distance settings, tuning the timing is a critical factor. For instance, in a discovery learning environment, we increased the delay between the discovery phase and the debriefing phase. The delay was

one coffee break in the presential setting and one week in the distance setting. Doing this, we lost most of the dynamics we usually got in the debriefing phase. Tuning the flow of discussion groups, i.e. the number of message per day.

4. Questions for discussion during the workshop

1. *Is SuperMario a social space ?*

2. *Can we build policies on the fact that virtual learning environments offer space of innovation?*

3. *How to support pioneers without killing the pioneers spirit ?*

4. *Is the priority that all teachers use Internet or rather than those who use it, use it in a pedagogically interesting way ?*

5. *Will the development of informal but socially rich virtual networks progressively take over official hierarchical school networks?*

6. *Should training effort include directors and inspectors?*