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The Classroom as ONE Learning Environment of the Future

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Abstract: Firstly, we consider important concepts to be taken into account when thinking about the classroom organisation and the design of learning environments. The concept of classroom integrates different facets including at first interaction between children and a system of available knowledge carried out either by human beings or multi-media contents. A very important facet is that the classroom is also a context for social interaction. Knowledge acquisition by human beings makes sense only if we take into account the need for socialisation of knowledge and a process that allows the sharing of it. We then consider recent results in cognitive sciences especially in the study of learning theories and focus on why and how this is to be considered when designing and implementing educational technologies.We need to consider user-centered approaches and human factors in the classroom.
We then describe the major characteristics of the classroom for future. The model we propose for the classroom is to be splitted in two parts : the kernel (as a set of real places where persons can meet physicaly) and the cloud (as a set of real or virtual places) reachable from the kernel via networks. The kernel plays a role of a fix point very useful for people having roots. The balance between activities taking place in the kernel and the cloud is then analysed. This leads us to discuss some basic principles underlying the global organisation. This kind of approach helps us to specify more precisely different points : teachers' roles and constraints on teachers' education. The need for mediatised resources meeting the needs in such schools leads us to propositions for methodologies to design educational resources.

Key Words: concept of classroom, distributed learning environments, educational technologies, educational resources design, learning theories

1 Introduction

In the first part of the text, we consider important concepts to be taken into account when thinking about the classroom organisation and the design of learning environments. These concepts concern mainly human, social aspects, roles of the classrooms and the link with learning theories. From this background, it becomes

possible to analyse major characteristics for the classroom of the future and propose a model for its organisation based on a concept of a *kernel* (seen as a fix point, real place allowing social interaction and direct contact of learners with „live" knowledge) and the concept of a *cloud* (seen as a virtual place allowing remote access to -or interaction with- knowledge and people). The effects of such an organisation on teachers' roles, teachers' education, multi-media resources design can then be described.

2 Concept of Classroom

The concept of the classroom integrates different facets including at first a system of interactions between learners and a system of available knowledge carried out either by human beings (one teacher or peers) or mediatised contents (books in library, multimedia tools). The main goal is to have the learners acquiring of, re-building for themselves this knowledge. It is clear for us that acquisition is here to be understood as „re-creation", „ re-construction" of knowledge in the learners' head rather than „transmission" of knowledge. So designing a learning environment (and the classroom is such a place even if not reduced to such functions!) means designing a place allowing for such a re-construction.
Another very important facet is that the classroom is first of all a context for social interaction : the room itself (once the door is closed) is a place allowing a kind of micro-social integration between children and the teacher. It is a place where equality of chance between children is to be guaranteed. Equality of chance means here that each child must find the possibility to reach her highest opportunity for personal developement and acheive her best personal level. This differs notably from equality in reached levels.
Knowledge acquisition by human beings makes sense only if we take into account the need for socialisation of knowledge and the process allowing the sharing of it.
The school in its whole is a place for social interaction including that involving adults playing roles like administration or parents.

We conclude from such remarks that when implementing educational technologies, we must consider such a process of socialisation including sharing of knowledge between persons. The classroom is not only a place for learning content in various separate disciplines, it is a place where it is possible to integrate knowledge from various disciplines, discuss and feel the social role of knowledge. So, even if the classroom is, among a lot of other „more modern" possibilities, only one of the possible places for learning (even if some consider it as an expensive one), we must keep it. Besides social effects are important. For learners, learning about social complementarities, learning that others may have better or weaker possibilities or skills for learning, learning managing differences in competences with respect to domains (some can get good marks in mathematics, others in arts, others in literature) is quite important to educating people with open minds. What I would call „learning in the large" is far richer than having people learning specific topics, focusing all their attention only on well-delimited issues centered on their personal direct interest. A

possible but worrying scenario we can imagine today would be to have children isolated „learning at a distance“ using educational resources available on CD-ROM or through INTERNET access, learning only what they want to learn. This is very important for children. Although we might accept that such considerations can be revisited with fewer objections when organising learning environments for adult learners engaged in professionnal contexts.

3 Background from Learning Theories

Recent results in cognitive sciences -specially in the study of learning theories- reenforce the approaches based on group projects, „learning by doing“ approaches (micro-worlds, constructionism, constructivism,...), and collective organisation of learning activities. This is to be considered when designing and implementing educational systems, in particular in the design of educational technologies-based scenarios.

It is clear that solving problems raised during the project imposes the availability of resources (human or mediatised) embeding the useful knowledge. The major part of the work of the learners is to identify, elicit, discuss with others (peers or teacher), separate and apply the useful items of relevant knowledge. Educational technologies can play a major role at this level. They can be implemented either as knowledge bases or under hypermedia resources, reachable either locally or via networks. This can play a role either to help when synthetising activities, or tutor while organising structured knowledge, or used during the evaluation process.

It seems very clear to us that it remains very relevant to consider user-centered approaches and human factors. Management of motivation and affectivity are very important to help the learning process. We conclude here that educational technologies, even if easily available at home via networks, will neither replace the classroom nor do away with the school.

4 Some Characteristics for the Classroom of Future

We describe here major characteristics of the classroom of the future.

4.1 A Model of the Classroom of the Future

For us, the model of the future classroom is split in two parts : the kernel and the cloud. The global model can be described as a global distributed learning environment, centered for each individual learner on a well-identified kernel acting as a fix point and a root and the cloud being more flexible and expandable in different directions.

4.1.1 The Kernel

The kernel consists in a set of real places where allocated persons can meet physicaly. People admitted in a given kernel are more or less always the same: These persons

know each others and allow minimal sharing of personal problems and direct communication when needed. The kernel plays a role of fix point very useful for people and anchors them to a social construct and a human support group.

4.1.2 The Cloud

The cloud is a set of real or virtual places, spaces of resources reachable physically or via networks. People can find here resources or external potentialities for virtual social interaction. Examples of items available in the cloud are other classrooms (exchanges between schools), distance education centers, educational resources available from servers, museum, teachers from other classrooms, experts in labs or engineers in firms and the like.

4.1.3 Articulation Between The Kernel and The Cloud

The balance between activities taking place in the kernel and the cloud is to be considered carefully. This can be done by focusing on either local aspects at the level of the classroom (in such a case, it is a problem of organisation of activities inside the kernel) or at the global aspects (the educational system in its whole).
For the first point, the coordination of activities conducted in the kernel and the cloud part is to be managed by the teacher.

4.1.3.1 Hybrid systems

For this later point, we discussed in earlier papers model of organisation called *hybrid systems* [see Vivet 95]. The main idea consists in observing that actual educational systems split people in two categories, each working in concatenated subsystems : those going to school and those having only access to distance education. We consider that rather than concatenation, it would be better to integrate subsystems, allowing access to distance education even for people having access to schools and allowing access to resources (such as multimedia tools, networks and the like) in schools for those who only have access to distance education. We discussed [see Vivet 95] benefits of such an approach from analysis of benefits and weakness of both kinds of systems.

4.1.3.2 Examples

For example, this would allow a children working -maybe from home- at a distance (in the cloud part of its classroom) during heavy traffic hours in towns, going to school (kernel part) when less traffic is possible.
For people who need to move, shifting schedules and hours when they are moving is a way to reduce danger and associated costs in urban areas. We can consider now scenarios where it is possible to take into account external and more global problems like traffic in towns, weather in some countries, overuse of rooms in countries where overpopulation occurs.

4.1.4 Concluding Remarks

We would conclude by using a metaphor. As we have harbours and airports to open a country on the world, as we have tele-ports to open a country to information systems outside a country, we would propose the concept of „knowledge port“ as the interface between the kernel and the cloud. This integrates in a global view on the one hand the social interaction of the kernel as a kind of „national identity“ and on the other hand the opening on the world as a source for enrichment for people.

4.2 Global Organisation

We discuss here some basic principles underlaying the global organisation. They include autonomy of the learners and the teachers, personalisation of the learning process combined with coordination of learning activities with others (others being physically present or at a distance), flexibility in learning styles available, time management, and in physical access to resources.
Considering the diversity and the mutual renforcement of the learning activities, we infer the diversity of the organisation of the real room itself.
In the kernel part,we must find :

4.2.1 tables

Furniture must be useful for workshops in small groups where project activities can take place. Such a table can allow one computer to be available here as a resource to serve as a local pedagogical assistant like the ROBOTEACH system we described in earlier papers [see Leroux 92a, Leroux 92b, Leroux et al. 96a], access to external networks via LAN and other such resources.

4.2.2 shared workstations

One or two separated workstations may be needed to have access to hypermedia tools or to networks. Such workstations can be used either by the teacher or by learners leaving their group to conduct a local investigation to carry back more complete information for a project;

4.2.3 a “show“ place

This is a place for presentation and collective use. It is equipped with black or white board and an overhead projector allowing video projection of computer screens. This place is to be used either by the teacher to present new content, the goals of projects, the organisation of the work, or by the learners when presenting the results of their work to the other project teams. Demonstrating one’s own solution to others and reviewing solutions and results by others on the same project make for sound learning. This is done with a presentation to others and a discussion among the group, the teacher beeing present or not during such discussions.

4.2.4 a "discussion place"

Conversation takes place around a large round table where it is possible to discuss goals of projects or share results from the projects. We can underline once more here [see Vivet 89c] how it is important to distinguished between pedagogical goals (which stay under the control of the teacher) and goal of the projects conducted by the learners.

4.2.5 "private" places

These are places where the learners can either have „private" discussions with the teacher or work alone and isolated in autonomy. Activities like preparing work, synthetising activities, reporting may be done here with a given pre-allocated duration.

4.3 One Example of Scenario

We consider here the possible organisation for a group of 27 learners needing up to 12 workstations (personal computers- PC). The kernel is designed as :
i- Three groups of three learners engaged in projects activities as those we conduct with micro-robots [see Leroux 92a, Leroux 92b, Vivet 86, Vivet 89c, Vivet 91a]. Learners can get autonomy here from help with a pedagogical assistant like the ROBOTEACH system giving advice and resources [see Leroux et al. 96b]. This needs three PCs
ii- Three groups of three learners having conducted activities as described in the previous i-point and engaged in a discussion (at the discussion place) with the teacher. Checking and signing for objects produced during projects ([see Vivet 92] for check and sign for micro-robots), sharing the results from projects, discussing new projects, can be done here.
The swapping of the two previous groups is to be managed by the teacher.
iii- One group of three learners engaged in discussion at distance via visio-conferencing with external experts, classrooms or looking for external resources according to needs which arose during their project or to specifications written from other groups. We emphasize here the need and the role of precise writing of specifications between groups, the increasing influence of skills for communication (either with paper or telecommunication tools). We need here one PC with communication devices -such as modem- to allow network access.
iv- One group of six learners engaged in a self-training session with CBT or CAL software or in self-evaluation session with specific software designed for formative evaluation. We need here six PCs.

We can see here that we need to specify clearly the pedagogical functions (like pedagogical assistants, networks access, self training and self evaluation) of the workstations. Such machines can be obviously rather the same from the hardware point of view! This helps in the organisation of the global learning space. We can see

that the positionning of the mahines in the room depends on the functions. We have here criteria to help us when arranging the workplaces.

4.4 Remarks

1) It must be clear that by activities we consider here only learning activities, those which are specially designed to involve the knowledge to be learned according to pedagogical goals. We must take care not to confuse activities and activism. We know that it is not sufficient to have children active and busy to have them learning. For example clicking at random without a goal in a hypermedia is not necessarily a learning activity (even if it is a nice way to appear busy!).

2) principles underlaying the organisation
Few simple but strong principles are required in the design of the classroom for the future:

- autonomy for the teacher as for the learners
  This can be done in organising work in a way allowing self-training, self-evaluation, self-assessment, using easily available resources
- personalisation
  This can be done in organisisng work in a way saving time for the teacher. Using pedagogical assistants helping group projects work while the teacher is involved in a deeper discussion, facing a specific problem within a group is a way. Another one is in the use of Intelligent Tutoring Systems embeding student modelling. We know results gained by research in this way but we also know it will be long before the general availability and dissemination of such tools in educational systems.
- flexibility
  We refer here to flexibility either in the global system (management of time, possibilitites for "life long learning"), articulation between educational systems and professional training possibilities or in the local system (scheduling of the courses and learning activities in the classroom).
- opening
  With this topic, we focus on the need for opening the classroom on the "society of knowledge " in its whole. Networks allow access to knowledge everywhere. INTERNET proves that the modern society is engaged in the capitalisation of large scale, widely disseminated knowledge bases. Training the learner of the future classroom to live in so open a world is in the responsability of the classroom of the future.

These principles are very important for having people ready for „life long learning“ processes as proposed by the European commission in the context of reflexions and actions conducted in 1996 during the „year for life long learning“.

3) self evaluation systems
Self evaluation is very important; we need to train people to acquire personal skills for self-guidance Beyond diploma delivery, the need for people to make decisions for continued education during professional life increases and the need for the design of specific environments for self evaluation is now well established [see Jacoboni 93, Jacoboni 94, Teutsch 96, Teutsch et al. 93].

4) As P. Purcell from MIT says in the design of channels facilitating access to educational resources, we are shifting from „broadcasting approaches" to „broadcatching approaches" (from private discussion with the author in Sophia Antipolis, June 1996). This means that people must manage voluntary activities rather than being passive consumers of delivered knowledge. They must be adapt at selecting relevant content; focusing on specific items in large sets of data or large knowledge bases; constraining navigation in large multimedia or hypermedia bases to only the subsets which merit being visited according to given goals; managing time with such tools, and covering new skills which are to be learned. It is enough today to visit in a university a room with workstations allowing free access to INTERNET to appreciate the need for advice to students to prevent them from possible negative effects.

5) communication skills usefull in future workplace : from tele-learning to tele-working
Work at a distance will have an increasing importance in the future; this can be demonstrated by observing the process spreading business throughout the world. Teleworking becomes everyday life not only for an increasing population of commercial people but also technicians, engineers, and decision makers. Teleworking can take place only if people have acquired communication skills using new information technology tools (NIT).We are now in a period where people can develop these skills. We also know they can be harder to acquire for older workers engaged for a long time in professionnal activities not involving NIT in everyday work. We have explored the possibilities [see Vivet et al. 93, Vivet 95] to use distance teaching scenarios to train people not only for knowledge and content they must acquire for direct professionnal reasons but to help them acquire, by side effects, these NIT-based communication skills. It is clear to us that the school of the future must take into account such a problem. We believe indeed that this will be done „naturally" from the new kind of organisation : access to the cloud will involve most of such technology, and skills developed here will be easily re-invested when needed at the workplace.
For the moment we consider such possibilities as possible positive benefits from hybrid systems as envisaged in 4.1.3.1.

5 About Teachers

This kind of analysis helps us to specify more precisely different points : for example, teachers' roles and teachers' education.

5.1 Teacher Roles

The teacher becomes more a manager of the learning space and an organiser of the work rather than a full-time direct provider of knowledge. With respect to the contents, its work takes place more at meta-cognitive skills levels. Among others, its activities include the management and the organisation of the kernel and its articulation with the cloud, the access to resources (locally or at distance), the determination of parameters for pedagogical assistants software [see Leroux 96a], and the examination of traces delivered by such pedagogical assistants for activities conducted within the groups, the synchronisation of activities, the collaboration with external actors to manage the external cooperation or competition (with other groups, classrooms). For learners, finding groups interested by your own production and having groups presenting results obtained for similar projects via networks to others groups concerned by the same topics can be a very motivating activity.

5.2 Teacher Education

Educating teachers to act in such environments is really the hardest problem to be faced. A good principle is to educate them using the same kind of organisation and approaches. So, to implement such ideas, teacher education centers (being understood here as kernels for such learners) are to open their clouds, become interconnected, with student-teachers able to learn using such distributed environments. We can underline the fact that approaching teacher education this way can help when the new teacher starts her work one year later in a isolated school. The new teacher can remain connected to the teacher education center, the teachers, the peers she met during her training period and find here the support she may need.

6 About Design and Availability of Educational Resources

The kind of organisation we are considering for the future classrooms suppose the availability of educational resources which must be designed according to the use we suppose they will have. By educational resources we consider :

i) firstly, learning material such as Computer Based Teaching -CBT- tools or Computer Assisted Learning -CAL- software tools in the usual sense. More advanced tools involving virtual reality-based worlds may be considered here. [see Whitelock et al. 96]

ii) secondly, data bases of project specifications linked to guidelines, booklets describing activities, eventually adresses of teams -either learners or teachers- having solved the project for which it could be interesting to cooperate either locally or through networks

iii) thirdly, pedagogical assistants engaged in cooperative work with the teacher and the learners. An example is ROBOTEACH. [see Leroux 96a] for a more complete description of such an approach.

It is also very relevant to consider who are the designers and the producers of educational technologies : are they developpers in software companies? teachers

acting as private developpers? teachers engaged in research groups in educational institutions?, „inspectors“ representing administrative truth? etc... Off the shelf -ready for use- products (looking to market to fascinated parents) also deeply differ from open packages, needing parametrisation to adapt them to learners and sessions conducted by a teacher. An example of the latter is pedagogical assistants as described in [see Leroux 92a, Leroux 92b] belong to this category.

6.1 AI&ED Approaches

A community of researchers has been working for several years to study reciprocal benefits between Artificial Intelligence (AI) techniques and educational problems. Major events are the ITS conference in Montreal -every four years- and AI&ED conferences organised every two years by the AI&ED society. Major issues under consideration include links with cognitive sciences including distributed cognition, topics like instructional planning and pedagogical control, student modelling, models for interaction with the learner, dialogue management, collaborative learning, learner/machine interface, self-explanation process or production of explanations and representation of pedagogical expertise in knowledge based systems. The work done in this area deals mainly with the design of educational software. It is very important for future applications; most of the prospective work is done in these area, new products, new approaches are under consideration but we consider that generally too few is said about the context for use, about the organisation of the learning place, the classroom and the school as a global system where such products will take place. We must recognise here that most of the work done in the AI&ED community relies on a search for more autonomy for the learner and more flexibility in the organisation. Thus, this work fits with the model and prospective views we describe in this paper. On the other hand, we are surprised to observe that people trying to explicate prospective views about educational systems evolutions (including conceptions of the future classroom) don’t refer much to AI&ED commmunity works.
The older work can be recognised around what had been called Intelligent Tutoring Systems (ITS). This leads us to a better understanding of problems to be faced to design knowledge based systems when the goal is to have a learner acquiring the embeded knowledge. ITS shells -just as expert systems shells- have been designed to help developers producing such software [see Vivet 89b]. A usual weakness of such systems is to start the design process of the software from knowledge representation rather than pedagogical activities (and a characterisation of the interaction one expects to have between the learner and the system). At the starting point of the design process, developers in general need to increase the precision in the specification of learning activities and the kind of interaction relevant to such activities.

6.2 Methodologies for Design of Educational Resources

This is a very important aspect to reduce costs and increase usability of educational software. We approached this aspect in earlier papers [see Bruillard et al. 93,

Bruillard et al. 94] to understand better what we did on such topics. The main idea is to consider that specification of educational software must start from the specification of a context and scenario for use. The process for developement follows a *spiral model*, enlarging loop including tasks such as specification of activites, prototyping, technical test and pedagogical evaluation by teachers in situ.

6.3 Evaluation of Educational Technologies

The evaluation of educational technologies is a crucial problem for which a lot have been written. For example [Vivet 96] explains our understanding of this problem. It is clear that if we want to have learners increasing their autonomy when working with educational technologies, less control on the content to be taught is done directly by the teacher. So the scientific content of software must be checked carefully. This is a problem of certification of the educational resources. This is a true problem, becoming more important as the role of the INTERNET technology increases. Important questions arise : who assess the scientific validity of mediatised contents ? How to assess the quality of available resources ?

6.4 Availability

The last problem to consider is the availability of the educational technologies. The first issue is the availability of hardware in schools. This is not so difficult a problem because costs are decreasing and the price as well as technical compatibility in some sense is no longer a barrier. The problem of availability of the software is more difficult even taking into account that dissemination through networks like INTERNET simplifies the problem.
A major problem is in the maintenance of applications. The main costs now come from the evolution of the software releases, most of which impose a too frequent change in the workstations. The life duration of applications _hardware + software_ is too short and the global economy has problems to support so many changes. A specific pressure comes from the fact that one is sometimes pushed to change machines when acquiring new software, losing at the same time availability of older applications.

7 Conclusion

We conclude by saying that even with a scenario of generalisation of use of educational technologies, the classroom of the future must leave place for social interaction. The life-long learning perspectives impose educating people by delivery of appropriate knowledge contents but also by reenforcement of communication skills and autonomy allowing open learning, self education, and self evaluation. Beyond the technology and rational in organisation, we must take care to keep young boys and girls laughing in groups, smiling because they are happy when learning and sharing knowledge.

Maybe the future classroom will include virtual places without walls, but it must keep the possibility to have real people with open mind and warm hearts.

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