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# Constructing Knowledge as a System of Relations

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## ABSTRACT

We examine how Nestor Navigator, a web browser and cartographer, supported the social dimension of the Transformational Process of information into knowledge (Diemers, 1999). We describe a qualitative case of a course in which the students had to develop a complex networked knowledge system that comprises interacting individuals, then- goals, "authentic" activities, constructed knowledge, and supports the related transformational process. Nestor was used to create a graphical information space, based on the map metaphor, serving as a social mediator of knowledge construction. Not only does it allow individual, monologue-like publishing of pages and map creation, but more dialogic types of publishing including annotations and commentaries of existing maps. We argue that the hybrid web maps built by the students (representing both individual experience and shared conceptual structures) can support dialogue and negotiation better than other kind of documents.

## CONSTRUCTING KNOWLEDGE AS A SYSTEM OF RELATIONS

In this paper, we propose a qualitative descriptive case study on Nestor Navigator, a web browser and cartographer, and the way in which this application supported the social dimension of the Transformational Process of information into knowledge. The purpose of our case study was to investigate:

1. The extent to which the students engaged in social interactions in the shared-workspace groupware to create understanding and co-construct knowledge,
2. Which collaborative accomplishments the students achieved in the shared-workspace. To understand the interconnections between social interactions, shared-workspace and knowledge construction, we examine the case through the lens of theories as situated cognition and social constructionism, which link together specific context and the constructed knowledge.

## THEORETICAL BACKGROUND

### Knowledge as a Process of Social Construction

A central assumption of situated cognition (Lave and Wenger, 1991) is that individuals build knowledge in a culturally situated practice. They do so by participating actively in social engagements as, for example, dialogue and collaboration, through which they create their own systems of meanings and form their social identities. Hence, constructing knowledge is a process of social participation, and the structure of the situation in which it takes place affects significantly the process.

Similarly, social constructionism based on Berger and Luckmann (1966) affirms that our representation of reality and the meaning we attribute to it is the result of social interactions in a specific cultural context that influences the way we create meaning.

Both the two perspectives consider knowledge as a product of social construction, and posit that individual cognitive representations, which are intrinsic to this process, in turn originate socially rather than being hard-wired in us. In addition, common to the two models is the role of the context in which social construction of knowledge is located. The framework of activities that individuals carry out constitutes the context.

Following these theoretical perspectives, our emphasis is not on how individuals acquire or develop representations of the world, but how they participate in contextually structured activities to form their personal and collective perspective. Although the environment guide us in the process of social construction, we are not — hopefully so! - passive acknowledgers and have different views of the reality that surrounds us. We attempt to reach a shared view of reality — and not without a struggle - by externalising and organising our different representations through social interactions. In the course of social activities, we share assumptions about how things make sense to us (Stahl, 2003). Social understanding is, in this way, the product of individual understandings. It is a circular process in which "the whole person acting in the world" (Lave and Wenger, 1991, p. 49) contributes through participation and legitimization in the community. The focus is on the ways in which building knowledge is 'an evolving, continuously renewed set of relations' (ibid: 50).

### The Active and Materialistic Nature of Knowledge Building

Another important assumption in this article is that knowledge building goes beyond learning (Bereiter, 2002). In fact, not only we were interested in what students learned, in terms of acquiring and changing their mental representations, but we were mostly concerned with what they *did*, in other words, with the product of their collaborative endeavour, in an effort to go beyond their existing representations. Following activity theory (Engestrom, 1999; 2001), we stressed the importance of externalisation and reification of mutual understandings and negotiation of perspectives into a jointly-built artefact.

Also in Wenger (1998), the negotiation of meaning is a twofold process of participation and reification: on the one hand, people interact with each other and engage in the community; on the other hand, they externalise and objectify their negotiated meaning. Through a community's interactions over time, the community establishes what Wenger calls a "shared repertoire", including routines, rituals, tools, symbols and concepts.

Whereas Engestrom primarily focuses on productive activities (e.g. the objects and outcomes of the activity), which are conducted by a community and mediated by a designed artefact, Wenger focuses more on the ongoing participation, engagement and meaning-making within the social practice itself. From these two perspectives, we can identify two closely intertwined processes and artefactual differentiations: the ongoing social construction of meaning and identity of the knowledge building community and the sources and products of knowledge building (e.g., models, concepts, documents, and discussions),

While the latter is a more easily observable level of the learning process, the former is a more invisible level that, however, is crucial as it defines the meaning of the objects and outcomes of the learning community.

Thus, learners as a social entity simultaneously produce concrete artefacts and a community or social landscape, in which the meanings of these artefacts are negotiated (Ponti and Ryberg, 2004).

### A Social Context/or the Transformation Information-Knowledge Process

As we were interested in *seeing* the outcomes of the students' collaborative efforts, we offered them a space where they could show and discuss the construction of the external, social product of their activities. This environment had to support students in the process of converting information into knowledge by way of a continuous and dynamic interaction between de-composition, through analysis, argumentation and critique, and re-composition of ideas and beliefs. Following Diemers' model of transformation information-knowledge - which unfolds through comprehension, contextualization and validation (Diemers, 1999) - such interaction underpins the development of a common interpretative space, where students share pieces of information and form personal understandings by embedding information in the context of a "real" activity. Through this stage of contextualisation, students can better appraise the value of the information they use and its relevance for accomplishing their goals. The information-knowledge conversion is assumed to take place at this final level of the model.

### THE SETTING OF THE CASE STUDY

The case study was conducted in an instructional setting where masters students worked together on an "authentic" activity, which consisted of using Nestor to build a web site about networked organizations.

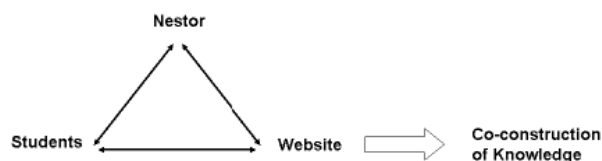
### Course Objectives

The title of the course is "the Net Company" and the subject is about network organizations. Students are expected to learn how to work in networks, not only through readings and lectures, but also by experiencing the dramatic role played by information and communication technology in all the network processes and the way in which they could contribute more effectively to managing people and activities in networked organizations. The matter of the course deals with different levels of networking: information networking (as it can be viewed from the Internet for example) and how it allows to create knowledge, processes networking both at intra- and inter-organizational level, company's networking along the value chain of their joint productions, and people networking. As the participants all belong to a Business school program, the accent is put on how to manage networking activities and networks of people.

### Participants

Twenty-one students attended the course<sup>1</sup>. Eight of them were non-French. The majority enrolled the program from the beginning of the year, with approximately half of them coming from the on campus Bachelor program (thus being in their second year on campus, the other half being in their first year on campus). The groups are build by the students themselves.

Figure 1. Structure of the Activity (after Cole and Engestrom)



### Instructional Activity

The course is built around two kinds of lectures: seven classroom lectures, and two virtual lectures, and two different kind of activities: individual activities and group activities, the group activities being the most important part. Each classroom lecture has a different theme. The virtual lectures are synchronous (date and time were negotiated at the beginning of the course) and allow to experiment computer supported collaborative work. The students prepare the classroom lecture by searching the web for information related the lecture theme and building individual maps with the Nestor browser.

At the end of the course they have to build a group web site presenting the view of the group of the course content. They do this by conducting self organized group work, out of the lectures.

The objective of the virtual synchronous lectures to experience virtual synchronous team work; the activity is a very concrete one: to produce a common map on one of the themes, each group acting as a virtual team, on the basis of the different maps realized by all the students of the class on this theme. All participants can access and edit all the maps.

The framework of activities carried out by participants to reach the goal represented the transformational context. In Figure 1, we represented the activity by using activity theory.

### The Shared-Workplace

Nestor Navigator is a Web browser client with some groupware features provided through a specific server-side software installed on top of Microsoft US Web server. Nestor differs from other browsers or groupware applications because the Web navigation is helped by maps, and its groupware features have been designed to support collaborative Web information gathering activities (see Esnault 2000 for further information about Nestor).

The typical activity for which this software tool has been designed can be characterised as "re-composition of information", that is, having a specific theme in mind, users have to a) collect information from Web documents; b) create a new document on the same theme aimed to serve a particular purpose which depends on their work context. This activity is achieved through querying Web search engines, navigating through the selected documents, de-composing those documents into elements, and re-composing the pertinent elements together with new contributions in order to produce a new document. Without describing in detail all Nestor features, for our purposes here it is enough to say that query and navigation are helped by interactive cartography with bookmarks and keyword objects; de-composition is supported mainly by copy/paste operations; re-composition uses structuring objects such as tables; contribution is encouraged through adding annotations, writing new documents and interlinking all materials; exchange and negotiation are supported by groupware features (e.g., chat, collaborative Web navigation, and synchronous map editing).

The nature of the typical activity is usually social, since it involves exchanging and negotiating information with other people. Besides, the characteristics of this activity, when performed in an appropriate context and mediated by an appropriate tool, are consistent with the principles of situated cognition, so that we can claim that it leads to transformation of information into knowledge and generates learning.

Nestor provides an environment where the “shared workspace” is constituted of maps. These maps are documents that provide an external representation, which aims to facilitate the operations involved in the activities described above: querying, navigating, de-composing, re-composing, exchanging, and negotiating. Map representation is a graphical network built from a set of nodes *and* relations. Nestor maps are also meant to support the process of reification of mutual understandings and the process of building cognitive representations on the external representations negotiated in the course of social interactions: in this sense, maps work as “social facilitators”. Their spatial structure affords - more than textual documents - for social participation in the construction of a common product (in our case study, the product of students collaborative endeavour is a Web site where most documents are maps). Map-based groupware tools support the social dimension of the transformational process of information into knowledge.

Map objects (e.g., bookmarks, text-memos, and tables) are diverse enough to allow for various “map styles”, ranging from poorly structured to well-structured maps, supporting navigation experience representation as well as mind-mapping and concept net, with the aim to allow all hybrid intermediary styles.

**METHODOLOGY**

**Research Goals**

We were interested in investigating:

- (a) how the students interacted with each other in the networked environment to share understanding and co-construct knowledge;
- (b) which learning outcomes the students achieved in the networked environment.

**Data Collection**

The data used for our analysis include all the files saved by the students, both during individual and collective work. We have two kinds of files: maps which have been intentionally saved by the students, and also navigation history files which were automatically saved by Nestor. The history files contain all the visited URLs along with an indication of the Nestor features used to access them “ in particular a code to differentiate between individual or shared access (examples of shared access URLs are: URLs accessed through joint synchronous browsing, or a URL visited by a participant who got it through a shared map or a message). Because Nestor synchronous features were not much used (due to security reasons), we decided to focus almost exclusively on the maps. We listed forty-four maps belonging to the group “knowledge management” described below. Some maps are only slightly different from their previous version. We found that the maps were very rich of information (names, structures, categories, etc.) that could be used to interpret the process of negotiation of meaning.

**Analysis and Results**

Commonly to what happens in all learning institutions, students at E.M.LYON form a community just because they belong to this institution: they develop a system of meanings and form their social identities mostly within the context provided by their management school. E.M.LYON’s community is a social entity serving as a background of all student learning activities. Therefore, we should not forget that the specific learning activity we describe in our case study takes place within this broader context from which it “inherits” important social properties.

Let us now go back to our hypothesis that the specific Nestor based collaborative activity requires its own “tailored social space”, which takes into account the particular constraints of the learning task at hand and the mediation effect of the tool. We focused on a group of five students who worked on the theme “knowledge management”, and we tracked their “negotiated experience” in practice across the nine weeks of activity.

Following Wenger (1998), we analyzed their trajectories of participation as indicators of the development of their identities in relation to this “elusive” social space. As we assumed participation as composed of action and relation, and taking action as being tool mediated, we analyzed the objects produced by the students - their reifications - in this perspective.

A first analysis suggested that collaboration unfolded along four stages, from plain individual work toward extensive collaborative work. As said before, in our case study the students produced maps; among other indicators, the names given to their maps gave evidence of the group state. For example<sup>2</sup>:

- At stage 1, we had a group of individuals who called their productions “my-surname.map” (e.g., Frederic.map).
- At stage 2, we saw map names - “2en1.map” or “Aurelie+Christele.map” that provided evidence of a work in pairs.
- Stage 3 was interpreted as the first attempt to incorporating the productions of all participants, leading to map names that suggested list of “things we don’t want to forget” (e.g., Kmmemo.map).
- Stage 4 showed the achievement of a final shared product whose name was no longer “member centered”, e.g., Arbre2.map (“arbre” meaning “tree”). In relation to this last name - Arbre2.map -, we can make two presumptions: (a) the name suggested the existence of successive negotiations (there should have been an “arbre1 .map”), (b) the content structure of the map determined its name (*arbre* = tree), suggesting that this structure is the main achievement of the negotiation, while we could have expected that the final product reflected the theme of the work (something like KM.map !).

In terms of the map structures, we could observe a clear evolution along the four stages.

- At stage 1, the maps were called “surf-maps”, which means maps that represent the navigations of an individual browsing the Web in search of relevant information (see Figure 2). The structure of these maps reflected the experience of their creator- This experience was essentially individual and the maps were not well suited for exchange.
- At stage 2, the exchange in pairs required more abstract elements that allowed for negotiation: we observe “hybrid maps” that incorporated both “experiential” elements (from the stage 1) and “conceptual” elements like tables and text memos.
- At stage 3, sharing information across a larger group imposed that experiential elements almost disappeared while conceptual elements occupied all the screen estate (see Figure 3). Still we observe a redundancy of structures (for example, tables and lists) that characterizes an ongoing negotiation process.
- At stage 4, the group negotiated the final structure that evolved from a table (Figure 3), then to a hub (Figure 4), and eventually a tree (Figure 5). The name of the map suggests that agreeing on the shared structure was the greatest difficulty. Note that the tree structure (*Arbre des connaissances*) is a collective production as it doesn’t appear in any previous map.

Table 1. Stages of the Collaboration

Stage	Type of collaboration	Work	Typical map names	Map Structure	Categories
1	Individual	Tool discovery	Test.map Frederic.map	Experiential: surf maps	Each individual has her own categories
2	Pairs	Pair work	MiseEnCommun.map 2en1.map Aurelie+Christele.map	Hybrid structuring elements: surf maps, tables, memos	Subsets of categories appear
3	Group	Starting group work	Kmprovisoire.map Kmmemo.map	Almost plain conceptual maps with tables and trees	Negotiating categories
4	Group	Finalizing group production	Arbre.map Arbre2.map	Negotiating structure: adopting the hub then the tree structure	Final categories

Figure 2. A Stage 1 Map: Mostly a “Surf” Map

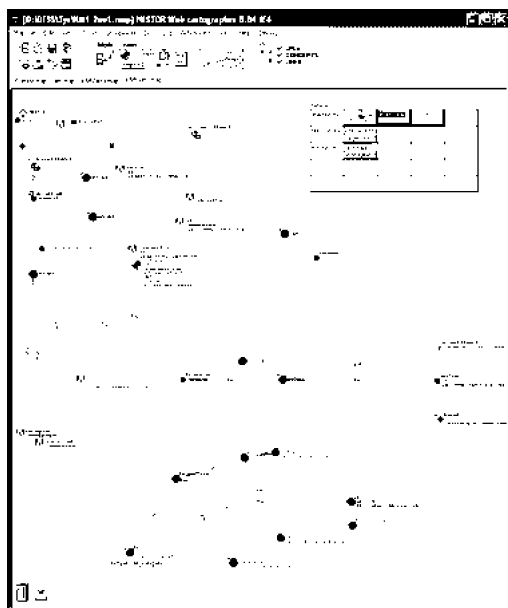
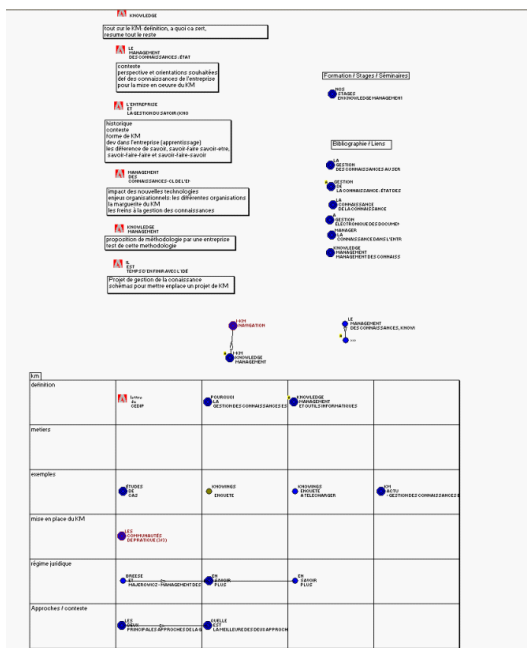


Figure 3. A Stage 3 Map: Experiential Elements Disappear and More Conceptual Elements Emerge



We could find another indicator of what we call “negotiation of meaning” when tracking the set of what was involved in the map structures. At stage 1, we found only emerging idiosyncratic categories suggested by the spatial grouping of the map objects (e.g., graphics, resources, enterprises). At stage 2, the tables showed a first set of named categories (for example, *regime juridique*) that varied with the maps. At stage 3, we had eight agreed categories (the table rows) that became seven at the “hub stage” and then were restructured in the final “tree” product.

We can track with more details the evolution of the “trajectories” of the categories involved in the maps with the aim to understand how the

Figure 4. Early Stage 4 Map: A “Hub Structure” Attempt

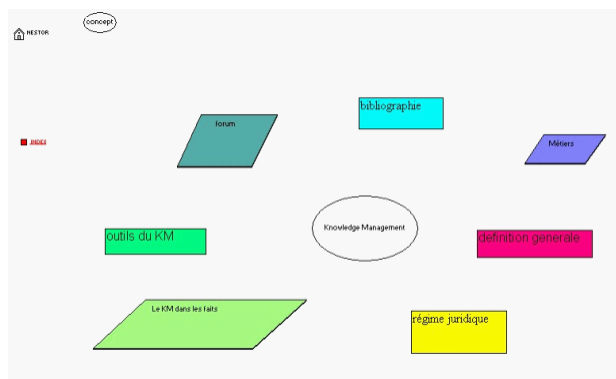
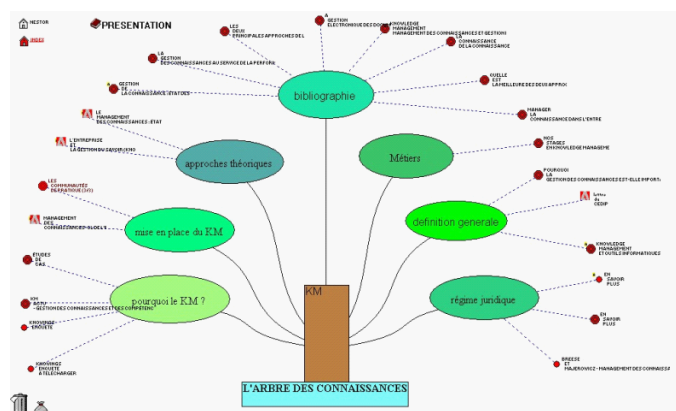


Figure 5. Stage 4 Final Map: Tree Structure



group members organized their work. This analysis could eventually lead us to suggest hypothesis about the participation of individuals and their identity building as according to Wenger, “identity in practice arises out of the interplay of participation and reification”. The categories we observe in maps are reifications.

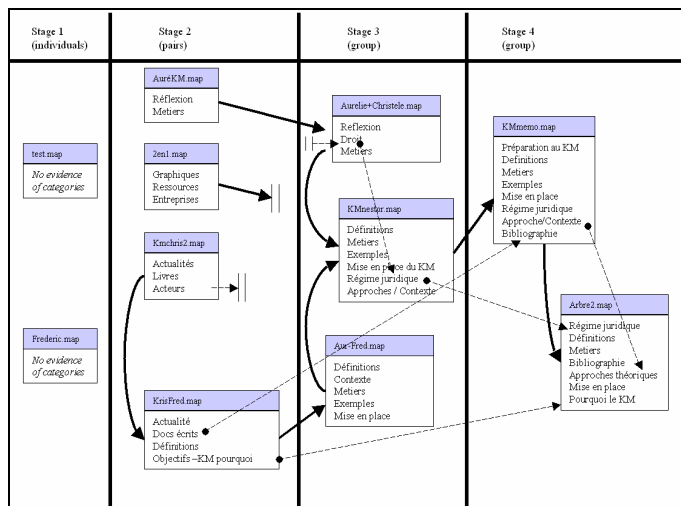
We schematized the evolution of the set of categories produced by the students in figure 6. Note that we had five students in this group: Alex, Aurelie, Aurelien, Frederic, and Christele. The reason why we mention their names is that it helps interpreting the map names. The main arrows represent the supposed evolution of the maps, while the dotted arrows represent the interesting evolution of a particular category.

**DISCUSSION AND CONCLUSION**

Our interpretation of the collaborative categorization process goes as follow: some categories, e.g., *Métiers*, *Definitions (jobs, definitions)* start since stage 2, they appear simultaneously in several maps and remain until the final product. These categories were not discussed by the students probably because they were conveyed through the teacher instructions. Some categories, e.g., *Livres, Doc écrits. Ressources (books, written docs, resources)* appear at stage 2 simultaneously in several maps, but with different labels: the discussion was easy because only then label was negotiated and the final label is *Bibliographie (bibliography)*. Some “fuzzy” categories, e.g., *reflexion, contexte, approche (reflection, context, approach)* were subject to difficult discussions as attested by their tortuous trajectory. The final corresponding category is *Approches théoriques (theoretical approaches)*.



Figure 6. Evolution of Categories Found in Maps Along the Four Stages



we can think of this as the result of an authentic group negotiation in which group identity was formed.

We conclude with two additional remarks, which are clearly acts of interpretation. Firstly, some categories suggested by participants seem to appear and persist, e.g., *Droit*,

becoming *Regime juridique* (law becoming legal regime), or, on the contrary, seem to disappear abruptly e.g., *Acteurs* (actors), as if the group strongly adopted or rejected them. This appearance/disappearance of the categories could be related to the trajectory of the members who made the suggestion. Secondly, one category, *KM pourquoi* (*KM why*) appears as early as at stage 2 and then disappears before being re-introduced in the very final stage, as if the group had difficulty to find an agreement and decided as a last resort to adopt the suggestion of one member. We could interpret this situation as a sign that this member moved from peripheral to more central participation.

These observations support the following arguments: for one thing, the spatial structure and the hybrid structure of the maps have facilitated collaboration and negotiation as they let different structures co-exist during the negotiation process and probably facilitate the internalization / externalization dialectics (Vygotsky, 1978). For another thing, knowledge was truly constructed as a set of relations: the relations between the group participants as well as the relations between them and the “knowledge objects”.

### Organizational Constraints

Our experience made evident a number of technical and organizational drawbacks associated with working with information and communication technology, which affected the collaborative process.

A first source of problems arose from the fact that the servers were located in another institution. As both E.M.LYON and the other organization were very concerned with security, they both implemented hard and soft security procedures which created many difficulties in using some tools (chat, ftp, etc.). This aspect affected our data collection and the choice of focusing almost exclusively on the maps as a source of data, as we could not rely on chat transcripts or other forms of textual documents.

Mobilizing extra resources to assure the success of the virtual synchronous sessions was another challenge. The synchronous sessions were scheduled late in the afternoon and we had to assure that technical staff was still in the office just in case a problem occurred with the network or the workstations.

### Methodological Limitations and Future Work

This case study relies on descriptive information provided by a number of selected maps. This leaves room for important details to be left out, and creates a potential threat to our interpretation process and inferential statements. The focus on maps allowed an inductive identification of the processes underlying the construction of the maps themselves as well as their deductive specification- In future editions of the course, we are planning to complement the analysis of maps with qualitative and/or quantitative questionnaires to investigate aspects of socialization and collaboration that are insufficiently examined by relying on maps, and to add variables and greater weight to the case study.

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### ENDNOTES

- <sup>1</sup> The course has been hold from several years. This specific study was done only upon one group of students. Nevertheless most of the features presented here confirmed was what observed – tough less formally – during the different occurrences of the course.
- <sup>2</sup> As the students work in the French language, many features including the maps’ names are in French. We apologize for this but we do not want to alter too much of the data by translating all the names. When necessary we will give equivalents in ().

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