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Developing Interoperable Collaboration Services to Sustain Activities of Communities of Practice

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Abstract

Communities of Practice (CoPs) have attracted the interest of professionals and researchers as successful environments for enhancing, developing and improving practices through collaboration between their members. More and more, CoPs are choosing virtual environments and services to support their activities. However, recent research has underlined the lack of adequate scaffolding in terms of technical support and appropriate use of technology for communication and collaboration.

The paper argues in favour of a collaborative design methodology for the development of services based on new technologies, open-source or "open-source minded". Producing interoperable, evolutionary, flexible *and truly* collaborative services appears of major interest to sustain activities of distributed CoPs. The paper uses as a case study the description of collaboratively designed services addressing the needs of distributed CoPs within the European Project PALETTE[1]. The example of PALETTE shows that in complex project situations, collaborative design sustained by Actor-Network Theory is a helpful framework to reach the goals of the project.

Keywords

e-Collaboration; collaborative design; Communities of Practice; Actor-Network Theory; Interoperability; Web Services.

1. Introduction

Communities of Practice (CoPs) have attracted the interest of professionals and researchers as successful environments for enhancing, developing and improving practices through collaboration between their members. Reification of knowledge (i.e. making knowledge more explicit and accumulating it), negotiation of meaning (i.e. building common representation and understanding), and developing a common sense of identity through a common body of

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[1] PALETTE "Pedagogically sustained Adaptive Learning through the Exploitation of Tacit and Explicit Knowledge" is an *Integrated Project* supported by the IST programme of the European Commission (DG Information Society and Media, project no. 028038).

knowledge and practices (Wenger, 2002) are the distinctive activities that make CoPs a unique place for people to reflect and interact.

More and more, CoPs are choosing virtual environments and services to support their activities, either totally or partially. However, recent research has underlined the lack of adequate scaffolding in terms of technical support and appropriate use of technology for communication and collaboration (including web-based platforms, wireless communications, mobile devices and extensive use of multimedia contents), the lack of tools and virtual environments supporting real-life problem-solving, the lack of support to reify knowledge and make it accessible to community members, and, finally, the inadequacy of the current tools used in supporting the individual and organizational learning processes and identity building. In order for new tools to be usable and efficient, they have to be acceptable by each CoP and capable of adapting to a CoP existing virtual environment and evolving needs.

People gather into CoPs in order to share, develop and improve a common practice which is characteristic of the CoP domain. CoPs members may deal with a certain job (CoPs of project managers, nurses, IS architects, etc.), a specific activity within a job (CoPs of teachers involved in implementing new IT in their institutions, CoPs of hospital staff experiencing a new technique of care, etc.), or any other type of activity (CoP of mountain ski riders). Within a CoP, people interact through shared activities, most of the time, mediated through electronic devices, because CoPs members are scattered geographically and organisationally.

The main activities that take place among CoPs' members intend to:

- favour participation in common activities;
- enable elicitation and reification of knowledge;
- produce, share and manage common resources;
- create a sense of belonging;
- create a common identity,
- develop learning processes, both at the individual and the collective (organizational) level.

Collaboration is ubiquitous in sustaining activities in CoPs. With the growth of Internet adoption, more communities of practice interact through computers and networks. Such communities "have to resort to technologies that are not real substitutes for face-to-face interactions" (Wenger, 2002).

Thus, a CoP needs tools that share some common features, such as:

- being available anywhere;
- allowing flexible use, adapted to the skills of the members regarding technology;
- covering a range of document management functions;
- covering a range of information representation and modelling functions, providing a mean for creating a common ground;
- covering a range of knowledge management functions, related to the practice and the identity of the community as well as its learning activities;
- enabling communication, collaboration and cooperation in a way which is useful for the community, both inside and between the community and its environment,
- aallowing to understand, represent, enrich, and share members' expertise.

The paper argues in favour of a collaborative design methodology for the development of services based on new technologies, open-source or "open-source minded" (the usefulness and quality of which are qualified by users, not by proprietary developers). Producing interoperable, evolutionary, flexible *and truly* collaborative services appears of major interest to sustain activities of distributed CoPs in the future.

The paper is organized in the following way: section 2 describes the PALETTE project global objectives; section 3 provides details about two specific interoperable services designed and developed accordingly to the promoted approach and section 4 debates about the design method.

2. The PALETTE Project

Palette is a European project (http://palette.ercim.org) funded under the 6th framework program; its main goal is the facilitation and enhancement of both individual and collective learning through CoPs.

Cross-fertilizing pedagogical and technological advances, elaborating, implementing and validating new learning environments, enhancing knowledge building and sharing in CoPs are the main challenging issues of PALETTE. To reach this goal, a collaborative design approach has been adopted for the development of a *palette of services* to improve efficiency of collaborative learning in CoPs, in terms of:

- expressing, representing and sharing practices as well as authentic problems;
- debating and reflecting about the practices and about the life of the CoP;
- developing, reifying and exploiting knowledge inside and outside the CoP, and
- and facilitating engagement, participation and learning.

The main collaborative design activity consists in elaborating activity scenarios supported by Web applications called PALETTE services. The acceptability, usability and reusability of such scenarios are targeted for the benefit of the various CoPs acting as PALETTE partners.

The collaborative design approach adopted in the PALETTE project has been oriented toward identifying and fulfilling the CoPs requirements in term of Web-mediated interaction. Clearly, the needs of the CoPs are versatile and evolve with their life cycle. Generally speaking, no single Web application is sufficient to support any CoP in its various activities and evolution.

Two levels of interoperability have been identified and handled in the framework of the PALETTE project. They can be classified as:

- **Concurrent developer-supported interoperability**, which corresponds to the need to exploit simultaneously two PALETTE services or Web applications to support a specific action. As example, getting automatically semantic tags from a document being written using a Web editor. Such a requirement calls for a tight integration between two services, one of them being hidden to the end user. In that sense, it relies on a classical Web services integration carried out by the service developers. The REST mechanism has been chosen for this purpose in the PALETTE framework.

Figure 1 – Levels of collaboration within the PALETTE Project

- **Sequential user-targeted interoperability**, which corresponds to the need to exploit Web applications one after the other in the course of one activity. As example, reaching an agreement in discussing alternatives and then sharing the result of this negotiation in a common repository. Here, the interoperability requirements are more at the level of data format compatibility and import/export feature availability exploited directly by the end users. The current Web 2.0 mashup approach that is currently spreading (Liu *et al.* 2007) can help in providing a graphical integration of the services supporting successive actions in chained activities.

The Figure 1 summarises the different processes of collaboration that occur within PALETTE context. The example of sequential interoperability between two PALETTE services, namely CoPe-it! and eLogbook is presented in section 2 after a short introduction to these two services.

3. Interoperability of collaborative services within PALETTE: the example of two services

3.1 The case of CoPe_it!

CoPe_it! (http://copeit.cti.gr/) is a tool of the Web 2.0 era. It complies with collaborative learning principles and practices, and provides members of communities engaged in argumentative discussions and decision making processes with the appropriate means to collaborate towards the solution of diverse issues. It builds on an *incremental formalization* approach, achieved through the consideration of alternative *projections* of a collaborative workspace, and through mechanisms supporting the switching from one projection to another (Karacapilidis & Tzagarakis, 2007).

Argumentative collaboration can admittedly augment learning in many ways, such as in explicating and sharing individual representations of the problem, maintaining focus on the overall process, maintaining consistency, increasing plausibility and accuracy, and in enhancing the group collective knowledge. Designing software systems that can adequately address users' needs to express, share and reason about knowledge during an argumentative collaboration session has been a major R&D activity for more than 20 years. Technologies

supporting argumentative collaboration usually provide the means for discussion structuring and visualization, sharing of documents, and user administration. Generally speaking, they aim at exploring argumentation as a means to establish a common ground between diverse stakeholders, understand positions, surface assumptions and criteria, and collectively construct consensus.

When engaged in the use of these technologies, users have to follow a specific formalism; their interaction is regulated by procedures that prescribe and constrain their work. This refers to both the system-supported actions a user may perform, and the system-supported types of argumentative collaboration objects. In many cases, users have to fine-tune, align, amend or even fully change their usual way of collaborating in order to be able to exploit the system's features and functionalities. Such formalisms are necessary to make the system interpret and reason about human actions, thus offering advanced computational services. However, there is much evidence that sophisticated approaches and techniques often resulted in failures. This is often due to the extra time and effort that users need to spend in order to get acquainted with the system, the associated disruption of users' usual workflow, as well as to the "error prone and difficult to correct when done wrong" character and the prematurely imposing structure of formal approaches.

To address the above issues, CoPe_it! pays much attention to various *visualization* and *reasoning* issues raised in a collaborative learning context. Such a consideration is in line with the process of sorting and organizing through numerous relevant materials. CoPe_it! builds on a conceptual framework where the formality and level of knowledge structuring during argumentative collaboration are not considered as predefined and rigid properties, but as an adaptable aspect that can be modified to meet the needs of the tasks at hand. By the term formality, we refer to the rules enforced by the system. Incremental formalization is achieved through a stepwise and controlled evolution from a mere collection of individual ideas and resources to the production of highly contextualized and interrelated knowledge artefacts. This evolution is associated with a set of functionalities related to the: collection and sharing of knowledge items, exploitation of legacy resources, informal/semiformal argumentation, informal/semiformal aggregation of knowledge items, semantic annotation of knowledge items, formal exploitation of knowledge items patterns, and formal argumentation and reasoning.

In our approach, projections constitute the vehicle that permits incremental formalization of argumentative collaboration. A projection can be defined as a particular representation of the collaboration space, in which a consistent set of abstractions able to solve a particular organizational problem is available (see Figure 2). With the term abstraction, we refer to the particular knowledge items, relationships and actions that are supported through a particular projection, and with which a particular problem can be represented, elaborated and - ultimately - solved. CoPe_it! enables the switching from a projection to another, during which abstractions of a certain formality level are transformed to the appropriate abstractions of another formality level. This transformation is rule-based (rules can be defined by users and reflect the evolution of the community collaboration needs). According to our approach, it is up to the community to exploit one or more projections of a collaboration space.

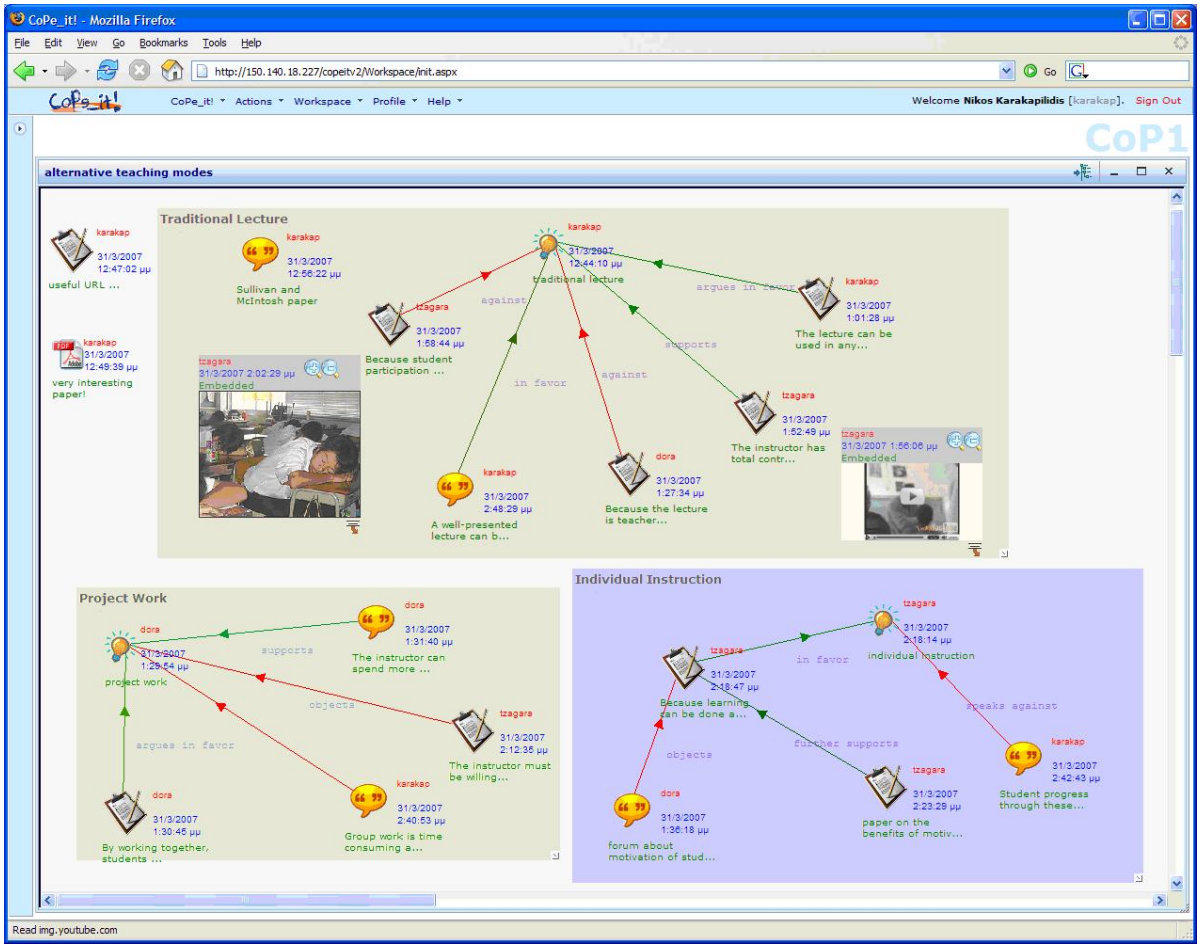

Figure 2 – An instance of a collaborative workspace in CoPe_it!

Finally, CoPe_it! reduces the overhead of entering information by allowing the reuse of existing documents, e-mail messages and entries of web-based forums.

3.2 The case of e-Logbook

The eLogbook Web 2.0 collaborative learning and knowledge management environment (Gillet *et al*. 2008) results from the PALETTE collaborative design approach and the thorough deconstruction of typical computer supported collaborative learning environments. The three main eLogbook features are:

- Full integration of and balanced focus between actors, activities or assets;
- Contextual user interface providing awareness and enabling privacy;
- Progressive appropriation and embedded evolution models for interaction.

Actors, activities and assets are the fundamental entities enabling and supporting collaboration and knowledge management in CoPs. An actor is any entity capable of initiating an event in the collaborative environment (e.g. people, Web services, agents or even online devices). An asset is any kind of resource (e.g. multimedia documents, wiki pages or discussion threads) shared between community actors. An activity is the formalization of a common objective to be achieved by a group of actors (topics, tasks). Events or actions related to these three main entities are governed by protocols.

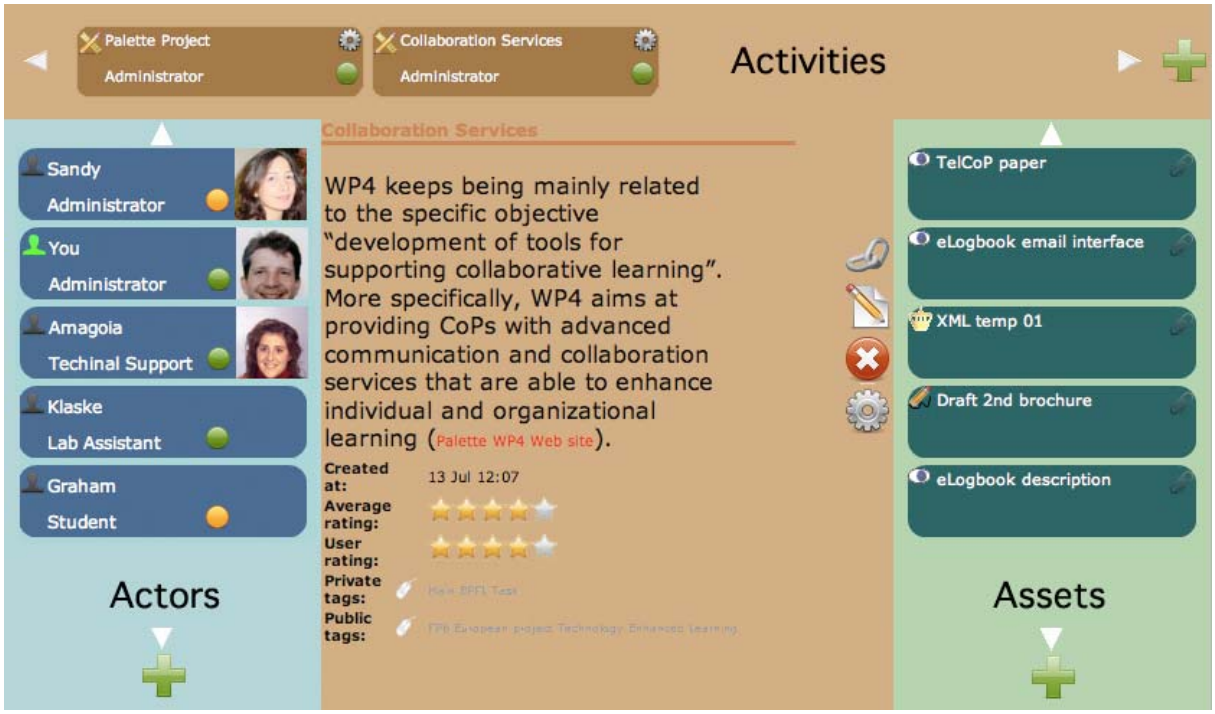

Figure 3: eLogbook context-sensitive Web 2.0 user interface.

The main eLogbook view is context-sensitive and integrates the three entities mentioned above. Its central region (see Figure 3) displays a focal element chosen by the user: either one of the three entities, or a deliverable. The three surrounding regions (left, top, right) display respectively the actors, activities, and assets related to the focal element. They also display the relationships between the focal element and these associated entities, and attach the possible related actions that the current user is allowed to perform. Awareness 'cues' of various types are seamlessly incorporated in every region through the use of symbolic icons, colours and display orders of information.

Figure 3 presents an example of the context-sensitive view where a specific activity is chosen as the focal element. The area surrounding this focal element is populated with the associated and complementary entities, contextually related. The view embeds different types of awareness that are important to the users. Entity descriptions can be altered using a Wiki-like editor. CoPs evolve dynamically within eLogbook by adding, updating or removing entities.

In addition to Web-based access, eLogbook also supports information delivery through a non-intrusive email-based interface. This alternative lightweight interface facilitates the appropriation of eLogbook by CoP members. Novice users can in fact share knowledge artefacts and be made aware of ongoing activities through their familiar email client software. It gives also easy access to eLogbook with smart phones or PDAs.

3.3 CoPe-it! and eLogbook interoperability

Efforts have been done on integrating eLogbook services into CoPe_it! in order to augment collaboration awareness in CoPe_it! [2], riven by the idea to provide a context-sensitive view as a complement to the CoPe_it! collaboration workspaces.

[2] A series of integration issues between CoPe_it! and eLogbook services is in progress; it is noted that this document is dedicated only to those related to awareness issues.

Satisfying CoPs needs might sometimes require a useful interaction between two different services. For instance, CoPs who have adopted CoPe_it! to support mediation and collaboration, might still benefit from the eLogbook context-sensitive view, which offers a high degree of contextualisation and seamlessly incorporates informal, conversation, task-based, presence and group structural awareness. This makes it very useful in situating the context of a discussion for a user and guide her in the decision making process. To make this view accessible for CoPe_it! usres, the following mapping was designed:

- A CoPe_it! discussion can be mapped to an eLogbook activity.
- Issues are also activities, each of which is linked to the discussion it belongs to with the link «issue».
- An alternative for an issue can be thought of as a deliverable for an eLogbook activity.
- A position in favour or against an alternative is an asset submitted to meet a deliverable with the comment «in favour» or «against» added. Documents attached to a position are attached to the asset as well.
- A position in favour or against a position is an asset linked to another asset, with the type of link being either «in favour» or «against».

When the user selects the option “Context-sensitive view” found on the workspace menu, CoPe_it! sends a request to eLogbook to do the mapping by calling eLogbook REST Services.

4. Collaborative Design as a Key Success Factor for sustaining collaboration in large multicultural projects

4.1 Collaborative vs Participatory Design

Participatory Design has been defined as a process of negotiation of usefulness (Abreu de Paula, 2004); this is achieved through reconciling the contrasting perspectives of various stakeholders, including users, designers and others. The main difficulty of Participatory Design remains the organization and management of an efficient participation – i.e. a participation that can truly influence the design process. Actors are heterogeneous in respect to their disciplines, preoccupations and interests: they do not speak the same "language". For them to interact necessitates that they construct together a "common ground". This is achieved through participative activities that mediate participation.

In projects where most of the working activities take place at distance, because of the geographical dispersion of partners, and of the organisational scattering of competencies among partners and countries, the distributed situation increases the difficulty of having "true" collaborative activity (see Zeiliger, 2007 about over reification in distributed communities). Synchronous activities, like virtual meetings, are supported by software applications that enable more or less participation. But asynchronous activities tend to unroll more on a workflow basis: a document is initialised by one researcher, and then posted in the project repository for being read and possibly completed by others. The problems occurring then are the following:

- if the first state of the document is already rather complete and well structured, it prevents the other from challenging it too much;
- some people see themselves rather involved in "downstream steps" and wait for the upper stream steps to be completed before involving themselves in the process (for example,

developers think they must wait for needs description before starting thinking about writing specifications); but this is not what is suggested in participatory design;
- some local sub-teams, who have opportunities to work face to face more often tend to go on quicker than the full team, thus presenting others members with a fait accompli. This situation, though advantageous for the rapid advancement of the project, may generate some frustrations among distant members.

It seems then that the collaboration is hampered by several factors:

- people's functions and primary competencies (whether they are more on the "user" side or on the "developer" side);
- the way people's perceive the moment where they "should" interact with the design process (linear life cycle vs participatory life cycle);
- the work at distance which amplifies the hindrances to participatory work.

Furthermore, the word "participatory" itself may not represent with enough strength the necessary requirement for a constant participation of all members all along the design process. Thus it might be psychologically more relevant to use other terms like "concurrent design" (in reference to "concurrent engineering"), or, more conveniently, collaborative design.

Collaborative design has been used mainly in the urban development, construction industry and industrial engineering (see for example Baskins et al., 1997). Also it has been used for IT development projects which are being developed through virtual teams working at distance, putting the stress on the collaborative resources that are used to support the design processes (see for example Arias, 2000; Fischer, 2001, Détienne, 2004; Gay). It seems to us that the situation within the PALETTE project, where collaboration is ubiquitous and takes place at different levels (see Figure 1), could be more successfully described and sustained by using collaborative design concepts and methodological tools.

4.2 ANT as a ground for Collaborative Design

In order to implement a collaborative design strategy and methodology in PALETTE there was decided to rely on Actor-Network Theory (ANT).

ANT[3] (Callon, 1999; Latour, 1992, 1996, 1999; Law 1992) provides a conceptual framework that sustains efficient participation of heterogeneous actor-networks in collaborative activities (Monteiro, 2000). Actors' heterogeneity is one of the ANT main originalities. An actor is first characterized by her capability to act and interact, i.e. her influence. ANT thus clearly acknowledges that a lot of "things" - humans and non-humans - do have an influence (McBride). The notion of participation is extended to take into account the participation/influence of non-human actors, such as artefacts and organisations, an obviously interesting feature when describing a socio-technical system.

ANT concepts seem appropriate for preparing collaborative design strategies (Esnault, 2006) that aim at aligning the interests of the actor-network, i.e. having all their influences fit together. The alignment of the network is obtained through the processes of enrolment, translation and inscription. Creating boundary-objects (Bowker and Star, 1999; Gasson,

[3] ANT was formerly the acronym for Actor-Network Theory. It is now used as itself [Latour 1999]. We will then use ANT as a name and not as an acronym

2006) facilitates mutual understanding and trust among participants with various backgrounds. A mock-up, a preliminary or intermediate version of the final product, a use-case or a scenario are classical boundary-objects.

The PALETTE actor-network is a dynamic entity which is made of all the heterogeneous actors and all the links that tie dynamically these actors for the purposes of the project. Translation and inscription are dual processes. In PALETTE, a successive number of translations are undertaken from CoPs to CoPs mediators, from services to services mediators, then to collaborative teams working together in producing scenarios of use (Esnault, 2006). The clarification of the notion of scenario was a collaborative activity in itself; several other collaborative activities were necessary to make explicit the representations/interests of the actors and progressively "inscribe" a definition and typical contents/forms of scenarios useful for all the actors, according to (Iacucci & Kuutti, 2002). A scenario regroups a set of activities, related services, data and meta data and the description of users' interfaces.

The CoPs activities are categorised into four main groups: enabling of commitment; management of common resources; support of activities; facilitation of learning processes.

For each category, one identifies a set of services and the necessary interaction between these services in order to support the activities. Three kinds of interaction are taken into account:

- *information exchange:* transmission of data and metadata between two or more services;
- *integration:* direct call to a service function from another service;
- *composition:* of functions belonging to other services.

The way data and meta-data will be shared and accessed by services is an important issue which raises several questions: is a common data repository needed? Do metadata and data need to be replicated in the different CoPs environments? Or should they be stored on the web to improve accessibility and sharing?

The integration at the user interface level will require semantic alignments between the terms and data structures. Reaching a high interoperability level between PALETTE services to avoid as much as possible specific coding, could possibly be solved by securing interoperability at the semantic level, by defining a common meta-model or ontology.

In PALETTE, significant progresses in collaborative design were made by using the collaborative tools and services developed within the project. For example, the collaborative writing of documents using a wiki (SweetWiki) contributed highly to enhance the satisfaction of groups in publishing documents that represent better the feelings and findings of the whole group.

5. Conclusion

PALETTE is a good example of a project where the concept of collaboration is evidenced at different levels. Research is undertaken collaboratively through multicultural research teams including people from social and education sciences and IT researchers with people involved in Communities of Practice. This collaboration takes places in a blended way, most of the time at distance, through e-collaboration tools and systems – both synchronous and asynchronous- and, from time to time, face-to-face. In PALETTE Actor-Network, the alignment of all actors' interests is tentatively achieved through a multiple loop collaborative design process aiming at designing and implementing activity scenarios. Interoperable

services are developed to support CoPs activities and in the same time used to support PALETTE collaborative activities as well.

The example of PALETTE shows that in complex project situation like this one, Collaborative Design sustained by ANT is a helpful framework, even if the implementation itself is a complex process, requiring several steps of alignment / translation / inscription loops before being able to reach the goals of the project. This requires a lot of efforts from the entire actor-network. The influences of the different types of actors (users, developers, designers, project management, tools, standards, services, uses, etc.) are never totally balanced; some actors are more "powerful", depending on the project stages; they tend then to over-influence the others and try to act as "attr-actors" to align the interests in their favour. Also, the size of the actor-network hampers the looping process, thus making it more difficult to improve the real participation of the whole actor-network in all the activities during the whole process.

There are still some of steps to achieve in order to fully implement the interoperability of services and better understand how to support practice development and activity growth in Communities of Practice. Nevertheless, we think we are now more aware of the importance of collaborative design in this kind of context.

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