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Preface

TEL-CoPs'06 (http://palette.cti.gr/workshops/telcops06.htm), the *1st International Workshop on Building Technology Enhanced Learning solutions for Communities of Practice*, was set up to promote and stimulate the exchange of knowledge on current research trends in technology enhanced learning solutions that aim at addressing the multiplicity and complexity of needs of Communities of Practice all along their lifecycle. The workshop advocated for approaches that build on the synergy of concepts such as multimedia information authoring and reuse, knowledge management, and argumentation. It aimed to bring together scientists and engineers who work on designing and/or developing the abovementioned solutions, as well as practitioners who evaluate them in diverse real environments. Particular interest was given to approaches that are built according to well-established pedagogical principles.

TEL-CoPs'06 was held in conjunction with *EC-TEL'06*, the *1st European Conference on Technology Enhanced Learning* (Crete, Greece, October 1-4, 2006). It was supported by and organized in the context of the *PALETTE FP6 IST project* (http://palette.ercim.org).

This volume contains 18 papers corresponding to the presentations given during the workshop. Out of 22 initial submissions, 12 were accepted as full papers and 5 as position papers. All papers were blind-reviewed by at least 2 members of the workshop's Program Committee**.** We are particularly happy to also include in this volume the paper of Chris Kimble, our invited speaker, entitled "Communities of Practice: Never Knowingly Undersold".

This volume would not have been completed without the active support of many persons. We first thank the authors of the included papers. Then, the members of the Program Committee for their help in the overall organization of this workshop, as well as their great effort during the reviewing process. The support of various PALETTE partners, and especially that of ERCIM, is acknowledged too. Our thanks also go to the organizers of EC-TEL'06, and particularly to Peter Scott, for hosting our workshop and helping us solve various administrative and organizational issues. Finally, we thank Elia Tomadaki for her valuable work towards nicely putting together the material included in this volume.

Nikos Karacapilidis
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Communities of Practice: Never Knowingly Undersold

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Abstract. This paper was prompted by the growing ambiguity about what is meant by the term Community of Practice and what such communities are supposed achieve. Like John Lewis' famous tag-line "Never Knowingly Undersold", the term "Communities of Practice" has proved to be both durable and capable of holding many levels of meaning and seems like an appropriate metaphor for the way that the term Communities of Practice is used by some.

This paper will show how the use of the term has changed from the early exploratory works of Lave and Wenger (1991), through the later, more theoretical, works of Wenger (1998a) to the current, more "business friendly", version propounded by Wenger, McDermott and Snyder (2002). It will argue that, just as when buying goods from a retailer, when dealing with the Community of Practice, one should also follow the dictum 'let the buyer beware'.

1 Introduction

Communities of Practice are an area of increasing interest for academics, consultants and practitioners. Perhaps this interest is not too surprising: they provide a useful socio-cultural description of the process of the creation and reproduction of knowledge, an account of agency and structure that can be applied to the business environment, as well as a social constructivist theory of learning applicable to groups. However, the very utility and popularity of the term has lead to it being used in a variety of different, and potentially conflicting, ways. This, in turn, has lead to an increasing number of articles that are critical of the way in which the term is used.

For example, in an earlier paper (Kimble & Hildreth, 2004) we questioned the applicability of the concept both to the modern business world in general, and to the virtual world of distributed working in particular. Similarly Cox (2005) offers a critical review of four different interpretations of Communities of Practice from the viewpoint of a management ideology while Roberts (2006) examines the limits of the usefulness of the concept and identifies the different ways in which it is used by management academics. This paper will continue that debate by examining the evolution of the concept of Communities of Practice during three key periods of its development.

The body of the paper is taken up with a review of literature on Communities of Practice. It begins by considering, principally, the two works from 1991 that first introduced the term: "Situated Learning: Legitimate Peripheral Participation" (Lave & Wenger, 1991) and "Organizational Learning And Communities of Practice" (Brown

& Duguid, 1991). This is followed by an examination of Wenger's later work centred around "Communities of Practice: Learning, Meaning, and Identity" (Wenger, 1998a) and concludes with some of the more recent 'consultancy based' work of Wenger such as "Cultivating Communities of Practice" (Wenger et al., 2002).

Following the lead of Cox (2005) and Roberts (2006) this takes an analytical approach to the literature and provides, for each period:

1. Some background to the period under examination. Here the aim is to place this particular view of Communities of Practice in its historical context.
2. An analysis of the way in which the term is used. Essentially we ask 'what is a Community of Practice, what does it do and how does it work?'
3. A summary of the key features of the view of Communities of Practice from this particular period.

The concluding section of the paper will offer some general observations on the way in which the usage of the term in the literature has changed and some advice to reader of that literature.

2   Never Knowingly Undersold

The claim "Never Knowingly Undersold" is one that has been used continuously since 1925 by the John Lewis Partnership, a chain of upmarket department stores in the UK. Essentially, it states that if a customer can buy the same item cheaper elsewhere, John Lewis will refund the difference.

The phrase "Never Knowingly Undersold" has been in constant use for over 80 years and has proved a durable and eye-catching headline, however, the claim is not quite so straight forward as it seems. The comparison must be with *exactly* the same product (brand, model, colour, size etc) which both John Lewis' and the competitor must hold in stock. Crucially for the 21st century world of retailing, the guarantee does not apply to web based companies and, more subtly, the type of goods offered by the John Lewis Partnership tend to be 'top of the range' goods with specialist service contracts so that the number of valid comparisons a customer can make is somewhat limited.

Notwithstanding this, the phrase "Never Knowingly Undersold" has been emulated by countless other businesses. Perhaps one explanation for this success is that it seems to signify certain desirable qualities (e.g. a guaranteed 'best buy' from an upmarket store) even when, on closer inspection, this is not all that it seems.

Some critical reviews have suggested that the term Communities of Practice shares similar properties to this slogan. For example, Fox (2000) suggests that viewing an organization as a community of practice can help deflect attention away from more contentious issues because, as Liedtka (1999) notes:

> *"... to see a business organization as a community of practice is to see it as held together by a shared concern for both the outcomes it achieves for stakeholders (be they customers or shareholders) and the personal development and learning of its members" (Liedtka, 1999, p 7)*

Similarly, Gherardi, Nicolini and Odella (1998) note that the 'positive, virtuous and consensual overtones' of the term can mask the tensions inherent in interactive social

learning. Although, this consensual view of shared goals and shared concerns, which occurs more often in the later literature, is not necessarily wrong, it is in conflict with some of the early views, as Henriksson (2000) points out:

> *"Quite contrary to their intentions, the metaphor* [of community] *downplays the very dynamic tensions, struggles and pluralism that Lave and Wenger in their original book seemed to wish to convey."* *(Henriksson, 2000, p 10)*

While such disparities may not be a problem to (for example) consultants trying to sell their expertise, they are much more fundamental to the work of the academic and it is these subtle distinctions of meaning that this paper sets out to explore.

3   The Early Period (1991 – 1995)

3.1   Historical Context

Many of the current notions of Communities of Practice first originated in the late 1980s in the Work Practice and Technology group at the Institute for Research on Learning (IRL) at the Xerox Palo Alto Research Centre (PARC). The research in IRL at PARC brought together ideas from several different academic disciplines and occupational backgrounds and consisted of an interdisciplinary group of researchers that included Lucy Suchman, Jean Lave, Etienne Wenger, John Seely Brown and Paul Duguid.

For many years, what were termed Behaviourist Models of learning had been dominant. These held that learning was principally concerned with the process of transmission of knowledge from teacher to learner; essentially, knowledge was viewed as an object that could simply be "transferred" from one person to another. However, during the 1970s and 1980s there began to be an increasing interest in what were called Social Constructivist models of learning. These saw learning not as a process of transmission of knowledge from one individual to another, but as a process in which knowledge was mutually "co-constructed". Much of the conceptual basis for these theories were founded on the work of Vygotsky (1978) who was concerned with the ways in which individuals learn within communities. Vygotsky believed that knowledge was socially constructed through collaboration and interaction in activities and used the notion of a Zone of Proximal Development (ZPD) to describe the way in which a learner interacts with others in a particular activity.

The two key texts that we will consider from this period were both published in 1991. The first, by Lave and Wenger (1991), is "Situated Learning: Legitimate Peripheral Participation"; the second by John Seely Brown and Paul Duguid is "Organizational Learning and Community of Practice: Toward a unified view of working, learning, and innovation" (1991). Both of these works have much in common and share much of the same source material (e.g. (Cain, Unpublished), (Marsall, 1972), (Lave, 1988), (Jordan, 1989), (Orr, 1990b) and (E Hutchins, 1991)) and although they both approach Communities of Practice in slightly different ways, they are both primarily concerned with theories of learning.

3.2   Situated Learning: Legitimate Peripheral Participation

The focus of the book is on informal learning in social situations; the book mainly drew on previously conducted studies of Liberian tailors, Mayan midwives, non-drinking alcoholics, butchers in supermarkets and navy quartermasters.

3.2.1   What is a Community of Practice?

The main objective of Lave and Wenger's work was to explore an alternative theory of learning to that of the dominant behaviourist models. At this point, they were content to leave the definition of a Community of Practice as a largely intuitive notion (Lave & Wenger, 1991, p 26) considering the value of their description of a Community of Practice to be primarily as a heuristic device that could highlight issues that had previously been overlooked. One the most frequently cited definitions of a Community of Practice comes from this work and describes a Community of Practice as:

> *"... a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping Communities of Practice." (Lave & Wenger, 1991, p98)*

It continues

> *"A Community of Practice is an intrinsic condition for the existence of knowledge, not least because it provides the intrinsic support necessary for making sense of its heritage ... the social structure of this practice, its power relations, and its conditions for legitimacy define possibilities for learning." (Lave & Wenger, 1991, p 98)*

3.2.2   What does it do?

Lave and Wenger (1991) were primarily concerned with situated learning, and their notion of a Community of Practice is closely related to this. It is largely based on the idea of learning through apprenticeship. A Community of Practice is seen as a mechanism for the reproduction of existing knowledge through active engagement with others in some form of 'practice'. Viewed in this way, learning is essentially the process of socialisation into a community.

Over time, the knowledge that is acquired in these communities begins to constitute both a sense of identity of oneself (as a member of that community) and becomes part of one's identity in the eyes of the others. Consequently learning becomes part of *"... generative social practice in the lived in world"* (Lave & Wenger, 1991, p 35).

Lave and Wenger call this complex reciprocal interrelationship between the practice and participation "mutually constitutive" (Lave & Wenger, 1991, p 117). Such communities are described as "enacted", that is that members can be thought of as 'performing' or 'improvising' their roles in the community as they go about their everyday activities (Tsoukas & Chia, 2002).

3.2.3   How does it work?

Lave and Wenger use the concept of Legitimate Peripheral Participation (LPP) to describe the underlying process of how this division of labour and responsibility is achieved.

>*"Legitimate Peripheral Participation provides a way to speak about relations between newcomers and old timers and about activities, identities, artefacts, and communities of knowledge and practice" (Lave & Wenger, 1991, p 29)*

By connecting participation and meaning, Lave and Wenger take Communities of Practice beyond a simple forum for learning and link membership of a Community of Practice to aspects of the members' social identity. Based on Cain's observations (Cain, Unpublished) of Alcoholics Anonymous meetings Lave and Wenger (1991, pp 79 - 84) illustrate many of the aspects of how LPP allows a Community of Practice to function.

In an Alcoholics Anonymous meeting, members tell stories that are a means of reinterpreting the past, understanding the present and visualising the future in terms of an alcoholic's identity, the ultimate goal being to conceive of oneself as a non-drinking alcoholic. Stories are told, retold and elaborated as the novice moves from peripheral to full participation in the community.

3.3 Organizational Learning and Communities of Practice

Brown and Duguid's (1991) discussion of Communities of Practice is mostly based on Orr's ethnographic studies of service technicians in Xerox (Orr, 1987, 1990a, 1990b). As the full title implies, the goal is to bring together theories of working, learning and innovation in order to provide new insights into organizational learning and the role of communities in the workplace.

3.3.1   What is a Community of Practice?

The starting point for Brown and Duguid's (1991) discussion of Communities of Practice is the difference between the way an organization describes a person's work and the way the work is actually carried out in practice. The former they describe as "canonical practice" and the latter as "non-canonical practice". Their aim is to show how, when canonical accounts of work break down, Communities of Practice continue to get by through improvising new solutions.

They describe Communities of Practice as interstitial communities that exist in the 'gaps' between work as defined, and the tasks that need to be done. They use the term to describe groups that are (a) fluid and dynamic *"... constantly adapting to changing membership and changing circumstances"* (Brown & Duguid, 1991, p 41); *(b)* emergent *"That is to say their shape and membership emerges in the process of activity, as opposed to being created to carry out a task "* (Brown & Duguid, 1991, p 49) and most crucially (c) exists, *"... outside the organization's limited core world view"* (Brown & Duguid, 1991, p 51).

3.3.2   What does it do?

Brown and Duguid argue that most organizations believe (or wish to believe) that complex tasks can be mapped onto a simple canonical 'map' that workers can follow without the need for either understanding or insight.

>*"Through a reliance on canonical descriptions (to the extent of overlooking even their own non-canonical improvisations), managers*

> *develop a conceptual outlook that cannot comprehend the importance*
> *of non-canonical practices." (Brown & Duguid, 1991, p 42)*

They argue that the reality of the technician's work is far more complicated and is as much about maintaining social relations with their customers and peers as it is about machines; consequently,

> *"... the reps must - and do - learn to make better sense of the machines*
> *they work with than their employer either expects or allows." (Brown*
> *& Duguid, 1991, p 43)*

Thus, in addition to the maintaining social relations, Communities of Practice also serve:

> *"... to protect the organization from its own shortsightedness" (Brown &*
> *Duguid, 1991, p 43)*

3.3.3   How does it work?

Brown and Duguid acknowledge the role of LPP in fostering learning (Brown & Duguid, 1991, p 48) but highlight three overlapping categories of their own - "narration", "collaboration" and "social construction" - which they claim get to the heart of the way these communities work.

Narration reflects the complex social web within which work takes place: stories have a flexibility that makes them both adaptable and particular. Collaboration is based on the exchange and elaboration of shared narratives, both across the organization and within communities. Finally, turning to Social Construction, Brown and Duguid comment:

> *"Simultaneously and interdependently, the reps are contributing to the*
> *construction and evolution of the community that they are joining what*
> *we might call a "community of interpretation", for it is through the*
> *continual development of these communities that the shared means for*
> *interpreting complex activity get formed, transformed, and*
> *transmitted." (Brown & Duguid, 1991, p 47)*

The collaborative telling and re-telling of stories contributes both to the construction of a technicians' own identity, and reciprocally to the construction and development of the community in which they work.

3.4   The Concept of a Community of Practice in the Early Period

Although there are some obvious differences in the focus of Lave and Wenger (1991) and Brown and Duguid (1991) both agree about what sort of group Community of Practice is and why they exist. For both sets of authors, Communities of Practice are seen as being primarily concerned with learning and Communities of Practice are seen as autonomous groups

Given the context from which the idea of Communities of Practice emerged, it is perhaps not too surprising that there is such a clear focus on learning. Although the precise mechanism by which this learning takes place is not always clear, the general

thrust of the argument is that knowledge is not an abstract, immutable object that can be passed from one person to another but is situated, mutable and socially constituted. The process of learning is seen as one that is ongoing; over time, meanings are contested, negotiated and re-negotiated through participation, both in the community and in the practice. The learning that takes place is based on a particular activity performed in a particular community; consequently, what is learnt in that community might only be seen as being valid within that community.

Perhaps less obvious is the degree to which both see Communities of Practice as essentially 'autonomous groups'. Both see Communities of Practice as being outside the 'formal' organization: Brown and Duguid (1991) deal with interstitial communities while Lave and Wenger (1991) focus on learning outside of the formal constraints of the classroom; but beyond that both see them as being somehow self generating and existing primarily for the benefit of their members. Lave and Wenger (1991) describe how

> *"... agent, activity, and the world mutually constitute each other" (Lave & Wenger, 1991, p 33)*

while Brown and Duguid (1991) use Daft and Weick's (1984) notion of "enactment" to describe how:

> *"... their shape and membership emerges in the process of activity, as opposed to being created to carry out a task" (Brown & Duguid, 1991, p 49).*

For both, Communities of Practice are seen as being 'wild' or 'untamed' in the sense that one might view a wild animal: they exist independently of the formalised world of organizations and are driven by their own internal needs.

4   The Middle Period (1996 – 1999)

4.2 Historical Context

The area of key concern in the earlier papers was what was seen as outmoded and inappropriate models of learning. The underlying theme for this next period in Community of Practice literature is the pre-millennium sense of optimism that the economy and perhaps society in general, was undergoing a fundamental shift. For at least 30 years, authors such as, McLuhan (1964, 1989), Ellul (1964), Toffler (1972, 1980) Bell (1974) and (Hiltz & Turoff, 1978) had been predicting radical social change driven by technological change and for some things finally seemed to have reached a tipping point in the 1990s.

For a variety of reasons, the 1990s were a period when Big Business was looking for Big Ideas. Probably the most obvious manifestation of this was the "dot-com fever" of the late 1990s when stock market speculation and hype inflated the value of small hi-tech start-up companies (known colloquially as dot-com companies), to astronomical levels. The NASDAQ Composite index, which traded heavily in such companies, increased by more than 500% between 1994 and 2000 and many executives and employees of such companies, who were partly paid in stock options, became instant millionaires.

One of the readily identifiable "Big Ideas" of the period was "Knowledge Management". Prusak (2001) states that the term was first used in early 1993 although others argue that it was first used in the Journal 'Public Administration Review' as long ago as 1975, (e.g. Goerl, 1975). Whatever the truth is, it is clear from studies of bibliographic data such as Serenko and Bontis (2004) and Ponzi and Koenig (2002) that widespread interest in knowledge management did not really begin to grow until the mid 1990s. As Hildreth, Wright and Kimble (1999) point out, much of this interest was fuelled by globalisation, downsizing and outsourcing, each of which has implications for the rate at which organizations lose knowledge and the efficiency with which they can manage existing knowledge.

It is against this background that the works of the middle period should be considered. All of the works from this period have Wenger as the sole author and cover the period between his earlier collaboration with Lave and his later collaboration with Snyder and McDermott. The principle work we will consider here is Communities of Practice: Learning, Meaning, and Identity (Wenger, 1998a).

4.3 Communities of Practice: Learning, Meaning and Identity

In the opening pages of this book Wenger makes it clear that he is keen to establish the intellectual foundations of his work (Wenger, 1998a, p 11). The source material for the book is drawn from an ethnographic study of clerks in a medical insurance claims processing office. In this book, Wenger elaborates some of the terms from his earlier work (e.g. identity and participation), abandons others (e.g. LPP) and introduces some new ideas (e.g. dualities).

4.3.1   What is a Community of Practice?

In contrast to his earlier, more 'intuitive' definitions of a Community of Practice, Wenger now provides a much more concise definition of a Community of Practice that consists of just three interrelated terms: "joint enterprise", "mutual engagement" and "shared repertoire" (Wenger, 1998a, p 72 - 73). Here Wenger is much more concerned with Communities of Practice in the context of a formal organization:

> *"Communities of Practice are ... a different cut on the organization's structure - one that emphasizes the learning that people have done together rather than the unit they report to, the project they are working on, or the people they know." (Wenger, 1998b)*

In essence, Wenger now argues that Communities of Practice arise out of a need to accomplish particular tasks although, as before he continues to view them as self-directed and self-organizing systems.

> *"Communities of Practice ... reflect the members' own understanding of what is important. Obviously, outside constraints or directives can influence this understanding, but even then, members develop practices that are their own response to these external influences. Even when a community's actions conform to an external mandate, it is the community - not the mandate- that produces the practice" (Wenger, 1998b).*

4.3.2   What does it do?

A Community of Practice is a forum where learning, meaning and identity are negotiated; it is through practice in particular that we experience the world in a meaningful way, as practice "*gives structure and meaning to what we do"* (Wenger, 1998a, p 47).

Wenger's (1998a) view of a Community of Practice shares many similarities to Brown and Duguid's (1991). He sees part of the role of a Community of Practice being to make work habitable.

> *"a significant amount of the processors' communal energy goes into making their time at work a liveable realization of their marginality within the corporation and the insurance industry" (Wenger, 1998a, p 171).*

Similarly, he argues that they can contribute to the 'host' organization, although in contrast to Brown and Duguid (1991), the contribution is phrased in "Knowledge Management" terms:

> *"Communities of Practice are important to the functioning of any organization, but they become crucial to those that recognize knowledge as a key asset ... Knowledge is created, shared, organized, revised, and passed on within and among these communities." (Wenger, 1998b)*

Finally, like Brown and Duguid's (1991) "collective of communities", Wenger (1998a, p 127) views the organization as a "constellation of communities".

4.3.3   How does it work?

Unlike his earlier collaboration with Lave (Lave & Wenger, 1991), LPP no longer features in the explanation of how Communities of Practice function, now Wenger argues that all of the activities in a Community of Practice can be described in terms of the interplay of four fundamental dualities which he describes as:

> *"... a single conceptual unit that is formed by two inseparable and mutually constitutive elements, whose inherent tensions and complementarity give the concept richness and dynamism" (Wenger, 1998a, p 66)*

The four dualities Wenger identifies are participation-reification, designed-emergent, identification-negotiability and local-global, although the participation-reification duality, with its strong connection to Knowledge Management, that has been the focus of particular interest. Wenger argues that Communities of Practice can contribute to the knowledge assets of an organization both through the knowledge they develop at their core, and through the interactions at their boundaries. It is participation that plays a crucial role in the creation of knowledge in the core while reification has a particular importance for interactions at the boundaries of the community.

4.4 The Concept of a Community of Practice in the Middle Period

In line with Wenger's stated aim of establishing an intellectual foundation for his work, some of the vagueness of the earlier descriptions has been removed and the ideas behind a Community of Practice are generally presented in a more direct and analytical way.   However, in many ways Wenger (1998a) bears some striking similarities to Brown and Duguid (1991).

While informal learning in social groups is still an important feature, it is now only considered in the context of formal organizational settings. All of the examples are taken from the workplace. Like Brown and Duguid (1991), the wider organization is viewed as consisting of a collection of inter-related communities and like Brown and Duguid (1991), Wenger (1998a) appears to view Communities of Practice as acting both as support systems for employees whilst simultaneously providing a benefit to the organization that contains them. Essentially this represents a move away from viewing Communities of Practice as a way of gaining insight into social leaning towards viewing Communities of Practice as a means of problem solving and sense-making within an organization.

The nature of a Community of Practice has also changed in another way. In the earlier works, there was little or no consideration of the world outside the community. Wenger (1998a) however is more explicitly concerned with this topic, particularly through his notion of reification.   Similarly, by the use of the notion of a "constellation of communities" and by stressing the value that Communities of Practice can bring to an organization, Wenger links what happens inside the Community to the wider social context within which it is embedded.

Finally, while it is still clear that Wenger sees Communities of Practice as being emergent, he suggest that Communities of Practice can be 'guided' or 'nurtured' in some way, for example.

> *"They self-organize, but they flourish when their learning fits with their organizational environment. The art is to help such communities find resources and connections without overwhelming them with organizational meddling." (Wenger, 1998b)*

However much of this comment concerns the role of internal leadership rather than external strategic interventions. This represents a shift from the previous view of "wild" Communities of Practice toward something that can be 'nurtured', but nonetheless, the view remains that Communities of Practice are essentially 'untamed'.

5   The Late Period (2000 – 2003)

5.2 Historical Context

Ponzi and Koenig (2002) in their article "Knowledge Management: Another Management Fad?" describe the way in which "fads" in the academic literature emerge quickly, are adopted with great zeal, then rapidly decline. They ascribe this behaviour to the way in which certain groups (consulting firms, 'management gurus', mass media, business schools, etc) initially proselytize on behalf of a particular technique only to drop it later when it becomes unfashionable. They describe how Quality Circles, Total Quality Management and Business Process Reengineering have

all followed this pattern and how Knowledge Management looks destined to follow them. It is against this idea of fads and fashions in management literature that we should consider the literature in this final section of the paper.

The preface to Cultivating Communities of Practice (Wenger et al., 2002) provides a clear illustration of the how the author's viewed the situation before the book was written. In an echo of Davenport's (1996) description of the growth of Business Process Reengineering they write how when they first met it seemed like *"the planets ... were aligned"*. All three were active management consultants and *"interest in Communities of Practice was exploding"*, for the authors it seemed that their book was destined *"... to provide a common foundation for this spreading movement"* (Wenger et al., 2002, p x).

However, within a few years it seemed the situation had changed. McDermott was writing articles entitled "How to avoid a mid life crisis in your CoPs" (McDermott, 2004) and a new wave of articles critical of the whole CoP approach were beginning to appear. Ponzi and Koenig (2002) indicate that the only real difference between a fashion and a fad is that fashions briefly show signs of maturity before declining. It is argued that these later works can be interpreted as attempts to demonstrate the 'maturity' of the CoP concept to delay the inevitable decline that must follow the initial evangelical zeal of the recent convert.

5.3 Cultivating Communities of Practice

The main work we examine here is Cultivating Communities of Practice (Wenger et al., 2002) however we will also include a number of later works, such as (Wenger, 2000), (Wenger & Snyder, 2000), (Snyder *et al.*, 2003), (Snyder & Briggs, 2003), (McDermott, 2004) and (Wenger *et al.*, 2005), which illustrate more clearly the way in which the focus of the Communities of Practice literature has changed during this period.

5.3.1   What is a Community of Practice?

Unlike his earlier book, this is not a theoretical work but is aimed specifically at practitioners; consequently, the majority of the book is given over to tips on how to cultivate Communities of Practice rather than an analysis of them. Thus Wenger, McDermott and Snyder (2002) simply state that although Communities of Practice can take many forms

> *"... they all share a basic structure ... a unique combination of three fundamental elements" (Wenger et al., 2002, p 27)*

Which are a domain of knowledge, a notion of community and a practice. In later a work, Wenger and Snyder describe Communities of Practice as:

> *"... groups of people informally bound together by shared expertise and passion for a joint enterprise* [which can] *drive strategy, generate new lines of business, solve problems, promote the spread of best practices, develop professional skills, and help companies to recruit and retain talent" (Wenger & Snyder, 2000, pp 139 - 140)*

while, Snyder and Briggs state that:

"Communities of practice steward the knowledge assets of organizations and society. They operate as "social learning systems" where practitioners connect to solve problems, share ideas, set standards, build tools, and develop relationships with peers and stakeholders." (Snyder & Briggs, 2003, p 7)

5.3.2   What does it do?

Wenger, McDermott and Snyder state that they will concentrate on *"... the ability of Communities of Practice to steward knowledge inside organizations"* (Wenger et al., 2002, p 219). There is a similarly emphasis in all of the literature from this period on the role that Communities of Practice can play in Knowledge Management, for example Snyder, Wenger and Biggs (2003) argue that Communities of Practice *"... complement formal units and help organizations weave critical connections across formal groups to leverage knowledge for performance"* (Snyder et al., 2003). However, it is also clear that there is now a far grander plan for CoPs. The preface to the book states that:

"We share a vision that Communities of Practice will help shape society [and] provide new points of stability and connection in an increasingly mobile, global and changing world" (Wenger et al., 2002, p xii)

The final chapter of the book lays out that shared vision:

"The principles that apply to our businesses ... also apply to the challenges faced by our society. The socioeconomic requirements for sustained prosperity ... demand that we apply these principles beyond the private sector." (Wenger et al., 2002, p 224)

In similar style, Snyder & Briggs (2003) tackle the role that Communities of Practice could play in government, reducing "red tape" by cutting across bureaucracies that are *"... designed to solve stable problems for established constituencies through centrally managed programs"* (Snyder & Briggs, 2003, p 4).

5.3.3   How does it work?

The issue of how a Community of Practice functions is not really dealt with in this book or the related literature: it is mostly taken as given that Communities of Practice can achieve what the authors claim. However, Wenger, McDermott and Snyder (2002) do offer a variation of the five stages of development identified in (Wenger, 1998a), and describe a five stage 'life cycle' for CoPs.

Although the authors state that their model should not be taken too literally, there is no mistaking the inevitable sense of progression. Each stage addresses a particular issue that is described as *"... a tension between two opposing tendencies that the community must address before it can move on to the next stage"* (Wenger et al., 2002, p 69), and at each stage the authors offer a convenient range of strategies that can be deployed to achieve this.

5.4 The Concept of a Community of Practice in the Late Period

The concept of a Community of Practice in the late period represents a profound move away from earlier notions of Communities of Practice. Vann and Bowker

(2001) describe this as the commercialisation or commodification of the concept although Cox sums up the transformation more succinctly as

> *"The reinvention of Communities of Practice as a managerialist concept" (Cox, 2005, p 534)*

This is represents a major change in the way in which the term Community of Practice is understood.   Firstly, Communities of Practice have now become manageable and unambiguously of benefit to the organizations that take the effort to do so. Although most of the literature from this period warns of the difficulty of managing Communities of Practice and some warns that Communities of Practice cannot be mandated, there is near universal agreement that, given the right degree of insight, skill and leadership, Communities of Practice can be made to deliver. As Wenger and Snyder put it *"These tasks of cultivation aren't easy, but the harvest they yield makes them well worth the effort"* (Wenger & Snyder, 2000, p 140).

Secondly, Communities of Practice are now directly linked the 'management' of knowledge, although there are few direct references to the term Knowledge Management. Instead, the term most often used is "stewarding" knowledge. Exactly what is meant by "stewarding" is never defined. The implication seems to be that Communities of Practice will act as "custodians" or "guardians" of knowledge on behalf of their host organization; thus, simultaneously avoiding any notion of the communities actually owning the knowledge and avoiding the use of the now slightly passé term Knowledge Management.

Finally, there is an explicit view that Communities of Practice can be geographically distributed and can even benefit from having a technological infrastructure to support their activities (e.g. Wenger et al., 2005).   This is a significant change from the earlier works where the topic was hardly mentioned. Although, like the difficulty of 'managing' communities, creating effective distributed Communities of Practice is not claimed to be easy, it is now seen as possible and even desirable for distributed communities of several hundred members to exist.

Communities of Practice have become CoPs and CoPs have become a means to an end - CoPs are now not only 'cultivated' but have also been tamed.

6   The Changing Concept of a Community of Practice

Since the term was first coined in 1991, it has undergone a number of significant changes. It is also clear that the final period of literature represents the most profound shift in the way that the concept of a Community of Practice is used.

"Communities of Practice" have undergone a transition from being a heuristic device to a theory and from a theory to an application. At first sight, this might appear to be perfectly natural, as this path is one often followed in the natural sciences - hypotheses are generated, a theory is developed and later the theory is applied. However, in this case, there not linear progression but a dislocation between the theory developed in the early work and that which is applied later.

In the early work Communities of Practice were seen as being, to borrow a metaphor from Hutchins (1996), "in the wild" in the sense that they existed outside

the systematised, planned and well ordered word of the formal organization. However, in the later works the metaphors that are used are those of "cultivation" and "harvesting": Communities of Practice have simply become a tool that can be used to produce a particular outcome; much of the early theory concerning emergence, enactment and the ambiguous nature of the relationship between community and host organization has been lost.

This is more than a semantic nicety or an indication that the concept that has reached maturity; it is a radical departure from the way in which the concept was previously used. In the work from the middle period, Wenger used the notion of reification to explain how the ideas and values of a Community of Practice could achieve independent existence; here in the later works the notion of a Community of Practice seems to have achieved an existence independent of the theory that created it.

Although these changes have been a radical, this in itself need not be a problem. The whole raison d'être of concepts is that we use them as templates to structure and make sense of the world around us, and as the world changes, so must the concepts we use. There is nothing fixed about the way in which we use concepts, as Mutch (2003) notes:

> "... we can use familiar concepts in new ways, or take concepts from one context to another and play with them"

However, to quote Mutch again, as academics we must also

> "... pay careful attention to our sources, making sure that we give due care to the consequences that the use of a concept brings with it".

In highlighting this latter approach Mutch (2003) notes that it brings with it the risk of textual exegesis, dogmatism and the unthinking adherence to the received word. It is not my objective to engage in *"textual exegesis"*, nor to be excessively dogmatic about the way in which the term ought to be used, but simply to highlight some of the different ways in which it can be used and draw attention to the potential this has for misconceptions and confusion.

The literature on Communities of Practice is used in pedagogy and in educational theory, e.g. (Barab *et al.*, 2004; Janson *et al.*, 2004; Schwier *et al.*, 2004); what has come to be called "CoP Theory" offers useful insights into both Knowledge Management and Distributed Working, e.g. (Janson et al., 2004; Papargyris & Poulymenakou, 2003; Schwen & Hara, 2003) and what might be called the "community" is used in areas such as Computer Supported Co-operative Work e.g. (Sharratt & Usoro, 2003; Trier, 2005; Zacklad, 2003) and Distributed Team Working e.g. (Kindberg *et al.*, 1999; Pemberton-Billing *et al.*, 2003).

So, should we simply reject large slices of this work because it is based on a 'wrong' interpretation of the theory? The answer to this is almost certainly 'No'. However, lack of attention to the context in which the term was originally used can create contradictions without meaning to by, for example, conflating a theoretical account of a Community of Practice based on LPP with another based on the notion of dualities. We began this paper with a suggestion that the marketing tag-line "Never Knowingly Undersold" and the term "Communities of Practice" had certain similarities and that sometimes, the term Community of Practice did not mean what it might at first be thought to mean. Finally, at the end of the paper we turn again to our

original 'sales' metaphor and urge the reader to follow the advice 'caveat emptor' (or more accurately caveat lector) when dealing with this term in the literature.

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A Document Reuse Tool for Communities of Practice

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Abstract. With the rise of the Internet, virtual communities of practice are gaining importance as a mean of sharing and exchanging information. In such environments, information reuse is of major concern. In this paper, we outline the importance of enriching documents with structural and semantic information in order to facilitate their reuse. We propose a framework for document reuse based on an explicit representation of the logical structure as well as links to domain ontologies. Such explicit representation facilitates the understanding of the original documents and helps considerably in automating the reuse process. Document reuse automation is based on matching techniques that consider several criteria including semantic and logical similarities.

Keywords: Communities of practice**,** Document reuse, Self-describing documents, logical structure, semantics, Schema Matching.

1 Introduction

Communities of Practice (CoPs) are becoming more important as a mean of sharing information within and between organizations. A Community of Practice emerges from a common desire to work together; it can be defined as a network that identifies issues, shares approaches, methodologies, documents, experiences, and makes the results available to others [21]. With the rise of the Internet, virtual CoPs are gaining importance as a new model for virtual collaboration and learning. In virtual CoPs, the common space is provided by a suite of collaborative and communicative environments, ranging from simple mailers, forum, discussion lists, and audiovisual conferences to more advanced collaborative work environments that enable information and knowledge exchange and sharing.

In this context, the process of capturing and sharing a community's collective expertise is of major concern. In [6], author describes such process as a cyclic one composed by four basic steps: *find/create*, *organize*, *share*, and *use/reuse*. The "find/create" step concerns the creation of knowledge/information gained through research and/or industry experiences, publications, etc. The goal of the two next steps in the cycle, "organize" and "share", is to first filter and organise expertise (e.g.,

creating different categories of knowledge related to specific purposes, linking such knowledge with available resources).   Second, the expertise is shared for wide availability making use of the Internet and other techniques of information sharing such as conferences and collaborative work environments. The final phase of the cycle, "use/reuse," enables shared expertise to be used and reused in order to minimize information overload and maximize content usability which decreases considerably time, effort and cost. In this phase expertise is applied and reapplied to solve real-world problems. The results are then captured as part of learned lessons and new expertise is created which enables the cycle to begin again.

In this paper, we essentially focus on document reuse within CoPs. As in [15], we identified at least two kinds of document reuse: (1) by *replication*: from a single document, several presentations are produced; and (2) by *extraction*: portions of a document are taken from one document and moved to another (generally performed by means of the now popular "Cut&Paste" command).

Since documents reflect in general authors' vision and "understanding" of the Universe, document reuse process requires access to the intentions and interpretations underlying the original document. The capability of reuse suggests then the understanding of authors' representation of the Universe in term of concepts and semantic relationships among them. Such representations only exist "in the mind" of authors and usually are not apparent in the document itself. Moreover, when reuse requires crossing system and application boundaries, several problems arise due to the heterogeneities of such systems. One response to these problems is to structure documents by using Markup Languages such as XML [22]. The advent of structured documents on one hand leveraged a promising consensus on the encoding syntax for machine processable information and such resolves several issues, such as parsing and character encoding recognition. On the other hand, mark-up identifies meaningful parts of a document, and thus makes authors' intentions more explicit.

In this paper, we essentially address the second kind of reuse (extraction). We consider documents as an effective mean for storing explicit knowledge, and study the additional benefits of using structure and explicit representation of metadata and semantic information. This work is carried out in the framework of PALETTE project[1] aiming to provide communities of practice with a set of services concerning data production, exchange and reuse; reification of explicit and tacit knowledge about practices and advanced collaboration.

The outline of the rest of the paper is the following: Section 2 describes a motivating scenario based on the observation of LEARN-NETT community. Section 3 gives an overview of the benefits of structuring documents. Section 4 proposes a multi-layered

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model for documents that is built using annotation facilities. Section 5 gives the conceptual framework for the proposed reuse tool.

2 Motivating Scenario

To elucidate the need for document reuse, we present a simple use case using observations we made to LEARN-NETT[2] community. LEARN-NETT is a virtual campus aiming at conceiving and trying methodologies for training teachers (also called students) based on a learning-oriented approach [8]. Students produce either group documents (reports, etc) or individual documents (dissertations, individual reflections). Tutors in LEARN-NETT community have a central role in the organization and the regulation of the students' groups. More exactly, they help students to express their needs, animate the work of the group, provide resources, regulate exchanges, and give quick feedback. For this, tutors rely on a pedagogical guide and a set of references and resources. Tutors are supported in their activities by a project coordinator. The coordinator participates in the elaboration of pedagogical guides and tools for tutors. He also produces a weekly report summarizing the project progress.

Produced documents reflect actors' experience and expertise. In this context, reusing such expertise is of major concern. For instance, a student group aiming to solve a real-world problem could reuse the expertise of previous groups. Instead of producing reflections, reports from scratch, we could maintain a material pool consisting of definitions, theorems and their proofs, exercises, book chapters, dissertations, reflections and examinations. When a student is producing a new document, he (or she) could reuse this existing material which reduces considerably time and effort. Students' researches (e.g., dissertations and scientific papers) could also be reused for designing tools and pedagogical guides for tutors. The major problem to address while reusing such documents is their heterogeneities. Heterogeneity arises in general from the fact that each author creates its own documents according to specific requirements and goals.

Based on these observations, we essentially distinguish two categories of heterogeneities: *organisational (structural) heterogeneity* and *semantic heterogeneity*. Organisational heterogeneities [12], [13] and semantic heterogeneities [20], [16], [10] have been well documented in the literature with a consensus of what each encompasses. In most cases, the distinction between the two can be characterized by differences in organisation (*how are the data in the document is organised?*) and interpretation (*what do the data mean?*). This distinction however is not always clear, since the organization of data often conveys semantic information. Semantic heterogeneity refers to domain level incompatibility. Examples include the attribution of different names for semantically equivalent concepts and the attribution of the same name for semantically different concepts. Organisational heterogeneity arises

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[2] http://tecfa.unige.ch/proj/learnett/

when semantically similar entities are modelled using different descriptions. As an example, we can consider the organization of pedagogical units (using an ascending or a descending approach). An ascending approach presents to students concrete cases and tends to generalize them in order to extract a theory. This theorization supposes a good understanding of the real facts. In such a strategy, bricks representing examples of a concept are presented before bricks describing the theory of the same concept. Contrary to the ascending strategy, the descending one consists in presenting at first the theory, and then when this one is supposed to be understood, examples are presented in order to assimilate better the theory. The goals of the two strategies are the same, but the organisation of pedagogical units differs. Reusing documents suggests the capability to resolve such heterogeneities.

3   Structured document reuse

3.1   Why structuring documents?

Structured document refers to a document conforming to a pre-defined grammar or schema that describes the permissible document components and their logical organization [1]. XML is the mark-up language for presenting information as structured documents. The document structure (described in a DTD or more recently using an XML Schema [23]) can be utilized to facilitate several issues such as document authoring, document publishing, document querying and browsing, etc. Based on structure, it is easy to achieve replication. Different layout formats such as HTML (for Web sites), PDF (Printed documentation), WML (for wireless devices) could be generated automatically. However, dealing with structured documents has also some drawbacks. Reusing structured documents (by extraction) raises a number of fundamental problems to transform or to adapt their intrinsic structure. Structure transformation process is known to be extremely laborious and error-prone. It is typically attained by writing manually translators (often encoded on a case-by-case basis using specific transformation languages such as XSLT [24]). This is generally achieved trough three main steps: understanding the source and target schemas, discovering schemas' mapping by means of inter-schema correspondences, and translating mapping result into an appropriate sequence of operations in a given transformation language [14].

3.2   Schema matching

A serious obstacle for translating directly between two structured documents is that a mapping between both schemas needs to be carefully specified by a human expert. Manual mapping is known to be a time consuming and error-prone process. One response to this problem is *schema matching*. Schema matching is the task of semi-automatically finding correspondences between two heterogeneous schemas. Several applications relying on schema matching have arisen and have been widely studied by

the database, AI communities and more recently document engineering community [18], [7], [17].

Mapping two schemas is a very challenging problem. Solutions to this problem have produced two types of matchers: *structural matchers* and *semantic matchers*. Structural matchers typically map two schemas according to their syntactic clues. Examples of such clues include element names, types, and common logical structure. See our previous work [4] for more examples of syntactic matchers. However, such clues are often unreliable and incomplete. For example the same labels may be used for schema elements having totally different meanings. In such conditions, the main challenge is not to only determine existing relations between schema elements, but also making sure that the matching process does not discover incorrect mappings. Moreover using only structural matching, semantic mismatches are largely undressed. In contrast, semantic matchers rely on explicit knowledge generally stored within a domain ontology[3] in order to improve mapping accuracy. Although these approaches use semantics, its use is limited to taxonomic knowledge to determine, for example, that the term used in one schema generalizes or specializes a term in the other schema. As a result, structural mismatches are not addressed although the structure of a document often conveys semantic information and traduces the designer point of view. We believe that both the logical structure of the document and additional semantic information relating to a domain of interest, are important for both identifying reusable document fragments and adapt them according to user needs.

4 Re-thinking document structure

In open and evolving environments, such as the ones used by communities of practice, the number of shared and exchanged documents is increasingly growing. As noticed in the motivating scenario (section 2), exchanged documents are of various formats. Examples include totally unstructured (documents containing raw text expressed in natural language), semi-structured[4], text documents (containing structural information such as chapter, section, sub-sections, etc), and highly structured documents based on predefined schema. In this context, one of the huge challenges we face that is the automation of such documents' content reuse. This difficulty is due to the lack of explicit structure and knowledge.

To address this problem, we propose a "*self-explaining*" document model. A document is considered to be self-explaining if it contains an explicit representation of its logical structure and semantics. As in [9], we conceive this model as a multi-layered model. The layout layer (or physical layer) reflects document format and publishing characteristics. It answers the question: "*how has to appear the document on a given publishing support?*" It is either embedded within the document in terms of typographic characteristics (Courier, Times, red, etc), or expressed outside the

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[3] An ontology is a shared conceptualization of knowledge in a particular domain.

[4] Semi-structured documents are documents where the structure is often irregular, partial, unknown, or implicit.

document by means of style sheets (e.g., CSS Style sheets for Web documents). The logical layer represents an organization in term of structure (Chapter, paragraph, title, etc). It is expressed generally in terms of logical elements and can be either implicit in the document or explicitly expressed using schema languages. The meta-information layer includes two types of information: (1) meta-data describing the intrinsic properties of a document (e.g., title, authors, etc) and are generally expressed in languages such as RDF [19]; (2) domain vocabulary and taxonomies (expressed using ontologies and/or thesauri) relating document content to a specific domain of interest.

The first objective of our work is to make structured, semi-structured and un-structured documents self-explaining. For structured documents, the problem is quite easy since the layout structure and the logical structure are already separated. The problem is more complicated for semi-structured and unstructured documents. One solution to this problem is to offer annotation facilities. Annotation refers to new information such as comments, semantics and new structures placed over existing documents. The goal is to progressively *facilitate* and *motivate* authoring of structurally and semantically tagged document content.

4.1 Manual annotation Vs automated structure/semantics extraction

With the advent of structured documents, several researches and industrial efforts have been dedicated to the analysis of raw or semi-structured documents in order to structure or re-structure them. In [11], authors proposed the MarkItUp system designed to recognize the structure of untagged electronic documents; their approach is based on learning by example to gradually build recognition grammars. Authors in [2] used a constraint propagation method to extract logical structure of library references. Work described in [3] proposed an approach based on the use of a transformation language to interactively restructure HTML documents.

Research in information extraction and automatic metadata extraction generally rely on the existing of many documents (sharing the same format) with similar structure and semantics, which is very difficult and inapplicable to communities of practice where a variety of documents are produced with very differing format, structure and semantics. In this context, we advocate the use of manual annotations. The main difficulty is enabling and motivating non-technical users to structure and semantically enrich their documents.

4.2 Requirements for annotation tool

One of the fundamental problems we face when designing an annotation tool for a communities of practice, is to incite their members to take the effort to produce structured documents and then semantically link document elements to available

domain ontologies[5]. To answer this problem, we fix a set of requirements for the annotation tool we aim to develop:

(1) Ease of use: the proposed annotation tool should be easy to use; this could be achieved by providing authors with a convenient graphical interface that abstracts languages syntax (XML Schema, RDF, Ontology description languages). Moreover, authors should be provided by a set of predefined schemas (deduced from the analysis of CoPs activities) as well as domain ontologies in order to assist him/her to annotate document content easily. However, authors should also have the freedom to modify and/or add specific elements to predefined schemas in order to answer their own need.

(2) Annotation result representation and evolution: Annotation result should be presented in a graphical manner in order to help the user in the validation of the produced result. Moreover, in a CoP evolving environment, documents can easily evolve; the annotation result should be then adapted without redoing the whole annotation process. One solution is to structure annotations. Structuring annotation result greatly increases its reusability, especially when documents evolve.

(3) Motivating annotations: authors will be motivated to annotate their document content only if they experience the added value taken from this exercise. The idea is to provide CoP's members with a set of services that consume structured and semantically enriched documents and produce useful results. Document reuse tool is one of these services. In the context of PALETTE project, several services based on structured documents will be provided (information discovery based on annotations, publishing services, etc).

5 Document reuse tool: Conceptual Framework

The proposed information reuse tool consists of a set of Web services. Web services are defined as loosely coupled, reusable software components that refer to programmatic interfaces used in the Word Wide Web for application-to-application communication. A main characteristic of Web services is that they are self-describing, which means that they contain all necessary information advertising their functionalities. Web services are particularly interesting for virtual communities, as they allow non-technical community members to combine them in new value-adding services. Based on our previous work on structured document reuse [4] [5], we propose a conceptual framework (Figure 1) that encompasses the whole document reuse process. The framework consists of four basic set of services:

Document restructuring services: include (1) annotation service which has to manage links between original documents, predefined schemas and ontologies; (2) the structuring of annotation result. Document restructuring services use ontologies provided by domain knowledge management services. They also interact with evolution services to manage annotations' changes; and with validation services to

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[5] A working team within the PALETTE project is focusing on developing evolving ontologies for CoPs

validate annotation results. To do all these tasks, document restructuring services rely on set of user interfaces. These services are currently under development in the context of PALETTE project. A set of tests and an evaluation process are planned with the help of several CoPs.

Matching Services: In order to reuse structured documents, we need to establish a set of similarities between the reused fragments and the document where fragments will be reused. To do this, we adopt a multi-criteria matching process. Each criterion is represented by a Web service. These services are extensible. As new criterion become available to resolve the schema matching problem, a new Web service is created. Examples of developed services include: (1) *Semantic similarity service*: measures the similarities between entities based on the meaning inferred from their names and their links to domain ontologies; (2) *Constraint similarity service*: relates schemas elements based on their respective constraints (specified in the logical layer). Such constraints include the use of Datatypes and integrity constraints; (3) *Structural similarity service*: relates schemas entities based on the similarity of the structural context in which they appear (defined by their ancestors and descendents in the logical model). The idea behind our proposed solution is to represent each element's context as a path and to then rely on a path resemblance measure to compare such contexts. To achieve this, we relax the strong matching notion frequently used in solving query answering problem. To compute path resemblance measure, we further use algorithms from dynamic programming. These services are finalized and details about related theory and algorithms can be found in [4], [5].
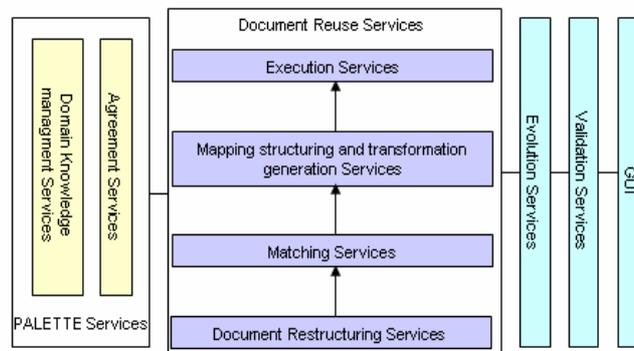

Fig. 2. Conceptual Framework for Document Reuse tool

Mapping structuring and transformation generation services: The main goal of these services is to combine all the above similarity measures and produce a mapping result that clearly defines source and target mapped entities, required transformation operations, and conditions under which the mapping can be executed. These services rely on validation services using graphical representation of the mapping result enabling the user to both valid mapping result and to add further constraints in a transparent manner.

Execution Services: These services generate automatically the appropriate transformation scripts based on the above mapping structure.

Additional services run along the entire reuse process, interacting with the former four modules. Domain knowledge management services are services that define lexical and domain-specific ontologies for CoPs. Agreement services are responsible for establishing a consensus on predefined schemas and/or ontologies. These two services are currently under development by other partners in the PALETTE project. Evolution services are responsible in keeping both annotation results and mappings in synchrony with documents changes.

6 Summary

Communities of practice are social networks of relationships that provide information, knowledge, and a space where people interact for mutual benefit. This paper studies document content reuse problem within CoPs. Faced with the diversity of documents formats, content and goals, a critical step in document reuse is to make such documents self-explaining. The main idea is that by enriching original documents with an explicit logical structure as well as linking content to available ontologies, we can assist authors in the reuse process. This is done by proposing a set of services able to determine similarities between original documents and reused fragments. We proposed a conceptual framework describing such services and their interactions. Currently, we are instantiating the framework in the context of several Cops participating to PALETTE project. In the future, the main task will be dedicated to the evaluation and enhancement of the proposed framework based on CoPs feedback.

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From the analysis of community activity to the appropriation of new tools. A methodological approach for the development of information technology solutions

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Abstract. More and more CoPs have chosen virtual environments and services to support their activities. However, recent research has underlined several problems: the lack of adequate scaffolding in terms of technical support and appropriate use of technology for communication and collaboration, the lack of tools and virtual environments to support real-life problem-solving and the reification of knowledge, the inadequacy of tools used by the communities in supporting individual and organizational learning processes as well as knowledge and identity building of CoPs. CoPs need new tools and services that are acceptable to them and capable of adapting to their existing virtual environment and evolving needs. Acceptability and adaptability of tools and services could be achieved through an iterative and participative process involving developers and CoPs' members in the co-development of scenarios of use. These scenarios can be considered as "boundary objects" facilitating the negotiation and collaboration between developers and CoPs' members. This process is experimented in the PALETTE project. In this contribution, we describe the characteristics of such scenarios of use and suggest a methodological approach to progressively design and represent these scenarios. In conclusion, we discuss questions and issues raised by the implementation of such an approach.

Keywords: community of practice, R&D methodology, participatory design

1 Introduction

For more than ten years, collaborative and networking processes have been recognised as an effective process for knowledge building and learning by professionals [7]. Wenger [12] has concretely described and analyzed the process by which adults enter in new communities of practice, learn and build their own identity. Wenger's social theory of

learning focuses on learning as social participation, as "a process of being active participants in the practices of social communities and constructing identities in relation to these communities" ([12] p. 4). Social participation, community building, development of identity, learning and knowing are deeply interconnected and are articulated around negotiation of meaning. For Wenger, negotiation of meaning is at the root of any individual and collective learning. Its goal is to ascribe meaning to our life experience. Wenger insists on the two interrelated processes of *participation* and *reification*, and on their duality which is fundamental to negotiation of meaning and to learning. On the one hand, participation describes "the social experience of living in the world in terms of membership in social communities and active involvement in social enterprises" ([12] p. 55). Participation thus means being an active participant in a social community and developing both the individual and the community identities. On the other hand, the reification process is one "of giving form to our experience by producing objects that congeal this experience into "thingness"" ([12] p. 58). Both participation and reification are supposed to lead to learning since they contribute to the development of identity. Wenger also stresses that three dimensions must be present for practice to be the source of community coherence: dense relationships of *mutual engagement* organized around what its participants have to do; negotiation of a *joint enterprise* defined by the participants in the very process of pursuing it; a *shared repertoire* that combines both reificative and participative aspects, reflecting a history of mutual engagement and being a source for the negotiation of meaning. Of course, in day to day practices, we may find that these processes are lived differently according to the CoPs, their domain of interests and their history [3] [4].

It has also been recognized that web-based technologies could support CoPs. More and more CoPs have chosen virtual environment 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 community environments supporting real-life problem-solving, the lack of support to reify knowledge and make it accessible to community members and beyond, and finally the inadequacy of the tools (forum, discussion lists, web-based training environments) used by these communities in supporting the individual and organizational learning processes as well as knowledge and identity building of CoPs. CoPs encounter the need for new tools and services to support their specific activities. If these new tools must be usable and efficient, they also have to be acceptable by each CoP and capable of adapting to its existing virtual environment and evolving needs.

The acceptability of a system is a combination of social and practical acceptability. Social acceptability refers to "whether the product will be used in the real world". Practical acceptability includes usability, but also reliability, compatibility, utility [9]. Social acceptability is namely related to the degree of the activity transformation induced by the uses of the new tools and services. This activity transformation may be encountered at different levels: aims, actions and operations. In other words, the computer artefacts

interact with and change people's work and mind. In return people adapt the artefact to fit their work or transform the artefact and develop their schemata and competence to fit their work [10]. To support this acceptability and the adaptation of the services and tools, an iterative and participative process of co-development by developers and CoPs of scenarios of use is proposed. These scenarios can be considered to be "boundary objects"[1] facilitating the negotiation and collaboration between developers and CoPs. This process is experimented in the PALETTE project[2]. In this contribution, we describe the characteristics of such scenarios of use and suggest a methodological approach to progressively design and represent these scenarios. In conclusion, we discuss the questions and issues raised by the implementation of such an approach.

2   Characteristics of the scenarios of use

In regard to the purpose of the PALETTE project, which is both to improve and facilitate the functioning of the CoPs and to develop online services, the scenarios of use should have some specific characteristics:

- They should speak both to the CoPs and to the partners of the PALETTE project in charge of the development of the services. Both parties' information needs must be met.
- They should depict the aims of the CoPs' activities as well as the chain of actions and operations which constitute these activities.
- They should integrate the use of one or more instruments, possibly as part of a system of instruments.
- Following the participatory design approach, the scenarios should be enhanced and detailed all along the development process up to the description of the operations.

According to the classification of scenarios proposed by Rolland et al. [11], a scenario can be described in terms of form, contents, purpose and lifecycle. The figure 1 summarizes the choices made within the PALETTE project regarding the purpose of the scenarios:

- The form of the scenarios will be text-based, illustrated by graphical representations. Different software will be used, notably MOT+ which allows the graphical

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[1] The term "boundary objects" was created by Leigh Star, in sociology of sciences, in order to describe the objects that coordinate, according to a given intention, diverse perspectives. Objects that belong to many communities and serve as links between diverse perspectives have the potential of becoming "boundaries" if these perspectives have to be harmonized.

[2] PALETTE is an integrated European project aiming at facilitating and augmenting individual and organisational learning in Communities of Practice (CoPs). More information can be found at http://palette.ercim.org/

representations to be exported in different standard formats (XML, IMS-LD, OWL) suited to the varied needs of the developers[3].

- The contents of the scenarios are descriptions of the activities of the CoPs (collaboration, information use, production of documents, knowledge management...) and their use of tools within a specific context (history, actors, roles…).

- The purpose of the scenarios is to meet the developers' information needs, to present a structured view of their own functioning to the CoPs and to build "boundary objects" useful for the negotiation, between the developers and the CoPs, of the scenarios themselves and the experimentation modalities.

- The lifecycle of the scenarios depends on the different negotiation stages within the participatory activities involving both the developers and the CoPs.
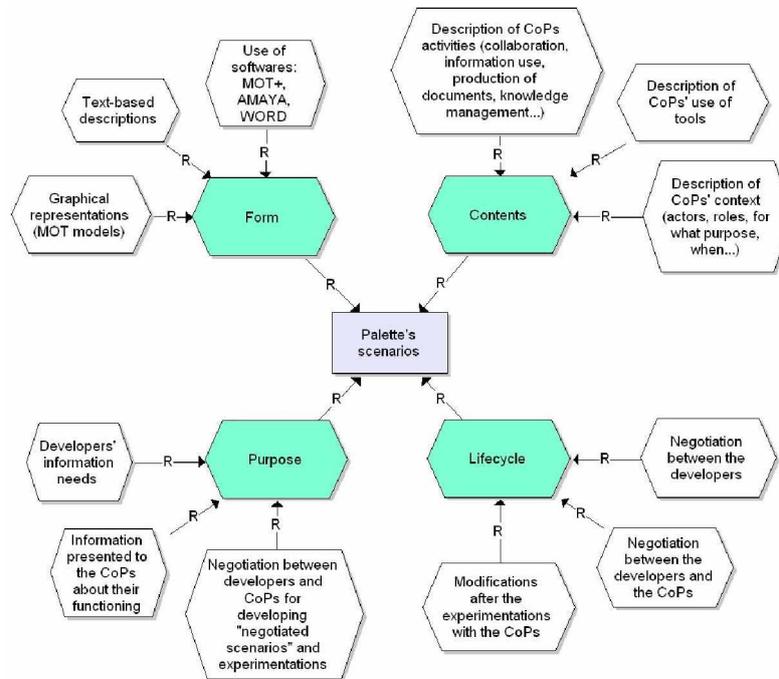
Fig. 1. Graphical model of the PALETTE's scenario of use

"R" means "Regulates" (or "has an effect on")	⬡ = Principles, objectives
	▭ = Object

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[3] More information about Typed-Objects Modelling Methodology as well as the MOT+ software can be found at http://www.licef.teluq.uquebec.ca/eng/index.htm.

An example of a specific scenario is presented in Figure 2. It is a graphical representation (form), describing a specific CoP activity – the decision making process concerning students' projects – (contents), which is used by the PALETTE's developers as a use case and presented to CoP's members in order for them to better understand their own functioning (purpose), and which will be negotiated and probably modified according to the vision of the CoP's members (lifecycle).
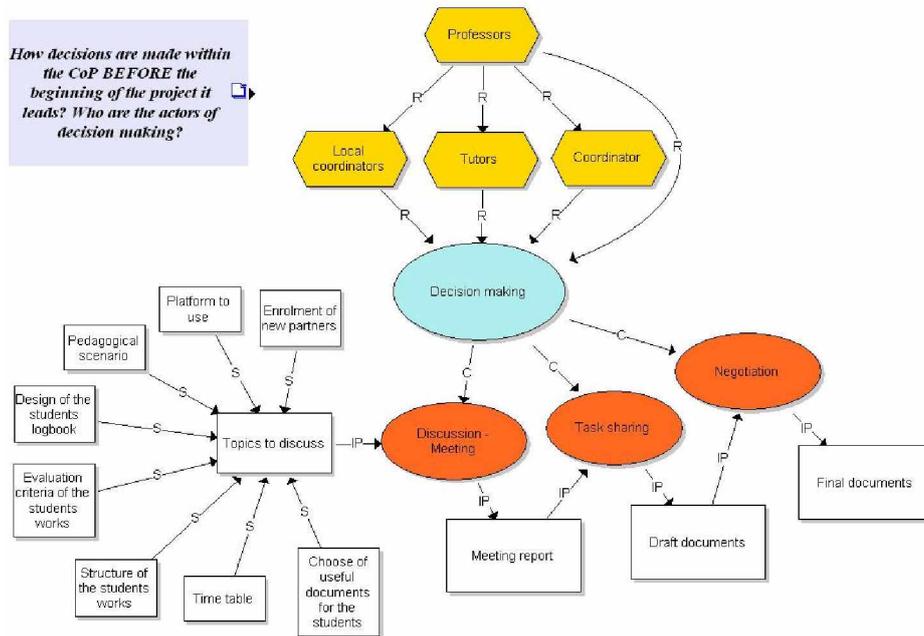

Fig. 2. Graphical model of a specific scenario of use

"R" means "Regulates" (or "has an effect on")	$\bigcirc$ = Processes, actions
"C" means "is Composed of"	$\hexagon$ = Actors
"IP" means "Input/Product-Output"	
"S" means "is a Sort of"	$\square$ = Objects, products

3   PALETTE's methodology

The scenarios of use and prototypes are conceived in stages with the participation of both developers and community members. This is fundamental to our methodology in which the representation of the CoPs' practice is elaborated in an iterative process which leads to the creation of the scenario and eventually to the specification of tools. The use of graphical representations such as the ones used in this article facilitates the exchange about the scenarios. They may be seen as a kind of boundary object between the two parties and must be understandable by both.

In this section we briefly describe the PALETTE's methodology represented in Figure 3 using three kinds of objects:

- The actors (oblate hexagons): the developers (the PALETTE's partners), which consist of the different Work Packages (WP) and sub-teams within the Work Package 1 responsible for the design of the methodology, and the CoPs with their delegates and members.
- The twelve processes of the methodology: the ones numbered from 1 to 10 happen one after the other while the first and last ones are recurrent. Indeed, throughout the ten stages, developers evaluate and follow-up the community's reflexive process on the transformation of its activity.
- The objects: the inputs/outputs in/from each process.

3.1   Analysing and categorizing tools (ongoing process)

This process intervenes at different times into the methodology and aims to provide an inventory and a categorization of tools developed by PALETTE's partners, used by the CoPs or existing on the market. Categories of tools are worked out according to different sources. The inventory produced is reused in different processes of the methodology: the modelling of the CoPs' activities, the design of prototypes and the dissemination to other CoPs.
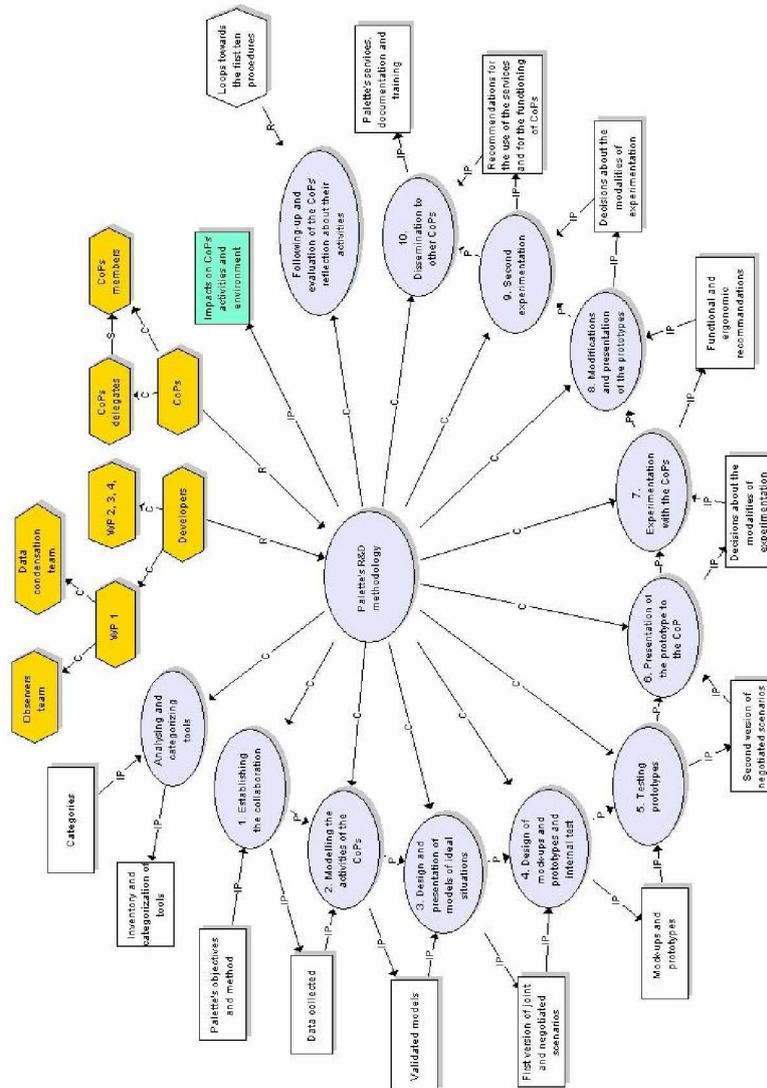
Fig. 3. Stages and on-going processes of PALETTE's methodology (with actors and inputs/outputs)

"R" means "Regulates" (or "has an effect on") "C" means "is Composed of" "IP" means "Input/Product-Output" "P" means "Precedes"	◯ = Processes, actions ⬡ = Actors ▭ = Objects, products

3.2 Establishing the collaboration with a CoP (Stage 1)

At the end of this stage, an agreement is reached between the CoP and the developers or the project is abandoned. To reach a collaboration agreement, the CoP – in its entity if it is small, or through chosen delegates if it is large – needs to understand:
- the intended stages of the methodology and the project's requirements;
- that ethical principles such as confidentiality will be respected;
- that it is in the community's interest to engage in the process and that it is free to retreat at any moment.

At this stage, negotiation allows to adapt the collaboration modalities to each CoP without modifying the purpose of the project.

After PALETTE's objectives and method have been presented and a negotiated agreement about the collaboration has been reached, the first participatory activity takes place. An initial set of data on the community activity is collected by the "Observers team" following an interviews' guide it has developed.

The interviews' guide provides the observers with a document which helps them to follow the methodological principles of the PALETTE project. It contains a description of the objectives and ethical issues of the interview process, the list of questions to ask as well as some tips.

3.3 Modelling the activities of the CoP (Stage 2)

This stage consists of a first analysis and modelling of the data collected. Five main steps conduct to the elaboration of "Validated models":
- Proposing grids for the data condensation/extraction process. This step mainly aims at choosing a representation mode useful both for the developers and for the CoP. The advices provided by Miles and Huberman [8] in the design of matrices have been useful. It has been chosen to present the data with short texts and graphical models.
- Processing the raw data in order to obtain the transcripts and the minutes of the interviews.
- Analysing the data following a method of category-specific analysis [1] [6].
- Presenting the functioning of the CoP based on the analyzed data using two different formats: text-based descriptions of and graphical models.
- Validating and enhancing descriptions and graphical models presented by the developers through discussions with the CoP.

This last step is important for the collaboration with the CoP because it could allow the CoP to develop a better understand its actual functioning. It also could arouse its interest in imagining new situations and solutions.

3.4   Design and presentation of models of ideal situations (Stage 3)

This stage (see Figure 4) is adapted from Checkland's Soft System Methodology [2]. At this point, the developers elaborate one or more possible technological and pedagogical solutions in order to model a new activity scenario representing an 'ideal' situation. This new scenario can then be compared to the actual situation by way of discussions with the CoP's members, structuring the negotiation process between the developers and the CoP. This aims to stimulate a reflexive process about the community's activity and to engage its members in the design of the new tools, in the definition of their use and in the identification of a strategy to support the appropriation process. Several meetings may be required in order to achieve a joint and negotiated scenario acceptable by the developers and the CoP and feasible in its particular context. At this stage, an acceptable solution is defined as one which does not bear too heavy a charge on the members of the CoP. Together, developers and members of the CoP thus try to optimize the workload induced by the use of new tools and new processes.

3.5   Design of mock-ups and prototypes and internal tests (Stage 4)

At this stage, the developers design and test a first version of the prototypes. It is a first internal diagnosis of the tools. These internal tests should confirm that the tools or services being developed actually correspond to the solutions previously negotiated. In addition, the developers try to establish a first measurement of the degree of acceptability by evaluating the instrumental distance [10] and the users' competencies necessary to implement the solution. Thus the developers among themselves develop a common vision of the solution.

3.6   Testing the prototypes (Stage 5)

The aim of this stage is to test the prototypes with delegates of the CoP. The test is designed to simulate authentic actions performed by the community. The delegates of the CoP and the developers strive to perform a second measurement of the degree of acceptability of the solution, and, if needed, negotiate a more acceptable solution. If this is the case, Stage 4 is repeated. Thus the developers and the delegates develop a common vision of the new solution.
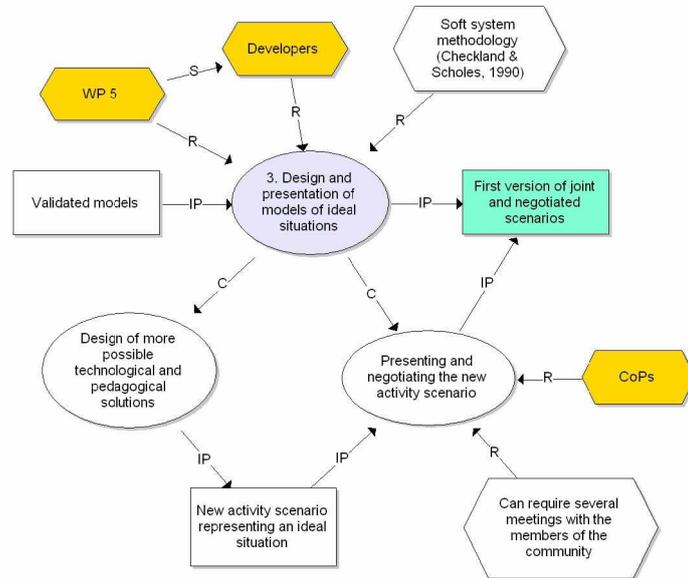
Fig. 4. Design and presentation of models of ideal situations (Stage 3)
 "R" means "Regulates" (or "has an effect on")   ◯ = Processes, actions
"C" means "is Composed of"   ⬡ = Actors, principles
"IP" means "Input/Product-Output"   ▭ = Objects, products
"S" means "is a Sort of"

3.7   Presentation of the prototypes to the CoP (Stage 6)

This stage aims to define modalities for the experimentation of the prototypes with CoP's members. These modalities could be different for each CoP. However two steps are required: the presentation of the prototypes or mock-ups to the CoP and a discussion about the modalities of the experimentation.

3.8   Experimentation with the CoP (Stage 7)

The seventh stage aims to experiment the prototypes by observing the instrumentation and instrumentalisation processes [10] as well as the individual and collective learning being carried out. To be reliable and valid, experimentation has to be led over a significant period of time.
- For the instrumentation process, observation focuses on the appropriation of the constituent functions of the tools (functions conceived by the developers).

- For the instrumentalisation process, observation focuses on functions created by the CoP's members (not conceived by the developers).
- For the individual and collective learning being carried out, observation focuses on the various types of mediation processes which lead to it: praxeologic, sociocognitive and reflexive mediation processes.

Based on these three observations, functional and ergonomic recommendations are made to improve the tools.

3.9   Modifications and presentation of the prototypes (Stage 8)

The developers modify the prototypes according to the results of the experimentations. Again, internal testing precedes the presentation of the new prototypes to the CoP and the negotiation about the modalities of a second experimentation. The prototypes could be then named "PALETTE's services, version 1".

3.10   Second (and further) experimentations (Stage 9)

Following the decisions about the modalities of the second experimentation, observations are conducted in the same way that was described in Stage 7. The product of this stage consists in providing recommendations for the use of the services and for the functioning of the CoP.

3.11   Dissemination to other CoPs (Stage 10)

This last stage aims at providing other CoPs and scientific communities with the project's products: the PALETTE's services, the documentation about these services and training.

3.12   Following-up and evaluation of the CoP's reflection about its activities (ongoing process)

The follow-up process influences the previous stages by accompanying the CoP through the reification of its activities and the production of knowledge. This reification is continually used and reused within the other processes through the different participative activities: interviews, validation of the scenarios of use, negotiation of the modalities of experimentation, etc. These activities, like in the CoP itself, provide a framework for the negotiation of meaning, reification of knowledge and reflection about the CoP's functioning and learning.

4   Conclusion: questions and issues raised by the implementation of the method

Conducting participative projects with CoPs raises specific challenges due to the nature of CoPs. These communities are not always stable bodies with a structured organisation. They use communication channels that are sometimes closed to outsiders. The interest of CoPs lies in their domain of practice, and the development, testing and appropriation of new tools is not a priority nor on every CoP's agenda.

The challenges lye in a) the appropriate choice of a communication channel, b) the choice of partners inside large CoP with whom the project can work, c) the management of the decision making process in general, d) the choice of criteria to identify CoP's members able to participate in the development of information technology solutions, e) the reliability of decisions, f) the transferability of experiences by one part of the CoP to the rest of the CoP or other communities.

a) The choice of a communication channel affects the policy of confidentiality. Shall the developers and the CoP's members use the existing CoP's channels such as forum, chat, mailing lists or the developers' channels which require separate logins?

b) Choosing the right partners inside the CoP is not easy. If the CoP's structure is somehow formalised, delegates might then provide data pertaining to Stage 1. The validation and testing of the solutions may be carried out by a special active subgroup willing to do so, or there may be a call to volunteers – both may bias the project.

c) There are many decisions to make internally and with the CoP. They concern the interpretation of the CoPs' functioning by the developers, the choice of the solutions, the length of testing and so on. However the decisional structure and procedure of a CoP are not often clear. In addition, the CoP's can discontinue involvement at any moment.

d) In special projects such as the development of information technology solutions to support CoPs' activity, one of the criteria for participation concerns the installation of software on one's computer. Not all CoP's members have the right to do so in corporate environments. Others don't want to install beta-versions of software that may destabilize their system. Finally, in non-corporate environments, CoPs may lack the technical ability to install and control server-based services.

e) Decisions are taken by some members of a CoP at a certain time, e.g. the use of a certain scenario to work with. There is a risk that new CoP's members or members that could not participate in the decision making process reject these scenarios. There is always a doubt about the reliability of the decision.

f) The transferability of experiences made with a motivated and willing group of CoP's members to the whole CoP, including the less active outer circle is important if a CoP adopts new ways of working and new tools. If the favourable experiences are not transferable because the "until now" silent majority boycotts the new culture, the CoP may be in danger.

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A model for representing professional development through the participation in a virtual CoP: uses for developing enhanced services

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Abstract. This paper presents a model of professional development through the participation in a virtual CoP. This model is rooted in a definition of professional development and of professional practice. The model is then used for analyzing the activity of a virtual CoP of tutors involved in a computer-supported collaborative learning training. The analysis provides guidelines for developing online services for supporting the activity of the CoP within a participatory design view. This research is part of a European project aiming at providing interoperable services for CoPs.

Keywords: community of practice, professional development, practice, modelling, R&D methodology, participatory design

Introduction

The call for papers of this workshop, in its 'motivation and background' section, pointed out that, despite to the development of new devices and services able to sustain the development of virtual CoPs, research underlines "the lack of adequate scaffolding in the form of both technical supports and usage of technology to:
- Express, represent and share practices;
- Debate and reflect about the practices and about the life of the CoP;
- Develop, reify and exploit knowledge inside and outside of the CoP;
- Facilitate engagement, participation and learning."

More than the lack of use of technology, this assessment also highlights the lack of understanding of the main processes underlying the functioning of a CoP as well as the learning achieved by the participants. Research has also identified many questions highlighting the difficulty to depict and to understand the conditions of processes such as involvement into a virtual group [8], debating and arguing at a distance [2], coordinating a virtual working/learning group [3], supporting confidence and human relations into a distributed community [17], etc. In addition, methodological questions also occur for inquiring into those groups [16] [9]: how to get in touch with the members, how to analyse in the same time different data such as interviews, emails or logs, how to validate the research approach, etc.?

It is usual to notice non- or "wrong" uses of new technologies [6] [15]. But this does not necessarily mean "wrong" technologies or "wrong" users. This would rather mean "wrong" relation between the technology and the users or a lack of understanding of their way to work with – or without – technology. Quite often, old technologies are used for new purposes or activities for which they have not been designed. If they don't work, it is not common to question the new purposes or activities themselves for better understanding them before to design new technologies or supports for the users.

When investigating a new research field, scientists usually firstly try to develop a general depiction of the processes and questions they intend to inquire into [18]. A first modelling aims at identifying main categories of meaning into the reality and to conduct exploratory research. Then validation or change of the first model can be done and new questions of research can occur.

The model presented in this paper aims at representing the main processes occurring into a virtual CoP, their connections and the conditions for their emergence and for the professional development of the participants. Then a use of the model will be presented into a European R&D project (PALETTE) for investigating one virtual CoP and exploiting this investigation for designing enhanced online information, knowledge management and mediation services.

1 Professional development and practice

Before the presentation of the model, it is important to define the two main concepts behind.

Several authors consider more and more professional development as a process supplied not only by prior training but also by interactions with professional peers and by personal reflexivity in and out the workplace [5] [12]. For example, a teacher develops her practice as professional in almost all the circumstances of her life, formally or informally, alone or in interaction with others, in or out her school. Lieberman (1996, quoted in [5], p. 3) gives some varied examples such as to hear colleagues speaking about new teaching practices, to get involved in decision groups in her school or to participate in professional networks. Outside school, she gives examples such as to participate in institutional working groups, to get involved in action-researches with universities or to participate in discussion groups. All these examples can take place into formal training but also in informal situations. More precisely, Donnay and Charlier [7] propose to define professional development with six specific characteristics. These authors have worked in the teachers training field but their definition is largely applicable to other professions. Professional development is a process:

- oriented: towards a goal, a project, a progress… that may be personal (one's own practices) or larger (the project of the institution);
- situated: embedded into a specific context composed of work situations, relations with colleagues, an institutional history and a particular functioning and organization;

- that can be partially planned: it is relatively unpredictable because in the most of professions, professionals are assailed by requests from different people or devices. Professional learning can occur at each moment.
- dynamic and continuous: learning that has been achieved is reused in new daily professional situations and continuously enhances professional doing;
- sustained by a professional ethic: professional development occurs for improving a service, for example the students learning, the quality of products or the quality of services to customers;
- with shared responsibility: the professional is responsible for her professional development but her organizational environment is responsible for providing her professional development opportunities.

These characteristics highlight the informal aspect of the development of professional practices. Indeed, Donnay and Charlier [7] also describe four dimensions of professional development:

- the professional practices are often the starting and the arrival points of professional development that acts for enhancing them;
- professional development is often anchored in or even becomes confused with personal development;
- professional development lives on otherness: confrontation, debate, sharing, etc.
- professional development is related on the construction of professional identity.

Within these characteristics and dimensions, collaborative work and participation in a professional community appear as important actions for the professional development process, especially for confronting and improving one's practices. This implies that practice is at the heart of professional development or, following Donnay and Charlier [7], constitutes both the starting point and the arrival point of the process of professional development. According to Wenger ([19], p. 47), "The concept of practice connotes doing, but not just doing in and of itself. It is doing in a historical and social context that gives structure and meaning to what we do. In this sense, practice is always social practice". Thus practice includes the formal and the informal of a profession: representations, tools, language, documents, symbols, roles, etc. The action and the knowledge of a profession as well as the processes by which they have been constructed are also components of the practice. The Wenger's definition also includes the theories and the ideals relating to a profession as well as the actions and operations characterizing the practical doing of this profession.

Donnay and Charlier [7] otherwise highlight the difficulty to understand what professional practice or know-how is concretely because it is:

- not always available for the professional: it is constructed, alone or with colleagues, within professional situations which are not necessarily described with words. Practice is embedded in action and often used as routines not analyzed or consciously decided.
- not always accessible for others: it is constructed within specific contexts into a specific vision of the profession. For being accessible, practice has to be processed and decoded.
- not fully conveyed: because not fully verbalized. To specifically translate with words a complex professional action and the professional experience of someone is almost impossible.
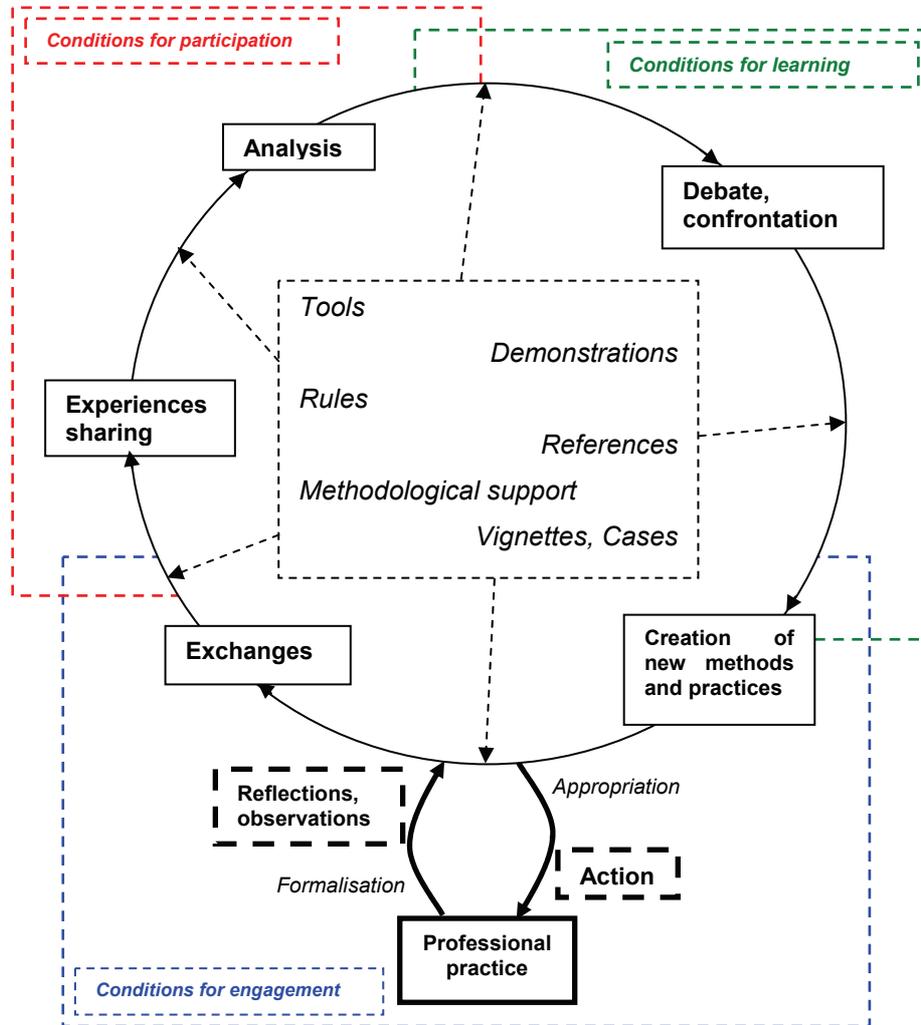
Fig. 1. Model of professional development within a community of practice

All along this cycle, participants can use and exchange objects such as:
- Tools (technical and conceptual) used in specific contexts and exchanged by the participants;
- Rules or references to regulations (administrative or legal for example) or to standardized practices classified by the profession;
- Methodological support such as advices from older colleagues;
- Demonstrations, i.e. argued discourses possibly based on literature;
- References to literature or to well-known standardized doing;
- Vignettes or cases such as little stories or anecdotes.

- peculiar to each professional: professional practice determines our professional identity all the way through our professional life and within a specific organizational context. In addition, professional practice is also full of emotions and affects.
- not always transferable: it is valid for its author as long as it is efficient in his/her context. The consequence is that professionals tend to generalize their own practices and it is not easy for them to change. However in return, practices are credible for other professionals and could be a part of a collective practice.

This large definition allows conceiving a model of professional development taking into account the complexity of a professional practice.

2   A model of the professional development within a CoP

In order to represent the different processes in action into the larger process of professional development, I built the model presented in the figure 1 [2], mostly based on the Huberman's *'Open' collective cycle* [10].

The entry point is the Professional Practice below the model. It is also the arrival point. At the workplace, a professional can encounter problems, ask questions, observe colleagues doing… in short, an event that arouses a reflection, not necessarily expressed but sufficiently explicit for leading her towards the community (the black central circle in the model). The practice is then formalized and "enters" into the community as an object which will be discussed.

Within this community, five processes occur from the interventions of the participants. In the model, they follow one another but we can imagine that they can occur independently or in another chain.

- Exchanges occur when a participant asks a question or proposes an observation made at her workplace or a problem. The exchange can be a question asking more information, a reformulation, a personal observation in another context, etc. "Exchange" is thus generally an answer to a message that can lead to a dialogue.
- The exchanges can lead to experiences sharing where participants develop their observations or their descriptions of their own contexts. Here, the answering participants get more personally involved in the conversation.
- An analysis can then occurs, i.e. a specific identification of what is exactly the problem, or a reference to literature or standard practices for explaining the problem or the practice described. Participants can then look for solutions together.
- The analysis can lead to a debate where different opinions are confronted with lines of arguments.
- A debate can possibly lead to the creation of new practices that the participants will try in their context. This leads then to action and appropriation by the participants in their workplace.

All these processes occur following a number of conditions. Three kinds of conditions occur before, during and after the participation in the community. For each participant, they combine together for defining, at one moment a specific configuration of variables that explain participation or learning.

- Conditions for engagement are related to personal characteristics of the participants, competences in the use of technologies, access to technologies, usual work environment, communities in which they take part and relations between those, personal representation of what is a community of practice, representation of one's professional development and learning processes, practices of reflexivity, etc.
- Conditions for participation are associated to personal characteristics (such as time available for participation, self-esteem, representations of one's competencies), participation support (such as animation and moderation of the community, rules for participation, framework given at the beginning to facilitate the exchanges between participants, usability of the tools, support to the new members), common project, security and trust issues, and shared language (own vocabulary developed within the community to speak about practice).
- Conditions for learning, professional development and changes of practice concern conceptions of learning, conceptions of changes, as well as conceptions of the community, the formalization of the exchanges, the role of the moderator to support individual learning and learning of the community and scaffolding opportunities to reflect on the learning process, and on the learning organisation.

This model can be used as a framework or as a grid of analysis for observing and understanding living CoPs.

3   The PALETTE project and its method

The PALETTE project[1] (6th European framework programme) aims at facilitating exchanges and learning in CoPs by developing online services and scenarios of use which will be implemented and validated with living communities. These services concern information management, knowledge management and collaboration. One of the original aspects of the project is that it is based on a participatory design methodology. Eleven communities of practice from three different domains (teaching, management and engineering) are actively involved all along the project through participative activities: interviews, tests of services, discussions about the designed scenarios, etc.

In this framework, there was a need of a clear vision of what a CoP is and how it works for professionally developing its members. This doesn't mean a "right" vision but a first well described vision for being discussed all along the project with the members of the communities involved. The model presented above was useful in this view and allowed to organize a first participative activity with the communities. A guide of interview has been designed with questions based in part on the processes, objects and conditions described in the model. Then the model has been used in part

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[1] More information can be found at http://palette.ercim.org/.

for the analysis of the interviews. Finally the presentation of the analyzed data follows on the one hand the advices of Miles and Huberman [13] with the construction of matrices and on the other hand a specific methodology of knowledge modelling MOT, Modelling with Typed Objects [14].

In the section below, I present the analysis of the interviews of one community in the teaching domain. This community of practice groups tutors involved in distance training. These tutors discuss about the problems they encounter for tutoring their groups of students (future teachers in secondary schools) who have to work collaboratively on a specific project. In this paper, my goal is not to deeply analyse the functioning of this community but to simply show the usefulness of a model for understanding its functioning and further to design tools and services that take into account its real organization, as suggested in the introduction. So, I only take four examples, four "pictures" of processes lived by the community. Then I will discuss how these pictures can be used both for supporting the development of the community and for developing tools and services in phase with these "living scenarios".

4   Graphical representations of some results

The figure 2 simply depicts the documents produced or used into the community. This refers to the exchanged objects in the model presented in the figure 1. Three kind of actors are represented, two of whom are members of the CoP (the coordinator and the group of tutors and local coordinators); the students participate in the distance training organized by it. Nine sorts (link "S") of documents are produced by the large community while they use only two sorts of documents (scientific papers and bookmarks). The tutors and the coordinators participate in the production of researches, a pedagogical guide for the students and pedagogical tools for tutors. This last production is especially a product of the tutors' CoP. Thus this figure depicts a very productive CoP. However the bottom half of the figure shows that only one of the products is reused in the next years for designing new distance training scenarios. What the students produce is not reused nor researches or practical tools. This could depict a CoP without memory… while in the model of the figure 1 one condition of learning is precisely the organization of knowledge management and the formalization of the exchanges.
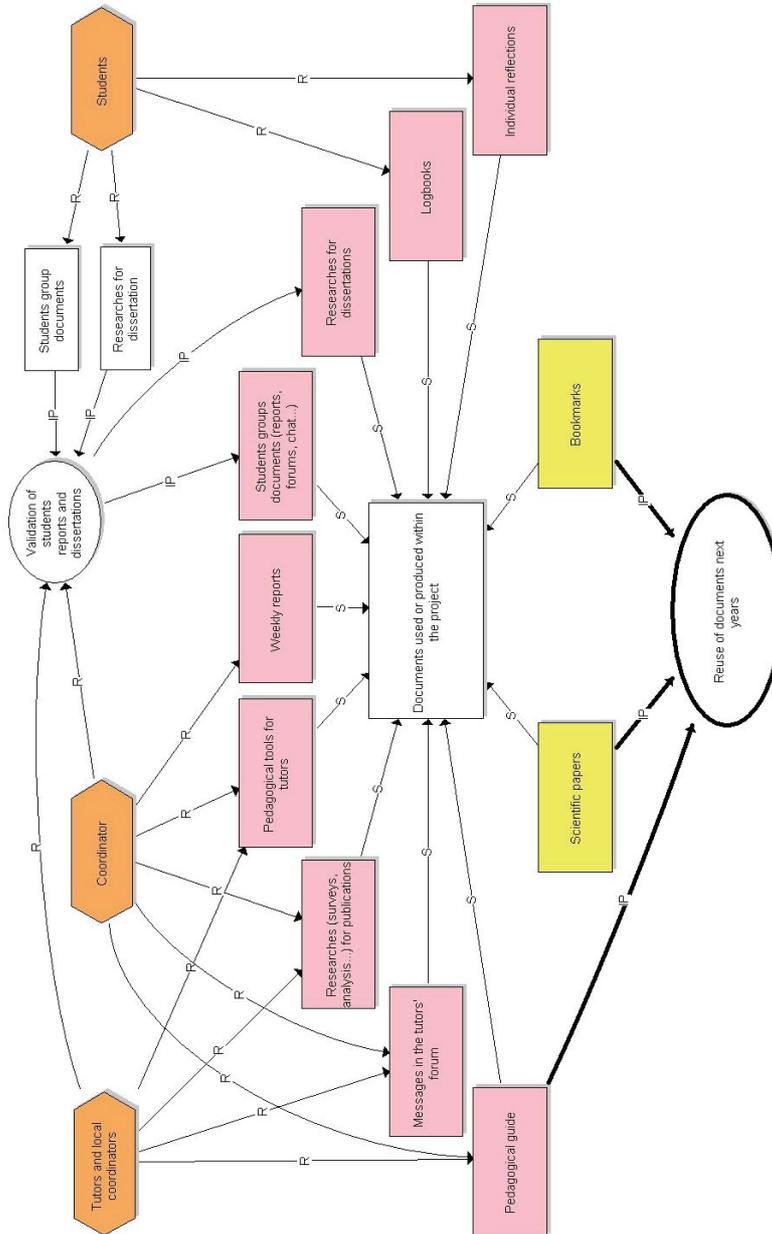
Fig. 2. Documents used and produced and actors involved

"R" means "Regulates" (or "has an effect on" or "acts on") "S" means "is a Sort of" "IP" means "Input/Product-Output"	⬭ = Processes, actions ⬡ = Actors ▭ = Objects, products

The figure 3 aims at depicting the decision making process before the training project begins, i.e. before the students involved begin to collaboratively work, when preparing and organizing the training. The students (future teachers) are from different European universities and will form working groups. Three kinds of actors are involved: the tutors of the students groups, the local coordinators in each University and the coordinator of the project. A lot of topics have to be discussed: the enrolment of new universities, the platform to use, the pedagogical scenario, etc. The decision making process could be divided in 3 sub-processes:

1. Discussion in face-to-face meeting: different topics of discussion are selected into an agenda and the goal of the meeting is to organize the work for producing the scenario and sharing tasks. The product of this activity is a meeting report.
2. Following the meeting report, the tasks are shared and the actors work for proposing to the others draft documents.
3. A negotiation (comments and proposals of changes in the documents) then occurs for producing the final documents and organization which will constitute the architecture of the pedagogical scenario.

This process of decision making refers to the processes of analysis and debate in the model of the figure 1.
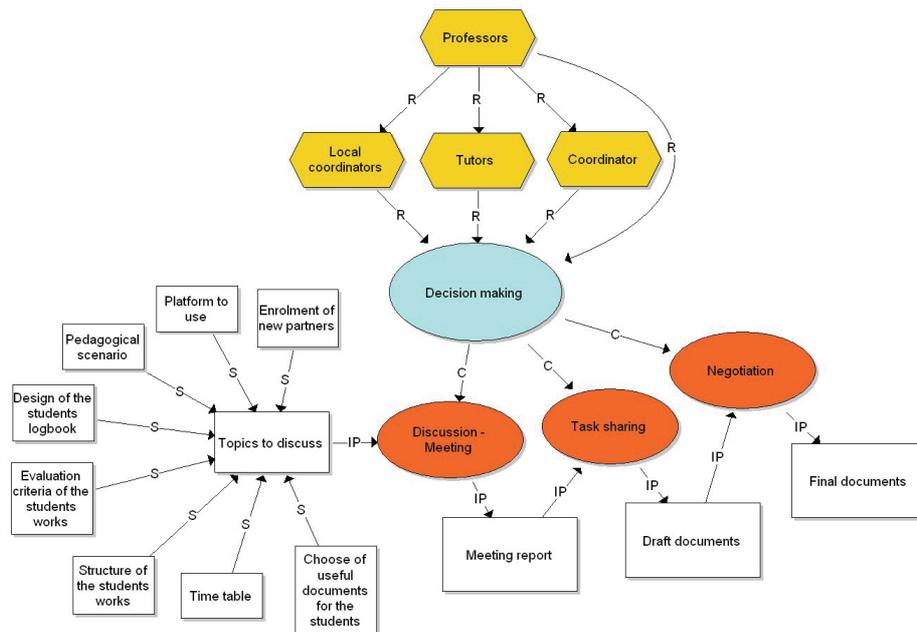

Fig. 3. Decision making process before the beginning of the training

"R" means "Regulates" (or "has an effect on" or "acts on") "S" means "is a Sort of" "C" means "is Composed of" "IP" means "Input/Product-Output"	◯ = Processes, actions ⬡ = Actors ▭ = Objects, products

However, during the project (figure 4), while students are involved with the tutors in working groups, decisions have regularly to be made relatively quickly. The normal and negotiated procedure is to organize monthly meetings with the tutors and local coordinators with an agenda based on problems, questions and topics that occur within the students working groups. A meeting report is written by the coordinator and information about the decision made is provided to all the participants (students, professors...).

However, it seems that sometimes, the project's coordinator has to make decision "on the fly", very quickly, for answering a specific question or because it would be too energy-consuming to organize a meeting with all the partners. Some interviewed people complain about this "parallel" process of decision making because they feel not involved in the process and they are not always informed about the decisions made by this way. This "hidden" decision making process is depicted with the dotted lines around the process "Decision by the coordinator".
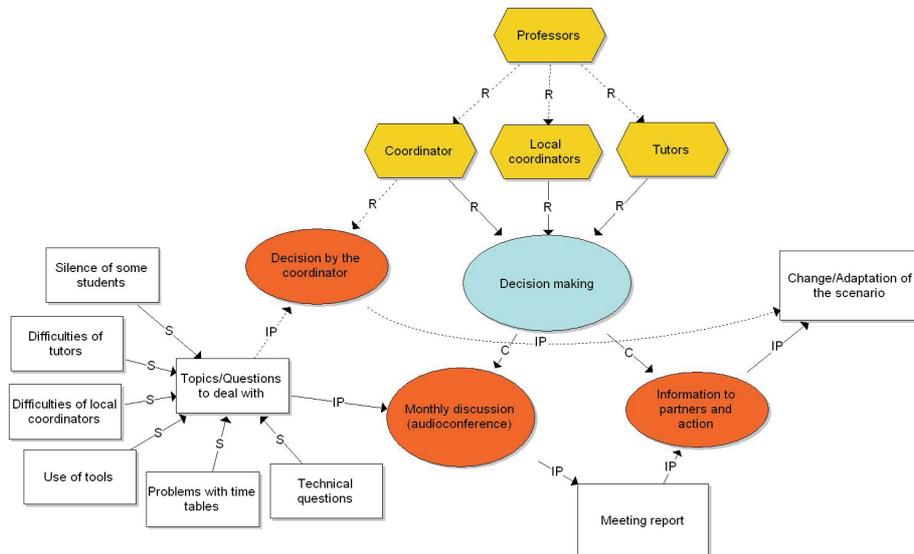

Fig. 4. Decision making process during the training

"R" means "Regulates" (or "has an effect on" or "acts on") "P" means "Precedes" "C" means "is Composed of" "IP" means "Input/Product-Output"	◯ = Processes, actions ⬡ = Actors ▭ = Objects, products

In the model of the figure 1, the coordinator (or moderator) of a CoP appears as a central element for the engagement, the participation and the learning of the participants. If the participants complain about the coordinator or if they don't trust in him/her, it could be a problem regarding the participation within the CoP.
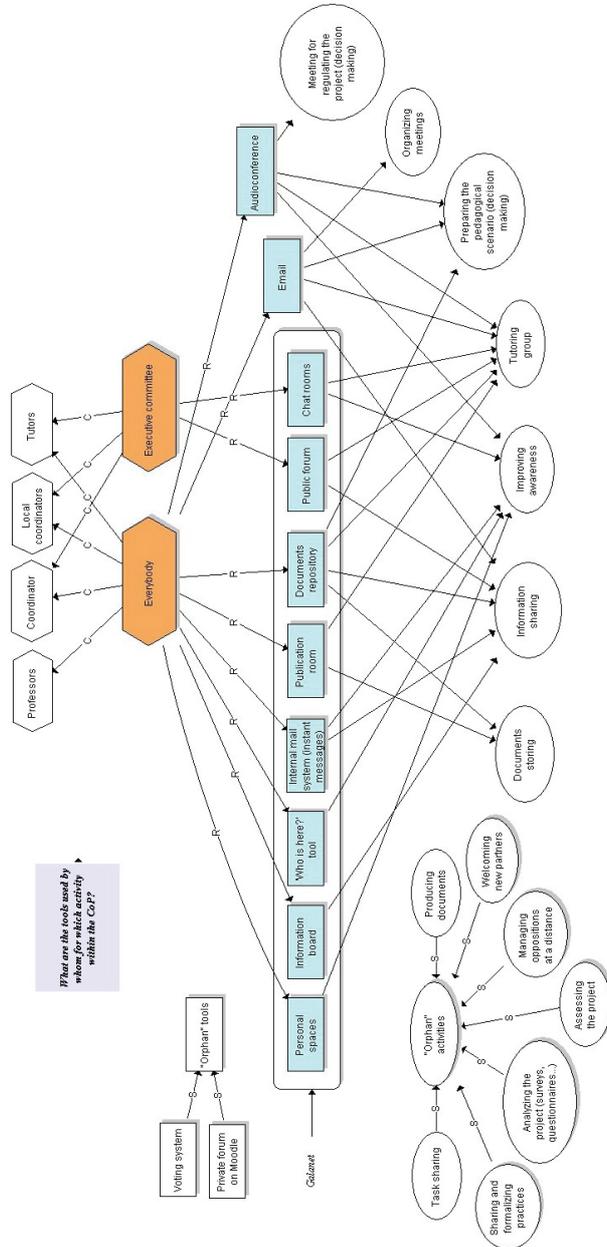
Fig. 5. Use of tools for activities within the CoP

"R" means "Regulates" (or "has an effect on" or "acts on") "S" means "is a Sort of" "C" means "is Composed of" "IP" means "Input/Product-Output"	◯ = Processes, actions ⬡ = Actors ▭ = Objects, products, tools

The figure 5 tries to depict three kind of knowledge:
- the tools used within the training project;
- the actors who use the tools;
- the activities supported by the tools.

Four types of actors are grouped in two categories: "Everybody" and the "Executive committee" for avoiding too much links between actors and tools. Height tools are integrated within the distance learning platform (Galanet). Two other tools are used: email (not a list of discussion) and audioconference (telephone). Two tools are "orphan" (= not really used): a voting system which was integrated within the platform but "let down" and a private forum for tutors which was not integrated within the platform. These 10 tools are used for specific purpose/activity (documents storing, information sharing, tutoring groups, organizing meetings, etc.). Seven activities are orphan: no tool is used for sustaining them.

For some of the orphan tools or activities, the interviewees complain: managing oppositions at a distance, producing (and searching for and into) documents, sharing practices and analyzing the project for improving it years after years. Globally, a question is asked: how to better organize or provide useful tools for sustaining the orphan activities?

In the model presented in figure 1, the use of tools appears as condition for engagement of the CoP's members (competences in the use of the CoP's tools and access to them) and for their participation (usability and acceptability of the tools). The tools used participate in the level of the members' comfort into the CoP.

5   Uses and perspectives

In the PALETTE project, these analysis and depictions of the functioning of the CoPs are used for two purposes. On the one hand, the researchers keep in touch with the CoPs and will organize with them other participatory activities such as discussions with focus groups or tests of services or scenarios of use of tools. With the figures 2, 3 and 4 presented here, the researchers could show to the CoPs how they understand their functioning and the questions they ask about it. Regarding the examples above, questions like "how to better reuse documents produced?", "does the decision making process satisfy everybody?", "how to enhance it if need be?", "which tools could support both the process itself and the communication of the decisions made to the participants?"… The CoPs involved in the project are voluntary and know that they possibly enter in a reflexive work. Discussions about these figures could help them to enhance their functioning.

On the other hand, these representations of the real functioning of CoPs will be used by the PALETTE's partners who develop services and tools. They are asked to propose services in phase with the functioning of the CoPs and interoperable with the tools they already use. Clearly, the analyses presented in the figures above could help them to have a specific vision about how a CoP can work and evolve. For example, the partners in charge of the development of knowledge management services could orient their work around the formalization but also the reuse of documents and knowledge within a CoP. In addition, the partners developing mediation services have

specific examples for proposing tools supporting argumentation and debate in order to make decisions.

From a participatory design point of view, these two uses of our analysis show that the researchers and the CoPs need each other for achieving their goals: developing useful and usable services for the ones and understanding and enhancing their functioning for the others.

From an action-research point of view, the model of the figure 1 has shown its usefulness for building a framework for the project. PALETTE is under way and its actions will surely provide enhancements for the model by specifying the processes and the conditions of engagement, participation and learning within a CoP.

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An Example of Participatory Design Methodology in a Project which Aims at Developing Individual and Organisational Learning in Communities of Practice

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Abstract.

The experience described in this paper is being developed in the framework of the PALETTE[1] project by two teams of researchers involved in collecting information from some Communities of practice[2] (CoPs) then in providing this information through suitable formats to their technical partners in the aim of designing an interoperable and extensible set of innovative services and specific scenarios to be implemented and validated in CoPs of diverse context (teaching, management and engineering domains). The aim of our paper is to describe and analyse the methodology created and applied to support this process.

Implementing a Participatory Interview Process

The participatory design process for the whole project was implemented following an Actor-Network Theory (ANT) [Latour, 1999; Monteiro, 2000] driven perspective. The main idea of the early stages of this process is the enrolment, though participatory activities, of actors of different kind, according to ANT –meaning human actor such as CoPs' members, CoPs' observers, etc; and non-human actors such as the inter-

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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 European Commission (DG Information Society and Media).

[2] "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly". "Because its constituent terms specify each other, the term "community of practice" should be viewed as a unit" (Wenger, 1998, p72).

view process, the interview guide, the methodological tool for collecting and retrieving the data and the technical tools used for the interviews, for example – in order to settle the collaborative process necessary to collect useful data for the project.

The role of our two researchers teams, a CoPs' observers team and a Data condensation team, as actors of the participatory design process for the whole project, is depicted in the MOT schema below (see Fig.1).

The project has decided to work not only with previous knowledge or report from previous research on CoPs, but also with a number of existing CoPs (about a dozen). These existing CoPs, more or less formalised as such at the start of the project, are not members of the project, but are more considered as a "field of experiment". It is thus important to explore how the project could meet their own interests so that at least some members would be able to spend time with project members answering to interviews. This was the first role of the CoPs' observers' team. CoPs' observers are members of the project; they are the "correspondents" of the CoPs within the project and the "referring people" for other partners within the project when they need information about CoPs. They are also the key people regarding the design and implementation of the interview process.
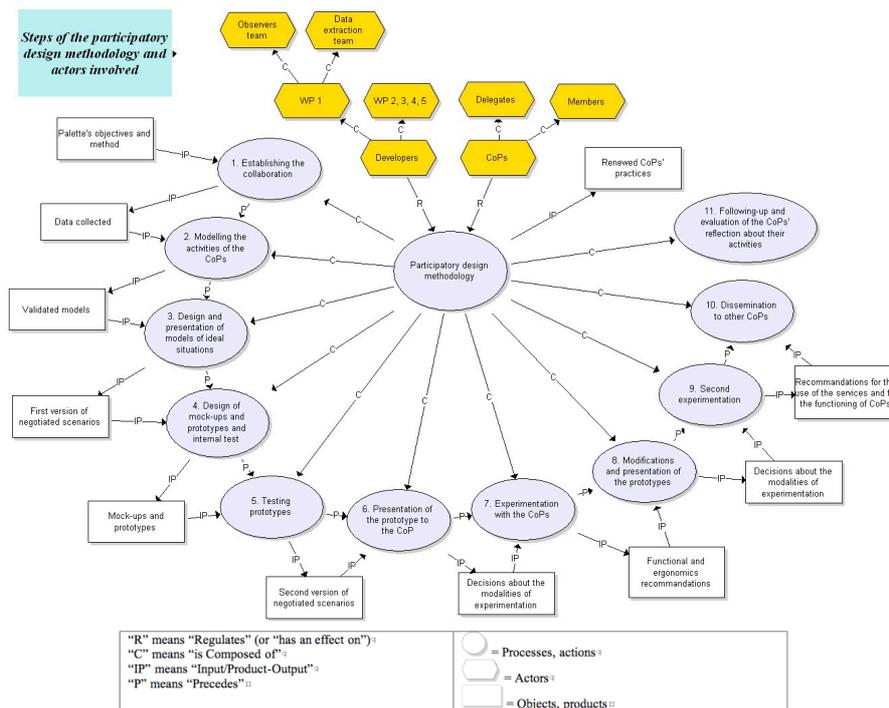

Fig. 1. PALETTE process of Participatory design methodology (MOT schema created by the PALETTE researchers : B. Charlier, F. Henri, A. Daele, M. Künzel)

The Role of the CoPs' Observers Team

The first step of enrolment was thus the one of CoPs' observers through two activities: their participation in designing the research methodology, and noticeably the interview guide and the collect of some knowledge about the CoPs involved through project members that had already some contact with these CoPs. The interview guide was thus constructed as a boundary object [Bowker and Star, 1999] between the project workgroup in charge of this part and the CoPs observers (see Table 1).

Table of contents

Table 1. Table of content of the Interview guide

Table of contents

Table 2. Table of content of the Methodology reference document

This interview guide was created using recommendations by Miles & Huberman (2003), with different issues (origin of the CoP, knowledge about the CoPs members, organization...) and a special attention towards software tools that CoPs are using or may need in their everyday life activities. Some general guidelines have also been provided in a Methodology reference document (see Table 2).

The Role of the Data Condensation Team

The second step of enrolment was the one of the project technical partners, who had to be willing to recognise the scientific value of the participatory design methodology and who were also included in the choice of the collaborative representation tool for the data. The MOT+ software is thus a provider of boundary objects between the work group in charge of collecting the CoPs data and the technical workgroups who are developing the tools.

The Data condensation team has started his work from the interviews and, by way of examples, they have proposed different kinds of data representations to our technical partners for their comments and potential proposals in what the follow-up of the process concern. They have managed like a MOT diagrams and vignettes (text format).

Our technical partners agreed on the five following data formats of interviews and other techniques: the audio record, the minutes by minutes timing, synthesis, MOT diagrams (on specific requests), retranscription of some audio records (specifically for KM services). They also add precisions about their requirements and priorities for the information to be treated by the CoPs' observers team and the Data condensation team.

Some Important Participatory Activities

The interview process by itself is done following several participatory activities:
- the interview by itself is a face-to-face process, involving two CoPs' observers and one or several CoPs' members; technically, the interview is registered as an audio file through a dedicated software; the interview guide is mainly here to remind the interviewers about the categorisation process of the data collection methodology
- the transcription of the interview at two level: one as a "minutes report", enlightening the correspondence between the questions in the interview and the minutes where to find related material (see Table 3); and some more elaborate transcriptions, with more content, organised according to a pre-categorisation process;
- the validation by the interviewee CoPs' members of the transcriptions;
- other data may be extracted from interviews in the form of "vignettes" (small stories), illustrating some typical examples of the CoP's life; such vignettes are written buy the interviewers and also validated by the interviewees.

The interviews transcriptions are thus boundary objects between the CoPs, the CoPs' observers' community and the project workgroup in charge of data collecting.

Name of the CoP : ████████████████████████████ - a community of learners made up of 21 members : 15 teachers and 6 learners	
Name and role of the interviewee : ███ pedagogical manager, moderator, responsible for access and planning - and ███ (from 01:22:20 to 01:31:27) - a learner	
Language of interview : French	
Date of interview : 09-05-2006	
Name of the observers : Martin Erpicum (ULg) – Nathalie Van de Wiele (ePrep)	
Author of the minutes: Nathalie Van de Wiele	
Email : nathalie.vandewiele@eprep.org	

Other documents collected about the CoP :
- A███████
- A████████████████████████████

URL of tools/documents used by the CoP :
- ████████████

File : BADGE-CGE.ogg (1:59:00)

00:00:00	Presentation of Palette's objectives by the observers
00:01:06	Bruno presents himself (involved in continuing education and in data networks)
00:01:36	History of the CoP (a ████████ created to provide a training suitable for working people)
00:02:10	The begining of the CoP (tools specifications, choice of a platform)
00:04:05	Training schema for ████████ face-to-face intensive courses (with multimedia CD-Roms and paper documents) for 3 days a month and online courses
00:04:55	Characteristics required for the platform, choice of Telje
00:05:26	Duration of the training (6 months per CES, mixing practical training and conducting projects)
00:06:10	About the ████████ a (specialized master - M2/D1 - for people having a L2 diploma plus 10 years of experience - the diploma is obtained in 2 or 3 years with 2 CES in 3 domains and is validated by ████████ conducted in 1 year)
00:10:30	About parity (only one woman for 6 learners)
00:11:58	The interactivity between the learners (they come from different parts of France or North Africa, with an almost similar background, with the same aim : to obtain the ████████ a)
00:14:10	How the CoP communicates to have new enrolled learner members (through workshops, press, Telecom Companies)
00:16:00	Creation of micro-communities (2 or 3 learners) inside the CoP for conducting projects (these projects are proposed by the teachers)
00:17:24	A first tool for this CoP : Telje (history of Telje - for Maghreb countries ; specifications : 1-for online courses, 2-for tests in limited time and corrections, 3-for interactive meetings - audio-meetings)

Table 3. An example of a minute by minute timing of an interview

The next step is the translation of audio and text data and their inscription (translation-inscription process in the meaning of ANT, see for example [Law, 1992] and [Callon, 1999]) into MOT+ schemata available for the whole project community, and especially the technical partners (see Fig.2). The MOT+ representation may also be sent back to CoPs' members, with comments, if they are interested.

Conclusion and Further Research

From a practical point of view, our experience could be used as a model by people who must, collaboratively and at a distance, understand and improve how CoPs act.. However, we have to be aware of two possible bias related to the status and involvement of the interviewees : the representativeness of the choosen CoPs and the status of the interviewed people inside the CoP to arrive to an understanding of the CoP functioning as realistic as possible.

With the information that was gathered yet, one CoP activity process (see graphical representation) gives a first idea of the services that could be further developed by PALETTE: technical services (how to produce reusable documents, how to annotate a document in an appropriate way) as well as pedagogical services (how to develop strategies that will make students more at ease for using a forum online), services that should in the end facilitate CoPs life.
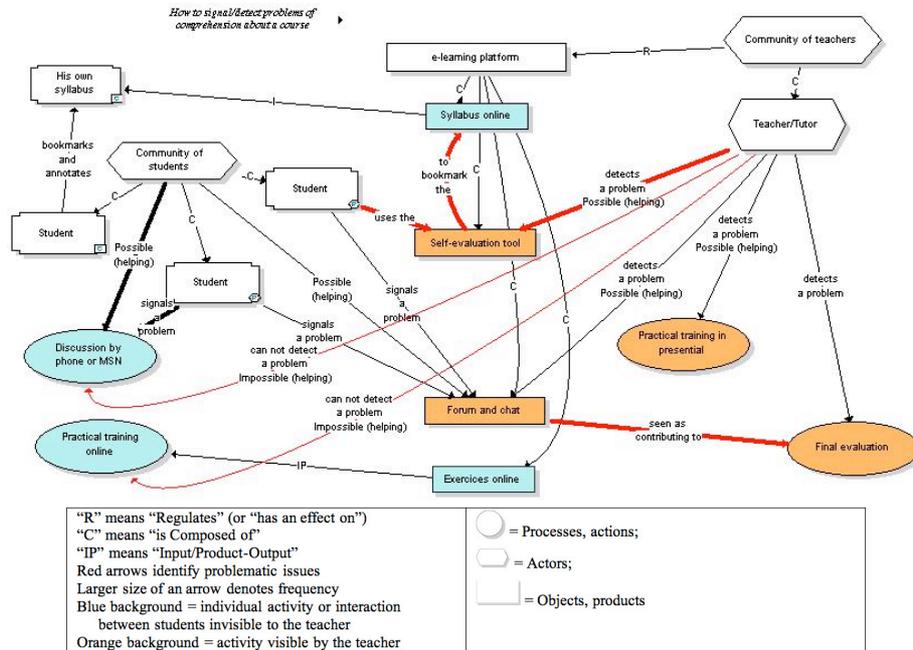
Fig. 2. Graphical representation with MOT+: How to signal/detect problems of comprehension about a course in TE CoP?

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Multimedia Authoring for CoPs

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Abstract. One way of providing technological support for CoPs is to help participants to produce, structure and share information. As this information becomes more and more multimedia in nature, the challenge is to build multimedia authoring and publishing tools that meets CoPs requirements. In this paper we analyze these requirements and propose a multimedia authoring model and a generic platform on which specific CoPs-oriented authoring tools can be realized. The main idea is to provide template-based authoring tools while keeping rich composition capabilities and smooth adaptability. It is based on a component-oriented approach integrating homogeneously logical, time and spatial structures. Templates are defined as constraints on these structures.

1 Introduction

In order to support the activities of Communities of Practice, the Palette project [6] will provide tools for document production and for document reuse in heterogeneous applications. The objective is to reduce the current limitations caused by the proliferation of data sources deploying a variety of modalities, information models and encoding syntaxes. This will enhance applicability and performances of document technologies within pedagogically consistent scenarios.

The LimSee3 project aims at defining a document model dedicated to adaptive and evolutive multimedia authoring tools, for different categories of authors and applications, to easily generate documents in standard formats (see the authoring process showed in Fig. 1). Our approach is to focus on the logical structure of the document while keeping some semantics of proven technologies such as SMIL [7]. This provides better modularity, facilitates the definition of document templates, and improves manipulation and reusability of content.

This paper is organized as follows: Sect. 2 presents a scenario example that will be developed throughout the paper and thereby analyzes CoPs requirements for authoring multimedia documents. We then define the main concepts on which multimedia authoring tools are based and we classify existing approaches in the light of these concepts. Section 4 introduces our LimSee3 document model and Sect. 5 shows how it can be used for the development of authoring tools tuned for specific CoPs. Last section presents the current state of our development and our perspectives in the context of the Palette project.
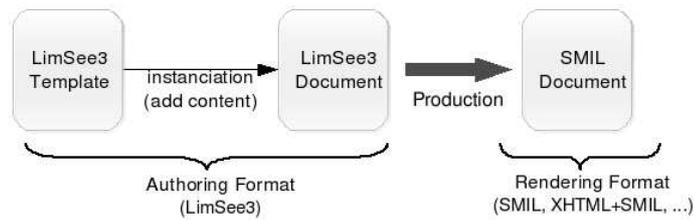
Fig. 1. The authoring process in LimSee3

2   Real-Life Example and Requirements of CoPs

The instrumentation of CoPs heavily relies on communication technologies. In this paper we are concerned with communication through sharing and collaborative authoring of information. We are studying scenarios where experience and knowledge are shared by means of multimedia data, such as annotated video or synchronized slideshow. The key point is that in CoPs, content readers are also content creators but usually have no skills in multimedia authoring. We develop below a concrete scenario of how a particular CoP shares information and then we identify the main requirements of multimedia authoring in such situations.

2.1   Experience sharing between reps

Studies of experiences at companies such as Xerox [8] have demonstrated that CoPs, as the copier repair technicians ("tech reps") CoP, are a very effective way for professionals to share informal or tacit knowledge gained from experience in the field. This sharing of tips, which could not be found in training manuals or classroom settings, was critical to help the tech reps do a better job and was even ultimately fostered by Xerox.

The practice of creating and exchanging stories has two important aspects. First of all, telling stories helps to diagnose the state of a troublesome machine. Reps begin by extracting a history from the users of the machine and with this and the machine as their starting point, they construct their own account. If they cannot tell an adequate story on their own then they seek help from specialists or colleagues (over coffee or lunch).

Brown took example on one service call observed by the ethnograph Orr in [12]. A rep confronted a machine that produced copious raw information in the form of error codes and obligingly crashed when tested. As the error codes and the nature of the crashes did not correspond, the case immediately fell outside the directive training and documentation provided by the organization. Unfortunately, the problem also fell outside the rep's accumulated, improvised experience ; his technical specialist was equally baffled. Solving the problem in situ required constructing a coherent account of the malfunction out of the incoherence of the data and the documentation. To do this, the rep and the specialist embarked on a long story-telling procedure. They explored the machine

or waited for it to crash for collecting data such as logs, screenshots, sound records. The rep and specialist recalled and discussed other occasions on which they had encountered some of the present symptoms via phone calls, webcam records, user feedback... Each story presented an exchangeable account that could be examined and reflected upon to provoke old memories and new insights. Yet more tests and more stories were thereby generated. The story-telling process continued forming a purposeful progression from incoherence to coherence.

Ultimately, these stories generated sufficient interplay among memories, tests, the machine's responses, and the ensuing insights to lead to diagnosis and repair. Through story-telling, these separate experiences converged, leading to a shared diagnosis of previously encountered but unresolved symptoms. Rep and specialist were now in a position to modify previous stories and build a more insightful one. They both increased their own understanding and added to their community's collective knowledge. A story, once in the possession of the community, can then be used – and further modified – in similar diagnostic sessions.

The information units that are exchanged in this particular CoP are multimedia story documents that are composed of sequences of story steps where data elements are heterogeneous and multimedia. The challenges are to enrich information with the synchronization of data elements (for instance a phone call with the corresponding webcam excerpt) and to provide a document structure enabling knowledge sharing and reusability (of experience stories).

2.2   Basic requirements

The cooperative platform to be provided to the CoPs must have the two following basic features: (i) authoring tool of stories dedicated to tech reps ; (ii) access tool to read the existing stories on different devices (desktop PC, PDA, mobile phone...). Looking more closely at the ways in which CoPs participants are producing multimedia information, we can identify some requirements for the authoring and presentation platform:

1. Simple and efficient authoring paradigms – because CoPs members are not (always) computer science technicians.
2. Easy and rapid handling of the authoring tool – because new members can join CoPs.
3. Modular and reusable content – because multimedia information results in a co-construction process between members.
4. Evolutive structuring of documents – because of the dynamic nature of CoPs.
5. Use of standard formats – because CoPs need portability, easy publishing process and platform-independence.

Basically, our approach proposes a template mechanism to cope with requirements 1 and 2, a component-based structuring enabling requirements 3 and 4, and relies on proven standard technologies to ensure the last requirement. Before further stating our authoring model, we present in the next section the main concepts and approaches of multimedia authoring on which this work is based.

3   Multimedia Documents and Multimedia Authoring

In traditional text oriented document systems, the communication mode is characterized by the spatial nature of information layout and the eye's ability to actively browse parts of the display. The reader is active while the rendering itself is passive. This active-passive role is reversed in audio-video communications: active information flows to a passive listener or viewer. As multimedia documents combine time, space and interactivity, the reader is both active and passive. Such documents contain different types of elements such as video, audio, still-picture, text, synthesized image, and so on, some of which having intrinsic duration. Time schedule is also defined by a time structure synchronizing these media elements. Interactivity is provided through hypermedia links that can be used to navigate inside the same document and/or between different documents.

Due to this time dimension, building an authoring tool is a challenging task because the WYSIWYG paradigm, used for classical documents, is not relevant anymore: it is not possible to specify a dynamic behavior and to immediately see its result. Within the past years, numerous researches have presented various ways of authoring multimedia scenarios, focusing on the understanding and the expressive power of synchronization between media components: approaches can be classified in absolute-based [1], constraint-based [9], [11], event-based [14] and hierarchical models [7], [15]. Besides, to cope with the inherent complexity of this kind of authoring, several tools [1], [4], [10] have proposed limited but quite simple solutions for the same objective. Dedicated authoring, template-based authoring and reduced synchronization features are the main techniques to provide reasonable editing facilities. But we can notice that these tools generally also provide scripting facilities to enrich the authoring capabilities and therefore loose in some way their easiness.

Beside timelines, script languages and templates, intermediate approaches have been proposed through "direct manipulation" and multi-views interface paradigms. IBM XMT authoring tool [2] and SMIL tools such as LimSee2 [3] and Grins [5] are good examples. In LimSee2, the time structure of SMIL is represented for instance in a hierarchical timeline as shown in of Fig. 2 (4). Time bars can be moved or resized to finely author the timing scenario. This kind of manipulation has proven very useful to manipulate efficiently the complex structures representing time in multimedia XML documents.

However even if XMT and SMIL are well-established languages, the above-mentioned tools are too complex for most users because they require a deep understanding of the semantics of the language (e.g. the SMIL timing model). Moreover these models generally put the time structure at the heart of the document whereas it does not always reflect exactly the logical structure in the way it is considered by the author. Our approach instead sets this logical dimension as the master structure of the document, which is a tree of modular components each one specifying its own time and spatial structures. Additionally, the document can be constrained by a dedicated template mechanism.

A template document is a kind of reusable document skeleton that provides a starting point to create document instances. Domain specific template systems
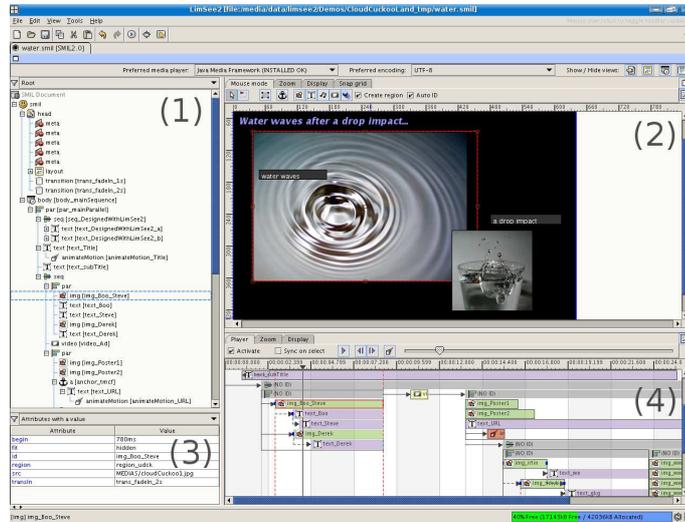
Fig. 2. Multiview authoring in LimSee2

are a user-friendly authoring solution but require hardly extensible dedicated transformation process to output the rendering format. We chose on the contrary to tightly integrate the template syntax in the document: the template is itself a document constrained by schema-like syntax. The continuum between both template and document permits to edit templates as any other document, within the same environment, and enables an evolutive authoring of document instances under the control of templates. There is no need to define a dedicated language to adapt to each different use case.

We believe that the combination of document structuring and template definition will considerably help CoPs in (i) reusability of materials, (ii) optimization of the composition and life cycle of documents, (iii) development and transmission of knowledge, (iv) drawing global communities together effectively.

4   The LimSee3 Authoring Language

4.1   Main Features

In the LimSee3 project, we define a structured authoring language independently of any publication language. Elements of the master structure are components that represent semantically significant objects. For instance a story report document is a list of step components. Each step is composed of several media objects and describes a phase of the story (failure description, machine exploration...). Components can be authored independently, integrated in the document structure, extracted for reusability, constrained by templates or referenced by other components.

The different components of a multimedia document are often tightly related one with another: when they are synchronized or aligned in space, when one contains an interactive link to another, and so on. Our approach, which is close to the one proposed in [13] is for each component to abstract its dependencies to external components by giving them symbolic names that are used in the timing and layout sections. This abstraction layer facilitates the extraction of a component from its context, thus enhancing modularity and reusability.

Finally, the goal was to rely on proven existing technologies, in both contexts of authoring environments and multimedia representation. The timing and positioning models are wholly taken from SMIL. Using XML provides excellent structuring properties and enables the use of many related technologies. Among them are XPath, used to provide fine-grained access to components, and XSLT, used in templates for structural transformation and content generation.

The authoring language is twofold: it consists in a generic document model for the representation of multimedia documents, and it defines a dedicated syntax to represent templates for these documents.

4.2   Document Model

A *document* is no more than a `document` element wrapping the root of the object hierarchy and a `head` element containing metadata. This greatly facilitates the insertion of the content of a document in a tree of objects, or the extraction of a document from a sub-tree of objects.

A *compound object* is a tree structure composed of nested objects. Each compound object is defined by the `object` element with the `type` attribute set to `compound`. It contains a `children` element that lists children objects, a `timing` element that describes its timing scenario and a `layout` element that describes its spatial layout.

The value of the required `localId` attribute uniquely identifies the component in the scope of its parent object, thereby also implicitly defining a global identifier `id` when associated with the `localId` of the ancestors. In Example 1, the first child of object `step1` has the local id `copyLog` and hence is globally identified as `step1.copyLog`.

The timing model, and similarly the positioning model, is taken from SMIL 2.1. The `timing` element defines a SMIL time container. The timing scenario of a component is obtained by composition of the timed inclusions defined by the `timeRef` elements, whose `refId` attributes are set to local ids of children.

```
<document xmlns="http://wam.inrialpes.fr/limsee3/"
  xmlns:smil="http://www.w3.org/2005/SMIL21/">
  <head><!-- some metadata --></head>
  <object localId="step1" type="compound">
    <children>
      <object type="text" localId="copyLog">...</object>
      <object type="image" localId="screenshot">...</object>
      <object type="compound" localId="AnnotatedVid">...</object>
```

```
    </children>
    <timing timeContainer="par">
      <timeRef refId="AnnotatedVid" begin="0s"/>
      <smil:seq begin="0s">
        <timeRef refId="screeshot"/>
        <timeRef refId="copyLog"/></smil:seq></timing>
    <layout height="100" width="100">
        <layoutRef refId="AnnotatedVid" left="0"/>...</layout>
</object></document>
```

Example 1. **A simple story step LimSee3 document**

A *media object* is actually a simple object that wraps a media asset, i.e. an external resource (such as an image, a video, an audio track, a text...) referenced by its URI. It is defined by the `object` element with the `type` attribute set to either `text`, `image`, `audio`, `video` or `animation`. The URI of the wrapped media asset is the value of the `src` attribute. Example 2 shows a text media object with local id `menuItem1` which wraps the media asset identified by the relative URI `./medias/item1.txt`.

Area objects inspired from the SMIL `area` element can be associated with media objects. They are used for instance to structure the content of a media object or to add a timed link to a media object. An area is defined as an `object` element with the `type` attribute set to `area`. For instance, in Example 2 the media object `menuEntry1` has a child area which defines a hyperlink.

Relations of dependency between objects are described independently of their semantics in the document. External dependencies are declared with `ref` elements grouped inside the `related` child element of objects. The value of `refId` of a `ref` element is the id of the related element and the value of `localId` is a symbolic name that is used within the object to refer to the related object. For instance, in Example 2, object `menuItem1` describes a text that links to the object `story.step1`, by first declaring the relation in a `ref` element and then using this external object locally named `target` to set the value of the `href` attribute of the link, using `attribute` and `value-of` elements taken form XSLT.

```
<object localId="menuItem1" type="txt" src="./medias/item1.txt">
  <related><ref localId="target" refId="story.step1"/></related>
  <children><object type="area" localId="link"/></children>
  <timing>
    <attribute name="begin">
      <value-of refName="target" select="@id"/>.begin</attribute>
    <timeRef refId="link">
      <attribute name="href">
        #<value-of refName="target" select="@id"/></attribute>
</timeRef></timing>...</object>
```

Example 2. **A LimSee3 object with external dependency relations**

4.3   Templates

Template nodes aim at guiding and constraining the edition of the document. In order to have better control and easy GUI set up, the language includes two template nodes: media zone and repeatable structure.

A *media zone* is a template node that defines a reserved place for a media object. It is represented by the `zone` element, that accepts a `type` attribute (`text`, `img`, `audio`, `video`, `animation`, `any`, or a list of these types) to define what types of media object can be inserted in this zone. The author can also specify content that will be displayed to invite the user to edit the media zone with the `invite` element (of any media type). For instance Example 3 shows a media zone for an image, with textual invitation. During the authoring process `zone` elements are filled with media objects inserted by the user.

A *repeatable structure*, represented by the `objList` element, is a template node that defines a homogeneous list of objects. Each item of the list matches a model object declared in the `model` child of the list. The cardinality of the list can be specified with the `minOccurs` and `maxOccurs` attributes. Example 3 shows a story template document based on an `objList` named `step-list`, and partially instanciated with three compound objects respecting the `step` model. Thanks to the use of XSLT-like syntax, the timing scenario can be specified independently of the content of children instances.

It is possible to lock parts of a document with the `locked` attribute, to prevent the author from editing anything. This permits for instance to guide more strongly inexperienced users by restricting their access to the only parts of the document that make sense to them.

```
<object localId="story" type="compound">
  <children>
    <objList localId="step-list" maxOccurs="20">
      <model name="step">
        <object type="compound">...</object></model>
      <object type="compound" localId="step1">...</object>
      <object type="compound" localId="step2">...</object>
      <object type="compound" localId="step3">...</object>
  </objList></children>
  <timing>
    <smil:seq begin="1s">
      <for-each
        select="children/objList[@name="step-list"]/object">
        <timeRef>
          <attribute name="refId">
            <value-of select="@localId"/>
    </attribute></timeRef></for-each></smil:seq>
</timing>...</object>
```

Example 3. **A partially instanciated story template**
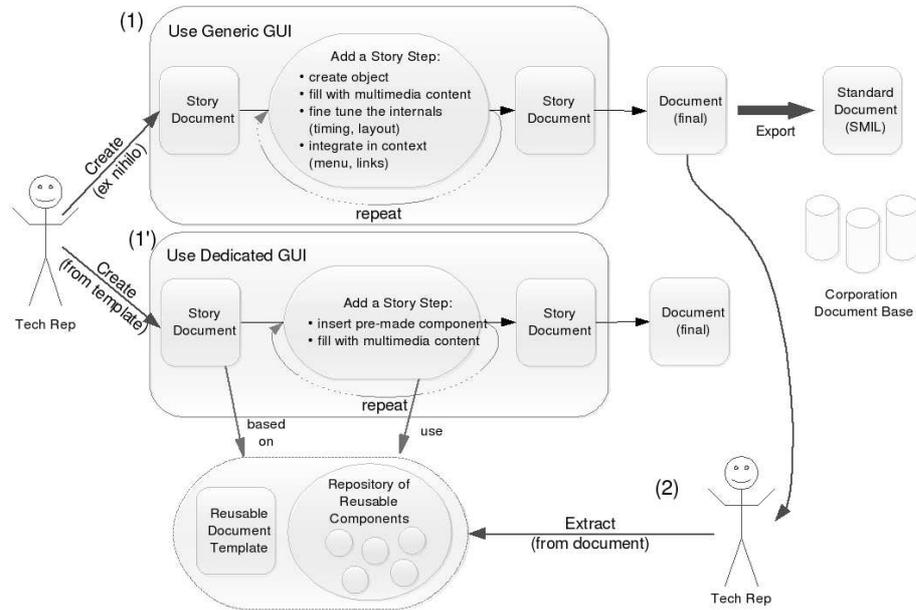
Fig. 3. Authoring with LimSee3

5   Authoring with LimSee3

Figure 3 (2) also shows the creation of a template document from an existing document. The main structure of the document, in this case a sequence of story steps, can be constrained by template nodes such as repeatable structures. Additionally, inter-object relations described in Sect. 4 facilitate the extraction of components from their context so that they can be reused in other documents. In the tech reps CoP, a possible workflow is to first create a story report from scratch (1), then to extract a template document from this report (2), along with a dedicated GUI, to ease the creation of further story reports (1'). This is a typical example of participative design leading to the development of a dedicated tool based on the LimSee3 generic platform.

The LimSee3 model leads to the development of authoring tools that fit the requirements of Sect. 2.2. We are defining a generic platform that permits to manipulate all the elements defined in the model (documents, compound objects, timing and layout details, relations...). It provides features based on the proven authoring paradigms described in Sect. 3 such as multi-views, timeline, structure tree an 2D canvas. In the reps CoP example described in Sect. 2, a tech rep could have used the generic GUI to create the story report ex-nihilo, as shown in Fig. 3 (1), incrementally adding story steps by creating and integrating new objects in the document (resulting in the LimSee3 document of Example 1). Once fully authored, the story report can be persistently added to the base

of documentation maintained by the company, and published on demand to any output format (provided its semantics is included in the document model).

Another approach is to use a domain-specific template with dedicated GUI, as shown in Fig. 3 (1'). For instance, a template for a story report could consist in a repeatable structure of story steps. These steps could be instantiated from existing template components such as an audio zone for phone calls, a text zone for machine logs, ... The constraints of the template would guide the tech rep in the creation of the document, reflected in the GUI by dedicated buttons or menu items such as "add a story step", "insert a phone call record", or a form-based interface for adding titles or comments to multimedia content. In the underneath manipulated model, the tight integration of template nodes in the document ensures a smooth evolution from the template to the final document.

6 Conclusion

The model presented in this paper develops a practice-based approach to multimedia authoring dedicated to communities where collaborative and participative design is of high importance. It improves reusability with template definitions and with the homogeneous structuring of documents. This document model is being implemented as cross-platform java software. In the context of Palette, we will use this model to develop dedicated authoring tools for pedagogical CoPs.

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Finding Communities of Practice from User Profiles Based On Folksonomies

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Abstract. User profiles can be used to identify persons inside a community with similar interests. Folksonomy systems allow users to individually tag the objects of a common set (e.g., web pages). In this paper, we propose to create user profiles from the data available in such folksonomy systems by letting users specify the most relevant objects in the system. Instead of using the objects directly to represent the user profile, we propose to use the tags associated with the specified objects to build the user profile. We have designed a prototype for the research domain to use such *tag-based profiles* in finding persons with similar interests. The combination of tag-based profiles with standard recommender system technology has resulted in a new kind of recommender system to recommend related publications, keywords, and persons. Especially the latter is useful to find persons to potentially cooperate with and to monitor the community to be able to enhance a user's current Community of Practice.

1   Introduction

For people in a community (such as professors and students in the research community), a well-defined profile expressing their current interests is highly valuable. As one main application, such profiles can help to find persons who work on related topics and, thus, help to facilitate cooperation within the community.

Two steps are necessary to create user profiles:

1. Determine the user profile schema, i.e., how the user profile should look like.
2. Determine how to populate the user profiles with actual data for particular users.

Both steps are interrelated: In general, the higher the accuracy of the user profile is, the more data the profile schema comprises, and a large schema in general leads to more complex handling and maintenance of the profiles. Especially the problem of populating user profiles with actual and accurate data is difficult to solve for large profiles as accurate data mostly is based on human inspection.

In this paper, we propose to use tagged corpora of objects to create user profiles in domains, where such folksonomies are available. The basic idea is to let people create their profiles by specifying the most relevant objects in the folksonomy. Afterwards, this *intermediate profile* comprising the objects is translated into the tag domain, assuming that the manually specified tags describe the objects with a high accuracy. Hence, the

representation of the *final user profile* is based on the tags of the most relevant objects. This has the advantage that users only have to specify comparatively few objects to generate a reasonably large user profile. Furthermore, it is easier to find related user profiles as tags are typically shared by several objects.

We apply our approach to the domain of digital libraries, using a subset of the DBLP data set as object corpus, which has been enhanced with 'tags', e.g., the keywords that were manually specified by the authors of the publications. The resulting user profiles, generated by our prototypical *TBProfile system*, are represented by keyword vectors and are exported in RDF (as already proposed in the eLearning domain [5]), so they can be reused in other domains with similar tags. The TBProfile system uses standard recommender system technology on these profiles to recommend other publications, other relevant keywords (for refining the user profile), and finally other relevant persons. These persons, being relevant for the user, are potential candidates to collaborate with and, thus, to be added to the user's Community of Practice.

This paper is organized as follows: The related work is given in Section 2. In Section 3 we describe our approach to creating and maintaining user profiles and present our experimental setup. Section 4 describes how to provide users with relevant recommendations based on these user profiles and how to build communities of practice. We conclude and outline future research directions in Section 5.

2   Related Work

There are different approaches to extracting user profiles from users' past activities and using them for discovering and analyzing communities. In [4], the similarity between peers in social collaboration networks is used to improve search in a peer-to-peer network. The similarity is computed based on publications and their references. The user profile is build based on the publications the user has stored on her desktop. This approach is too broad as the documents a user stores are usually not focused enough. The system takes into account all publications found, including ones dealing with topics the user may no longer have interest in or that the user has stored without even reading them or working on the topic.

Middleton et al. [9] present a recommender system for online academic publications where user profiling is done based on a research paper topic ontology. The system monitors what research papers a group of person has downloaded from the web and stores them on a server. For all downloaded research papers, terms are extracted from the full text using standard information retrieval techniques to be able to represent the paper with term vectors. The system uses different classifiers to assign topics to the papers. User profiles are automatically built based on the vector-representation of those research papers, downloaded by a particular person in the monitored group of persons, and can be refined based on relevance feedback. Finally, the system gives recommendations for each user based on the user's profile. While an automatic update of the profile based on actual browsing of papers (similar to other publication recommender systems [1, 11]) can reduce the efforts for creating and maintaining user profiles, this is in contrast to the issue that user profiles are typically rather stable over time, while the 'browsing task' is often focused on a short-term goal (e.g., help a colleague to find

something or explore a topic which finally turns out not to be interesting). Hence, not all browsed documents are relevant to the user, even if we take into account the time spent on the respective document. Also, we would like to limit the collection of explicit relevance feedback which can create quite a workload for the user. Furthermore, the approach is pretty intrusive as it requires the monitoring of the browsing behavior of a group of persons. In contrast, our approach is based on publicly available information about objects and manually-assigned tags of objects. As manually assigned tags are assumed to be highly accurate, our approach does not suffer from the inaccuracy of an automatic classification system.

Existing systems to recommend publications in the domain of research are mainly keyword-based search engines (e.g., google scholar, ACM digital library etc.). They are mainly intended to fulfill short-term search objectives (find a paper with a specific title, find the paper for a specific author etc.). However, some papers are difficult to find based on keywords only, especially if a research domain is already well known. Furthermore, once a researcher has written a paper, she might turn to a different topic within her research interests, but still would like to be informed about the development in some of the topics, she has previously worked on. Hence, a recommender system for research papers [8] based on a long-term user profile is highly desirable. While the issue of user profiles has been found to be highly relevant for recommender systems [10], it has not been addressed sufficiently in the literature, and there are no existing systems which share the user profiles they are using to take advantage of the distributed knowledge about the users. This gap is intended to be filled by our TBProfile prototype.

3   TBProfile: A Tag-Based User Profile Generator

This section presents our approach to creating and maintaining user profiles. The basic idea is to relate a user with a set of tagged objects and store them in an intermediate user profile. The final representation of the user profile is based on the tags associated with the objects. An example set of objects (publications from the Semantic Web domain) forming an intermediate user profile is shown in Table 1.

Publication title	Tags (Keywords)
Magpie: supporting browsing and navigation on the semantic web	named entity recognition (NER), semantic web, semantic web services, . . .
Bootstrapping ontology alignment methods with APFEL	alignment, mapping, ontology, . . .
Swoogle: a search and metadata engine for the semantic web	rank, search, semantic web, . . .

Table 1. Example: Intermediate user profile comprising a set of tagged publications

A user having selected only these three publications will be described by the final user profile shown in Table 2. Using the tags in the user profile has several advantages:

User	. . .	NER	Semantic Web	SW Services	Alignment	Mapping	ontology	rank	search . . .	
A	. . .	1	2	1	1	1	1	1	1	. . .

Table 2. Example for the final representation of a user profile

– A more accurate description of the user's interests based on the content of the selected objects.
– A denser population of the user profile, i.e., less non-empty values (assuming that the objects are on average tagged with more than one tag). This approach can be extended to adding those tags to the user profile, which are clearly subsumed by another tag (such as 'RDF' being a sub-topic of 'Semantic Web'). These can automatically be derived, for example, using the GrowBag approach [2] and can further reduce the sparsity of the user profile.
– A lower dimensionality of the user profile if the number of tags is smaller than the number of tagged objects. For this purpose, a controlled dictionary [14] can been derived from the set of all tags. As tags are typically power-law distributed [7], removing the rarely-used tags can reduce the dimensionality of the user profiles by several orders of magnitude (in our experiments, 8600 tags out of 130,000 represented 60% of all occurrences of tags).
– A higher connectivity among the different user profiles as the user profiles are more dense and because the tags in folksonomies tend to be power-law distributed.

In our approach we want to support several different ways of creating user profiles starting from a corpus of tagged objects:

1. Search or navigate through the set of available tags, selecting a subset of the most interesting ones to be able to present the objects associated with this subset of tags, from which the user can select the most interesting ones. This can make use of automatically derived relations between tags as proposed in the GrowBag approach [2].
2. Browsing through the set of objects already existing in the user profile, adding / deleting objects and / or single tags.
3. Browsing through the list of recommended objects (such as publications or persons in the publication domain) and tags and adding the most interesting ones to the profile.

Each user has the possibility to individually modify her profile by adding new objects or removing objects the user is no longer interested in. Also, it should be possible to mark certain topics as 'not interesting': If an object has been tagged by several persons, not all the tags of an object may describe the interests of one particular person. In the publication domain, for example, this means that not all the keywords of a publications with several authors may be relevant for the interests of one particular author; the non-relevant keyword might be referring to a part of the publication written by another co-author.

The tags are typically gained using a manual 'tagging' approach (e.g., in the publication domain, the authors already provide a set of keywords describing their publications). Alternatively, keywords can be retrieved using Information Retrieval methods, for example, from the title, the abstract, or the full text of the publication, though they are typically of lower quality.

3.1 Approaches to Creating and Maintaining User Profiles

Which of the three earlier mentioned ways to creating user profiles are best suited for a particular user strongly depends on the type of user: For users without a profile, we

first try to bootstrap a user profile based on the tags, the user herself has contributed to the folksonomy system (if existing). While this is easy in general folksonomy systems, problems arise in the publication domain because of missing user ids. Hence, it is necessary to match the user name with the names of all authors in the publication dataset and present a list of papers, where the author names match the user name. The user can subsequently process this list to eliminate publications from other authors having the same name.

If a new user has not tagged any objects herself, she can alternatively search the set of available tags to find those tags which best describe her interests. They are used as a conjunctive query to identify a list of potentially interesting publications. To accommodate too large / too small result lists, tags can be added / removed on-the-fly to get a reasonable size of the result list. Tag hierarchies as generated by the GrowBag system [2] can be used to easier navigate through related tags.

After having selected a set of tags, a user can preview and browse the current intermediate user profile comprising the list of objects that are annotated with these tags, adding interesting objects to the user profile or deleting those objects, which are no longer interesting. This also means that the tags associated with this object are added to or removed from the final tag-based profile. This approach enables an automatic assignment of cardinalities in the user profile. For example, if a user has selected five objects as interesting from which three are tagged with 'Semantic Web', the cardinality of the tag 'Semantic Web' in the user profile will be three. In contrast, if the user chooses the interesting tags directly, she would have to assigned the cardinalities manually.

Based on the user profile, the system can also recommend other possibly interesting items or even related tags (cf. Sect. 4). They can be used to further extend and refine the user profile, in case the user agreed with some part or with all recommendations. This is especially useful for people who already work in their community for quite some time and want to monitor the dynamics of the community.

After the user has finished editing her profile we want to export the profile in the RDF format (similar to a FOAF file) which the user can put on her homepage. This allows for an easy exchange of user profiles within a community. Furthermore, other tools can be used to change and maintain the user profile and re-introduce it again to our system later. Hence, we export both the tag-based user profile and also the collection of objects on which the user profile is based. For this purpose, we need unique identifiers for the objects, such as a URL. Moreover, users can also directly view their profile with any RDF viewer and see how their interests overlaps with their colleagues.

3.2   Experimental setup

The TBProfile system applies our ideas to the digital library domain, where the tagged objects are publications and the tags are the keywords, manually annotated by the authors of the publication.

We have used the DBLP collection of around $650,000$ computer science related publications, providing the URLs for about $330,000$ of the publications. As described in [2], all manually annotated keywords were extracted from the provided URLs using a wrapper-based approach. From about 53.000 URLs, proper tags could be found, resulting in a 'folksonomy' of tagged publications with around $130,000$ popular unique

tags. All tags were post-processed using acronym replacement (e.g., WWW → World Wide Web) and Porter stemming and the tags which were mentioned less than five times were filtered out. This resulted in a controlled vocabulary of about $8,600$ 'main' tags, representing 60% of all occurring tags due to the power-law distribution of tags.

The TBProfile system comprises also a web application which allows the users to select tags from the controlled vocabulary of tags, either by browsing the set of available tags or by starting from the set of defaultly assigned publications and using the recommender system. For the selected tags, a user can search for publications and select the ones relevant to her current interests. When the user has finished editing her list of publications, she can view her profile and get recommendations about other publications, tags, and persons.

As an example, Table 3 shows the tag-based profile of 'Wolfgang Nejdl', which has been gained only using his publications available in our tagged DBLP collection.

Keyword name	Occurrences	Global Frequency
XML	1	554
UML	1	302
Web services	1	193
Ontology	1	158
Adaptation	1	102
Semantic Web	5	190
Peer-to-peer	4	123
Personalization	4	92
Standards	1	61
Query languages	1	63
Hypermedia	1	93
Generalization	1	25
Web search	1	49
E-learning	1	59
Network management	1	49
Diagnosis	1	49
Ranking	1	31
Pagerank	1	38
Web engineering	1	35
Adaptive hypermedia	2	30
Meta-modeling	1	9
XML scheme	1	23
XMI	1	9
Asynchronous collaboration	1	8
Synchronous collaboration	1	5
Adaptive Web	2	5

Table 3. Tag-based profile of Wolfgang Nejdl

The column 'Occurrences' denotes the number of times the keyword appears in the profile and 'Global Frequency' represents how many times the keyword appears in all publications of the community.

Additionally, we also want to let the users explore different sources for the tags assigned to an object. In the digital library domain, this can be, for example, keywords

derived from the publication title, or keywords derived from the abstracts. While manually created keywords usually have a very high quality, using keywords extracted from the title / the abstract leads to a larger set of tagged documents for the case that not all documents were manually tagged by the authors.

4   Using Tag-Based Profiles for Recommendations

One application of the created user profiles is to provide the user with recommendations about related objects or tags (i.e., to use in regular search engines), and related users with similar interest, who are candidates for collaborations. The main intention is to deeper analyze the research community.

4.1   Basic Idea

The basic idea is to use the tag-based profiles as input to standard recommender system technology [12], to be able to recommend related objects, tags and persons. Hence, we combine the 'user profile' aspect of collaborative filtering systems with the feature-representation aspect of content-based systems. This means, we combine the idea of letting users 'recommend' items, which is a different interpretation of users tagging objects, with the characteristics of legacy information retrieval systems and the derived content-based recommender systems, where objects are represented by their features, typically a vector of terms.

The TBProfile system comprises a user-item recommender system, that computes similarities between users based on a cosine function, that has been extended with the concept of an 'inverse user frequency' [3] as the analogue concept to TFxIDF in the recommender system domain. The similarity between two users $U1$ and $U2$ is computed as shown in Eq. (1)

$$cos\_iuf(U1, U2) = \frac{\sum_i v_{U1}(i) * iuf(i) * v_{U2}(i) * iuf(i)}{\sqrt{\sum_k (v_{U1}(k) * iuf(k))^2 * (v_{U2}(k) * iuf(k))^2}} \qquad (1)$$

with $v_U(i)$ being the normalized 'vote' of user U for the item i, and $iuf(k)$ defined as shown in Eq. (2)

$$iuf(k) = log(\frac{\text{number of users}}{\text{number of votes for k}}) \qquad (2)$$

As an example, for a user $U1$ having selected three publications for her profile with in total 10 distinct keywords K_{U1}, $v_{U1}(i)$ will be $1/10$ for $i \in K_{U1}$.

The neighborhood N_U for each user U is computed using the k-nearest neighbor approach [13] with $k = 20$. Finally, we compute the recommendation for a certain item I by aggregating the votes of all neighbors of U in a similarity-weighting [6] approach according to Eq. (3)

$$rec(U, I) = \frac{\sum_{j \in N_U} v_j(I) * cos\_iuf(U, j)}{\text{neighborhood size}} \qquad (3)$$

The neighborhood size can at most be k, but may be smaller if only very few similar users are found for the given user U.

Our system can provide several kinds of recommendations:

1. Objects based on users.
2. Users based on objects.
3. Users based on co-tagging.
4. Tags based on users.
5. Users based on tags.

In the first case, the recommender system uses a standard user-object matrix to be able to recommend related objects (e.g., publications in the digital library domain [8]). In the second case, the matrix is transposed to be able to recommend users instead of objects. This is one variant to get information about other users in the community. In the third variant, the recommendation is based on a matrix of users having tagged the same objects. This can also be used to get information about people in the community. The fourth case is the first one, where we actually use the tag-based user profiles to create a user-tag matrix and finally recommend tags for the users in that matrix. By transposing this matrix, we are able to recommend users based on the tags users have annotated, which is the last variant described here.

4.2   Experimental setup

Our TBProfile application can give recommendation for publications, keywords and other users of the system. For our experiment we have selected the top 60 authors who have published publications with the topics "semantic web" and "OWL". For these authors we have built their profiles based on the keywords of the papers they have authored. The intermediate profiles comprised on average 34 publications while the number of keywords per authors was only 16 due to the fact that only 20% of the publications in our database are tagged.

For the profile from Table 3 we show the recommendations in the following tables regarding recommended authors. We only provide the user with at maximum the top ten results.

Table 4 is the result of case 3, i.e., based on a co-author matrix.

Recommended author	score
Rudi Studer	0.0512828
Dieter Fensel	0.0362056
Ian Horrocks	0.0238108
Peter F. Patel-Schneider	0.0221371
Raphael Volz	0.022023
Alexander Maedche	0.0183598
York Sure	0.013157
Timothy W. Finin	0.0268965
Nenad Stojanovic	0.00993426
Enrico Motta	0.00619568
Daniel Oberle	0.0060706

Table 4. Recommendations based on coauthorship

These recommendations clearly focus on the 'senior' people, having long lists of publications. In this recommendation, tags have not been used at all. In contrast, the

Recommended collaborators	score
Steffen Staab	0.390822
Axel Polleres	0.311705
York Sure	0.299058
Siegfried Handschuh	0.253242
Nigel Shadbolt	0.214939
Dieter Fensel	0.21334
Ruben Lara	0.206428
Yuan-Fang Li	0.193029
Bijan Parsia	0.187487
Carole Goble	0.17375

(a) ... based on keywords

Recommended collaborators	score
Siegfried Handschuh	0.411228
Rudi Studer	0.274152
Dieter Fensel	0.137076
York Sure	0.137076

(b) ... based on publications

Table 5. Recommended collaborators...

recommendations based on the tags (cf. Table 5 (a)), are based on the content and are not related to the number of publications. Hence, also 'junior' people are recommended by our main scheme. For comparison, we also show the result of case 2 in Table 5 (b)), where we use the transposed user-publication matrix to recommend users. We can see, that only four persons can be recommended here, for other users of the system this list of recommendations was even empty. This is because the user-publication matrix is in general less connected than the matrix based on the tags as people tend to share tags and use some of them very often (the 'stars' in the power-law distribution).

5   Conclusions and future work

Having a well-defined user profile can be very helpful, especially in research communities where people are explicitly interested in finding out firsthand about what happens in their line of work. No matter if people are interested in finding new relevant publications, related topics or about people to collaborate with, their user profile can support the information flow in their Community of Practice. In this paper, we use the tags from a folksonomy system to build user profiles and feed them to a recommender system, especially to identify related persons in the community. This unique combination of the user profile aspect of collaborative recommender systems with the feature-based schema to describe user profiles (as used in content-based recommender systems) is intended to better capture the interests of the users in the recommendation process and to reduce problems with sparse user profiles. We have shown the TBProfile prototype, implementing a rudimentary system for creating tag-based user profiles in the digital library domain and using a user-item based recommender system to find potential people to extend a user's community of practice. Even though only 20% of the publications in our database are tagged, we have shown evidence that using tag-based profile can give more recommendations than standard object-based user profiles.

For future work, we want to focus mainly on the evaluation of our system, especially involving relevance feedback of real users by notifying them regularly about new interesting publications, persons, and keywords and using answers about the value of

the recommendation to update the user profile. Furthermore, we want to compare the recommendations provided by different tagging schemas (manually tagged vs. automatically derived from the title or the abstract). You can see our current prototype at http://www.l3s.de/∼diederich/TBProfile.

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On the Use of Actor-Network Theory for Developing Web Services Dedicated to Communities of Practice

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Abstract. Communities of practices are more and more recognized by companies, individuals and groups as valuable places to share and create knowledge. Communities of practice have to be cultivated in order to fully create the value they may bring to their environment. They need interoperable, flexible, ubiquitous, and specific collaborative tools to support their work. Developing such tools and enabling their use among communities of practice requires adopting a Participatory Design approach. Actor Network Theory (ANT) is then used to define a methodology that fosters the participation of heterogeneous stakeholders to the design process. As a case study, we show that ANT concepts are useful to analyse the design context of an European project named PALETTE that aims at developing interoperable services for helping communities of practices to better cultivate themselves

Keywords: communities of practice, participatory design, actor-network theory, European projects

1 Introduction

Our focus is on reflecting upon a design methodology that could help providing a community of practice (CoP) with enough suitable and usable tools so that it is able to cultivate itself appropriately. Wenger et al. (Wenger et al. 2002) identify seven principles for cultivating communities of practice: design for evolution, open a dialog between inside and outside perspectives, invite different levels of participation, develop both public and private community spaces, focus on value, combine familiarity and excitement, create a rhythm for the community.
We are well aware that these processes of cultivating communities of practice go far beyond the design of tools. But collaboration, communication, knowledge management, document exchange, problem solving are activities that cannot be accomplished without a strong support from technology enabled tools, all the more so because communities members are scattered in different locations and even across different organizations.

Usual communication tools like e-mail, and forums are naturally the common basis for communication. But they are not efficient enough to really support the development of the activities of a community of practice to the point where it can start create value for

itself and its environment. CoPs need tools that answer better to their specific needs and usages. They have - simply - to create, reuse, store, share, exchange, publish, represent and capitalize information. But the nature of the information, the content and the value of it are somewhat different than what a usual database or document management system can provide. The information that is manipulated in a community of practice is more often informal, declarative, textual or graphic, qualitative, practice-oriented, sometimes not well formalized or even expressed. It may deal with a lot of different subjects, the relevance and value of which are only decided by the community. Thus a community of practice needs tools that share some common features, among which:

- be available anywhere;
- allow flexible use, depending of the skills of the members regarding technology;
- cover a range of document management functions: creation, modification, publication, exchange, storage, retrieval, all on a collaborative basis;
- cover a range of information representation and modelling functions providing a mean for creating a common ground within the community;
- cover a range of knowledge management functions, related to the practice and the identity of the community, and the learning activities within the community;
- enable communication, collaboration and cooperation in the way that is useful for the community, both inside the community and between the community and its environment;
- allow to understand, represent, enrich, share members' expertise.

Such tools might be different - even radically - from the usual IT that are used in companies or for the day-to-day job. They are merely based on new technologies, open-source or "open-source minded" (the usefulness and quality of which are qualified by users, not by proprietary developers). They have to be interoperable, evolutionary, flexible *and truly* collaborative. They are likely to appear as a set (a "palette" of interoperable web services.

2 Designing web services for communities of practice: Actor-Network Theory and Participatory Design

The Participatory Design approach may be considered as a process of negotiation of usefulness to be achieved through reconciling the contrasting perspectives of various stakeholders, including users, designers and others. We argue that using ANT[1] to

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[1] ANT was formerly the acronym for Actor-Network Theory. It is now used as itself, and even one of its first creators, Bruno Latour, recognises that it has become something different, and if it was created now, he would probably not have used the same words, specially the word network that he feels confusing now [Latour 1999]. We will then use ANT as a name and not as an acronym

analyse design situations where CoPs[2] are involved can help defining a suitable Participatory Design methodology.

There are different interpretations of the usefulness of technology. As stated by Abreu de Paula: "perception of usefulness is not statically embedded in its design, but is dynamically and constantly created and shaped by different social groups. In this respect, one important goal is to attempt to reconcile these often contrasting perspectives" (Abreu de Paula, 2004). While Participatory Design does not explicitly address the social construction of usefulness, it may be considered as framing the social interactions that eventually lead to a recognised useful system.

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. Each actor of the design process is an expert of her domain and this expertise influences the design process. However actors are heterogeneous in respect to their disciplines, preoccupations and interests: they don't 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. Examples of such activities include brainstorming meetings, prototype demonstration, scenario performing, role playing, design games. Participative activities are often hampered by suspicion and even conflict.

Some of these activities may focus on creating boundary-objects (Bowker and Star, 1999; Gasson, 2006) i.e. objects "to-think-with" that facilitate mutual understanding and trust among participants with various backgrounds. A mock-up, an intermediate version of the final product, a use-case or a scenario are classical boundary-objects. This concept is closely related to what Wenger says about reification: "reification … refer to the process of giving form to our experience by producing objects (…) In so doing we create points of focus around which the negotiation of meaning becomes organized"(Wenger, 1998).

ANT provides a conceptual framework helping formulating and building a design methodology that sustains efficient participation of heterogeneous. ANT portrays an alignment that differs from the traditional system development one along crucial dimensions: there is an open-ended array of "things" that need to be aligned including work-routines, incentive structures, system modules and organisational roles. It follows immediately that there can be no strict top-down control over such a collection of things (Monteiro, 2000). Actors' heterogeneity is one of ANT main originalities. An actor is characterized first hand by its capability to act and interact, its 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

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[2] Just as for ANT, we will use the term CoP to refer to a community of practice, following Wenger's recommendation that "community-of-practice" should be viewed as a unit (Wenger, 1998)

participation/influence of non-human actors, such as artefacts and organisations. This is obviously an interesting feature when describing a socio-technical system.

ANT concepts seem appropriate for preparing design strategies, in a Participatory Design context, 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 processes of translation: translation means both a move of some actor's interests and a translation - in the sense of change of language or representation - of those interests in order to align them with the interests of other actors. According to Callon (Callon, 1999), the translation process includes several steps, among which: *interessement* and enrolment. *Interessment* and enrolment focus on negotiating acceptable roles for the human actors.

The next ANT concept is inscription, meaning that "aligned interests [are] inscribed into durable material" (Law, 1992). A translation process supposes a medium or a material in which it is inscribed (boundary objects, for example, may support inscription*)*. According to Akrich: "A large part of the work of innovators is that of inscribing their vision of the world in the technical content of a new object" (Akrich, 1992).

Finally, ANT introduces the concept of black-boxing. Back-boxes are "sealed actor-networks" (Stalder, 1997) whose alignment has been obtained, whose aligned interests have been inscribed in a stable association that is no longer questionable – except at a heavy cost. In this sense, a project plan is a black-box that has been sealed after a translation process has succeeded in aligning the interests of the project partners.

3. A case Study: the PALETTE European Project.

As an illustration of the concepts described above, we would like to present the context of a European Project named PALETTE[3]. It gathers about fifty researchers from thirteen Institutions in seven countries. The PALETTE project aims at facilitating and augmenting individual and organisational learning in communities of practice. To reach this aim, an interoperable and extensible set of innovative services as well as a set of specific scenarios of use will be designed, implemented and validated in CoPs of diverse contexts. The PALETTE services are classified into three categories: *information services, knowledge management services* and *mediation services*. PALETTE adopts a participative design approach, establishing a good balance between technological and pedagogical experts. Evaluation is integrated in the same process, in order to provide direct, frequent and detailed feedback.

It is expected that the adoption of the developed services and scenarios will result in

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[3] (6th Framework Programme - Priority IST-2004-2.4.10 -
Technology-Enhanced Learning). PALETTE stands for:
Pedagogically sustained Adaptive LEarning Through the
exploitation of Tacit and Explicit knowledge

- the facilitation of tasks performed by learning CoPs by removing barriers imposed by current approaches;
- the exploitation of diverse mental models, knowledge resources and competences of CoPs member through the social interaction of codified and tacit knowledge;
- the creation of new knowledge, which can lead to the evolution of the associated learning resources;
- the easy access and reuse of knowledge built by the CoPs;
- the increase of active participation of individuals in CoPs;
- the emergence of new CoPs, inside and outside organisations;
- the increase of the overall quality of learning in CoPs.

PALETTE will provide innovative models and technical solutions with regard to the following dimensions:

- efficient reuse and sharing of information among the CoPs' participants;
- user-friendly production and use of multimedia content to support the expression of practices (behaviour, rules, personal theory, etc.);
- efficient and effective support of the individual and organisational learning process, the incoming of new participants in a CoP, and the capitalization of knowledge.

PALETTE will implement the conditions for the exploitation and development of open source services by a large number of CoPs. Thus the PALETTE services and scenarios will not only address the needs of identified CoPs but also describe the conditions for their enhancement through the active participation of users in their development.

One of the first tasks of the project, which started in February 2006, was to settle a design methodology implementing the conditions for Participatory Design. It seemed that ANT was a good support for creating a common understanding of the methodological context of the project.

3.1 Using ANT to implement the participatory design methodology in Palette.

McBride (McBride) suggests a 7 steps methodology where ANT is used as an analytical tool "to identify actions which may speed the social embedding of the technology and the successful take-up of (a) system": identify stakeholders, investigate stakeholders, identify stakeholders' interactions, build actor-network models, identify irreversibility (provisional stabilities), identify inhibitors and promoters, identify actions for aligning the network (participative activities).

In PALETTE, we apply an analogous methodology to implement the Participatory Design process:

- the first steps consist in identifying the various stakeholders, their interests, the inhibitors and the promoters for the enrolment of these actors in the actor-network;

- then, by attempting to "align" these actors' interests, we will build the actor-network and an ANT-based description of the issues related to bootstrapping the participatory approach in Palette;
- finally we will propose a set of actions – mainly participative activities with boundary objects – and select a set of inscription medium with the aim to "enrol" the various actors and promote the social design and acceptance of the new technologies.

3.2 Building the actor-network: identifying and enrolling the actors, aligning their interests

There are a lot of actors gathered for the project purposes.
- CoPs, CoPs members, CoPs animators
- CoPs observers, community of CoPs observers
- Project, DoW[4], project coordination, project management
- Research teams
- Work Packages, tasks groups, sub-tasks groups
- Pedagogical tools: social sciences methodologies, interviews, scenarios, data collection methods, data representation methods…
- Methodological tools: ANT, MOT…
- Management tools: (reports, time-sheets, deliverables)
- Technical tools: from the project (existing and potential) and existing outside the project
- Technical tools designers and developers (called "Ts" in the project)
- Pedagogical tools designers (called "Ps" in the project)
- Methodological tools providers (Ts + Ps)

Most of them already existed before the project and will continue their life after the project: researchers, institutions, currently existing tools, some CoPs, etc.. Some of these actors had already build relationship between themselves, some other not. Some actors will exist only due to the project: the newly developed tools, the Work Packages, the deliverables, for example. The PALETTE actor-network is a dynamic entity which is made of all the heterogeneous actors (meaning human and non human, but also of different granularity[5]) and of all the links that tie dynamically these actors for the purposes of the project (and also for other possible reasons).

The situation of an actor within an actor network is not fully defined by the existence of the actor. Some links have to be knitted with other actors to materialize the presence of the actor in the network, through enrolment. Enrolling an actor within an actor-network means that there are some agreed common interests between this specific actor and the actor-network at some moment. Building the partnership between institutions

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[4] Description of Work, the reference document for the project
[5] A workpackage, or an institution, or a project is made of a lot
of persons and other elements; thus a person and a group of
person are actors of a different level of granularity

(in fact groups within institutions) to submit a proposal to the European Call for Projects was a first kind of enrolment

Enrolling actors in an actor-network requires going through some participative activities where actors can discover and share their common interests. The CoPs are not members of the project, but it is really important that they become actors of the project. Thus, They have to be enrolled, by identifying some common interest between CoPs, and/or CoPs' members, and other actors of the PALETTE actor-network. The Participative Interview process that is used to gather data about the CoPs is the main step toward enrolling them.

Currently existing collaborative tools (like Lotus Notes or e-Rooms, or Moodle, etc.) are not partners of the project as well. But they are used by a lot of people and by CoPs outside the project. They have to be taken into account in the project, from a technical point of view - which is a matter of interoperability and standards - and from a user interface point of view as well. This is done through the Tool Inventory/Categorization process, which is the main participative activity through which tools are enrolled in the PALETTE actor-network. For "inside" tools (those developed by partners), the categorization is not the only enrolment process; another enrolment process is that they are used within the project (for example, a document management software is used to collaboratively publish project documents)

3.3 Inscribing aligned interest in scenarios of use

Translation and inscription are dual processes. In PALETTE, a successive number of translations are undertaken from CoPs to CoPs observers, then to interviews transcriptions, then to data condensation; the data are finally inscribed in data representation supports available as boundary objects for other actors. Different media are used for inscribing, like documents, story telling, vignettes, and MOT schemas (Paquette et al., 2006). Another example of the translation-inscription process is the activity aiming at clarifying the notion of scenario: what is a scenario, its content, its form, etc., according to the different PALETTE actors. Several participative activities are designed 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].

3.4 PALETTE incremental project life cycle.

The organisation (structure and stages) of a project life-cycle is a key factor for the success of a Participative Design approach. Let say it in ANT terms: the building of the actor-network, its evolution throughout the project, the nature of the translation-inscription processes, as well as the nature and number of boundary objects depend on the type of project life-cycle. The project methodology used in PALETTE is based on an agile perspective (Schwaber, 2004, Highsmith, 2004): go for a "first design round",

with some "sample" CoPs, a few data from interviews, a few tools, and try to build from this the first scenarios. This would allow us:

- to validate the methodology
- to validate the feasibility of the whole process;
- to understand better what the different steps are (especially the data representing and the scenario building);
- to explicit the processes of enrolment, translation and inscription and see if it fits really well and if everybody agrees with;
- to go further into inscribing communities practices and web services into scenarios of use.

From these scenarios, some adjustments (including possibly incremental or full new developments) could be done in the partners' tools to better suit CoPs users' practical situations. Then we will be able to re-loop the loop with other CoPs and other tools (to keep it simple, though there are all other actors involved). Step by step we will build, in a constructive perspective, our scenarios and use-cases.

The multi-rounds project life cycle allows going on rather quickly in the validation of the whole project system and enables actors working more collaboratively from the beginning.

4 Conclusion and further research

PALETTE has just started in February 2006. We are still in the process of looping the first design round. What we were able to agree upon so far is that descriptions of design situations based on ANT concepts have helped launching an efficient Participatory Design methodology. The inscriptions as MOT schemas, for example, were agreed a "good" boundary objects by both the Pedagogical and Technical partners. A lot has still to be achieved before the end of the project in January 2009. Nevertheless, we think that PALETTE is a good example of a complex socio-technical project, and that this experience of using ANT could benefit other kinds of complex socio-technical projects.

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Personalization Services in Argumentation Tools: a Catalyst for Learning

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Abstract. Argumentation is considered as an essential element for effective learning since it enables learners to develop their points of view and refine their knowledge. Our aim being to facilitate CoP members as learners, we argue that argumentation tools should provide personalized features and functionalities in order to fit the specific individual and community learning requirements. More specifically, we propose a set of personalization services that can act as catalysts for individual and community learning. The proposed set of services has derived after the careful consideration of a generic Learner Profile, developed to formalize human actors in settings where learning takes place.

1 Introduction

As organizations start to acknowledge the significance of *Communities of Practice* in helping them meet their business needs and objectives, new efforts to better understand the processes of learning in these communities are constantly emerging [1]. The term Communities of Practice (CoPs) is commonly used to define groups of people who share an interest in a domain of human endeavour and engage in a process of collective *learning* that creates bonds between them [2]. Such communities are formed by groups of people having similar interests or goals, and are willing to share their knowledge, in-sights and experiences about specific work aspects, the ultimate aim being to learn from each other [3]. As stated in [2, 3], the key aspect to successful learning within a CoP is the provision of the proper means for information exchange and peer-to-peer collaboration so as to enhance the organizational knowledge flow.

On the other hand, modern learning theories support the value of communities and collaborative work as settings for learning [4]. As regards to collaborative learning, an especially valued activity is *argumentation* [5], meaning the process of introducing, supporting or defeating a set of alternative courses of action, based on structured arguments. More specifically, argumentation is considered as an essential element for effective learning since it enables learners to develop their points of view and refine

their knowledge. This is because, during collaborative argumentation processes, participants focus on the same issues, share their knowledge and learn to negotiate conflicting opinions in order to reach a commonly accepted solution [6, 7]. As stated in [8], on-line collaborative argumentation can serve as a tool for informal learning situated in the context of CoP members everyday work experience. Still, it is generally acknowledged that traditional software approaches supporting argumentation are no longer sufficient to support contemporary communication and collaboration needs [9]. This is because they are focused in the logical structure of the argumentation, and they do not provide the means to support learning.

In our approach, argumentation tools are knowledge sharing environments where learning is taking place in the exchange of problem interpretations, interests, objectives, priorities and constraints, which may express alternative, fuzzily defined, or even conflicting views. In this vein, argumentation tools should satisfy the community members' needs to construct and refine their ideas, opinions and thoughts in meaningful ways, in order to successfully assist individual and community learning. At the same time, individual standpoints should be articulated in such a way that can be proven useful for the rest of the community's members. In addition to that, support should be offered for the development of learning skills, such as the interaction with other actors, as well as growth of the learners' autonomy and self-direction. Moreover, identification of CoP members' individual characteristics, as well as the culture, norms and incentive schemes of the community should be appropriately handled. For this, personalization services should be provided, so as to promote learning and to encourage creative, parallel and lateral thinking during argumentation.

In the following we present a set of proposed personalization services that has been developed to address the abovementioned requirements for the efficient and effective learning between CoP members during argumentative discourses. Towards this aim, we first performed a comprehensive literature and practice survey of related issues regarding Communities of Practice, Argumentation and Learning. Based on the findings of this research, we concluded that personalization services could enhance learning in both existing and to be developed argumentation tools. In order to propose a set of personalization services suitable for CoP members, we developed a generic Learner Profile model to formalize CoP members as human actors in settings where learning takes place. Our aim being to facilitate CoP members as learners, we present in this paper a set of personalization services for tools facilitating argumentation that can act as catalysts for individual and community learning. More specifically, we propose the development of a virtual environment for collaborative argumentation providing personalization services in accordance with the proposed Learner Profile. We envisage this as an environment where learners are able to express personal ideas and opinions, being provided with the proper means for the articulation and sharing of the learners' knowledge.

The remainder of this paper is structured as follows. Section 2 presents the proposed Learner Profile model. Section 3 presents the proposed set of personalized services towards learning and their relation to the proposed Learner Profile. Furthermore, it discusses implementation issues regarding the embedment of the proposed set of services to existing or under development argumentation tools. Section 4 pre-

sents a discussion about existing argumentation tools. Section 5 concludes this paper with some final remarks and our future work directions.

2   The proposed Learner Profile

Taking the above issues into account, we acknowledge learning as a major part of CoPs activities, and we argue that one of the most significant roles undertaken by almost all CoPs' members is the role of a learner. Related research findings about learners' modelling prove that due to the complexity of human actors and the diversity regarding the learning context, the development of a commonly accepted learner profile is a highly complex task [10]. For instance, the Learner model in [11] depicts a learner as a concept hierarchy but it does not refer to issues such as the learning object, or the learners' interactions with their environment and other people. However, it provides interesting information about a learner's cognitive characteristics and it provides a representation of knowledge assessment issues. Another related approach, the "PAPI Learner" conceptual model comprises preference, performance, portfolio, and other types of information [12]. Yet, this model includes only the minimum information necessary to satisfy the functional requirements and be maximally portable, and it does not provide any information about a learner's profile dynamic aspects. The IMS Learner Information Package specification [13] is a useful collection of information that addresses the interoperability of internet-based Learner Information systems with other systems that support the Internet learning environment. But, the aforementioned approaches cannot be employed for the representation of a community as a learning entity.

After the careful consideration of the above approaches, we developed a generic Learner Profile that can be employed for the representation of both individuals and communities as learners (see Fig. 1). Thus, the proposed model can be employed for developing customized services for both individual and group learners. More specifically, the proposed Learner Profile consists of two types of information, namely *static information* and *dynamic information*. Static information comprises information about the name, contact details, education, training, working experience etc. of the CoP members, as well as information about the CoP(s) they belong to. Such information is considered as domain independent in our approach. The Learner Profile dynamic information elements were chosen to reflect one's individual behaviour during his participation in a specific CoP's argumentation activities. Thus, all four dynamic elements, i.e. *preferences*, *relations*, *competences* and *experience* are to be implicitly or explicitly defined through the learner's interaction with a tool supporting collaborative argumentation. *Preferences* regarding the use of resources and services provided by the tool, as well as *relations* among individuals, CoPs and learning items (e.g. argument, URL, or document) can reveal the learners' different personality types and learning styles. *Competences* refer to cognitive characteristics such as the creativity, reciprocity and social skills. *Experience* reflects learners' familiarity and know-how regarding a specific domain. It should be noted that all dynamic elements of the proposed Learner Profile can be of assistance towards learning. Nevertheless, the

domain of the issue under argumentation is a decisive factor. Thus, dynamic aspects of a learner's profile are treated as domain specific in our approach.
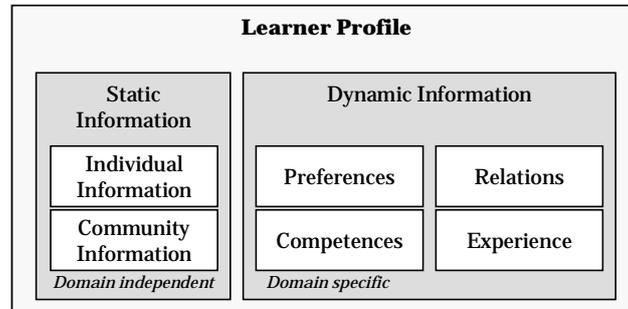

Fig. 1. The proposed Learner Profile

3   The proposed set of services

Perceiving users as learners, in the following we present a set of services that can augment argumentation tools towards facilitating individual and community learning activities. The proposed set of services has resulted out of a thorough investigation of the related literature, including case studies that consider diverse aspects of learning within a CoP. More specifically, CoPs consider *system awareness services* as one of the most valued services for argumentation tools. This kind of services comprises a set of notification actions for the provision of helpful personalized information about system events to CoP members. Such events could be the entrance of a related learner to the system, the creation, termination or any other related action over a specific discussion and the notification about the insertion of new content into the system (arguments, documents etc.). In order to enable this personalized awareness, terms such as "related" or "interesting" that define a relation between the learner and the content should be determined by the learner himself or automatically by the system through the manipulation of some characteristics from the user profile.

Personalized searching is another service that can facilitate learning activities, especially for autonomous learners. During searching, a Learner's Profile can provide useful information to rank search resources according to a number of factors, such as the learner's preferences, or even his competence and experience level. In this way, the system will be able to adapt to an individual user's needs. Moreover, the information about the user's domains of interest will provide additional information with which a search can be better contextualized, thus leading to more relevant results. Furthermore, reasoning mechanisms could be employed for providing the necessary filtering features for capturing and reusing the knowledge shared in past argumentation activities.

Another issue to be carefully treated regards the representation and visualization of arguments so as to assist the participants to better organize their thoughts and present them in a more clear way to the others. *Personalized presentation* of context can provide learners with a working environment that fits to their preferred visualization style. System personalization includes alterations in colours, fonts and text effects, enabling and disabling pieces of information in the working panel, predefinition of system responses in user actions etc. In this vein, filtering and recommendation of content services can further support learning. Content that is inserted in the system should be filtered according to each learner's preferences and be recommended as interesting incoming information. For instance, some of the attached documents of posted positions that contribute to the strengthening of an argument should be suggested for view. Furthermore, a document library could recommend some documents that are related to a specific learner (e.g. experienced learner's recommendations or popular documents).

Learner expertise and action tracking services can also assist learning in the community. Such services enable the community members to find and communicate with their co-workers in a more knowledgeable way. Furthermore, if coinciding with a community's norms and wills, such services could also be used for the assignment of weights regarding the weight of a member's arguments. Such services could be based on the learners' level of experience (as recorded in their profiles), in addition to attributes deriving from the users' participation in the community's activities.

Finally, *privacy policies and access control services* are a critical requirement for the employment of all the above services. These should be provided in order to satisfy the learner/users' need to know what information about them is recorded, for what purposes, how long this information will be kept, and if this information is revealed to other people. Platform for Privacy Preferences Project (P3P) is a W3C approach that supports the description of privacy policies in a standardized XML-based form, which can be automatically retrieved and interpreted by the user client [14]. Furthermore, the security assurance while establishing connections between users and services, or while accessing stored information, should be taken into consideration as well. Towards this end, two major techniques are broadly used to provide denial of access to data, i.e. anonymity and encryption. Anonymity cuts the relation between the particular user and the information about him, while information encryption provides protection of the exchanged personal data.

3.1 Acquisition of learner profile data

In order to enable the operation of the abovementioned personalized services, the Learner Profile has to be populated with the appropriate data. Such data can be acquired in two ways: *explicitly* from the users' preferences, and *implicitly* based on the users' behaviour within the system. The later could be based on a rule-based event engine. In this way, a personalized argumentation tool may comprise two kinds of personalization services, those explicitly and those implicitly initiated by the user. The former, refer to service approaches that adapt to the system based on the explicitly stated characteristics or preferences of the user. The later, refer to approaches that

implicitly adapt to the system based on the user's actions within it. Implicit personalization mechanisms are automatically triggered by the system utilizing data in the proposed Learner Profile. In the following, we briefly describe each acquisition method.

Static information of the Learner Profile is explicitly provided by the user, as a required initialization step of the registration procedure. While such information is usually provided when registering to the system, users should be able to edit this set of profile information at any time. Such explicit data acquisition constitutes a subjective way of profiling, since it depends on the statements made by the user (e.g. experience level, competences etc.). Their subjective nature may influence personalization services in an unpredictable way (e.g. suggesting to a novice user a document that requires advanced domain knowledge because the user misjudged his experience or competence level). To cope with such issues, we are currently in the process of designing methods that assess explicitly stated profile data, based on the users' behaviour. We refer to these ways as *implicit* or *behaviour-based data acquisition*.

In general, the aim of implicit or behaviour based data acquisition is to assess experience, domains, competences of an individual user based on the users behaviour, leading to a quantification of profile information which provide a more reliable information source for personalization and decision making services. Implicit data acquisition utilizes the users' actions and interactions and attempts to extract information that can permit assessing or augmenting a user profile data. Towards this aim, a rule-based engine is required that recognizes user interactions and system events, and triggers computations that modify the users' profile data.

In our approach, a rule-based approach has been chosen so as to facilitate incorporation of new rules once they are observed or modification of existing ones if they prove to be too restrictive or even harmful. More specifically, we propose the development a set of rules that deal with resource access, as access to resources are logged and a number of rules operate on the logged data to provide additional information to resources and/or user profiles. These can be based on the frequency of access and the competence and experience levels of users (e.g. a document that is frequently accessed by novice users should augment the documents metadata with elements that mirror this fact so that this document can be recommended to any novice user entering a discussion). A second set of rules observing discussion contribution could control how user behaviour in the context of discussions will affect the users' competence and experience (e.g. users that actively and frequently participate can be assigned with a high experience level). Another useful indicator associated to the proposed learner profile is the reasoning about how a competence level of a particular user changes in time. This may provide useful insights about the learning capabilities of the particular user and the usefulness of the system.

3.2   Implementation issues

According to current trends in developing web-based tools, for reasons such as the reusability of components and agility of services, our approach builds on top of a service oriented environment. In order to exploit advantages enabled by the Service

Oriented Architecture (SOA) design paradigm, the proposed set of services should be based on web service architecture so as to enable the reusability of the implemented modules, as well as the integration or the interoperation with other services (from external systems).

Considering the above, an overall design for the enhancement of existing argumentation tools with personalized functionality towards learning is depicted in Fig. 2. In this approach, we sketch a generic architecture design in which a Learner Profile Service is the basis for the storage and the provision of each learner's characteristics to a set of proposed services that contribute to the system's personalization. Considering the set of proposed services as non-exhaustive, this "architecture" is open for the addition of new personalized services (see Fig. 2, block "New Service") and can use the Simple Object Access Protocol (SOAP) for both internal and external communication, following the web services standards.
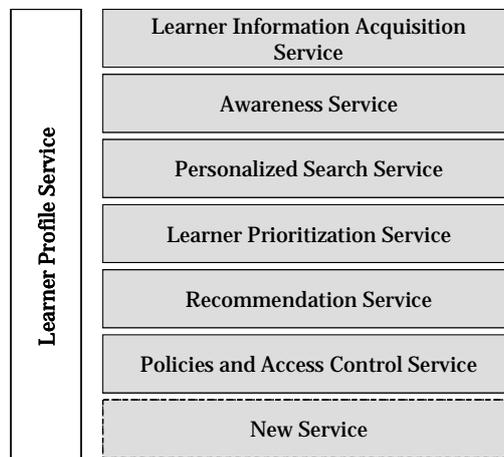
Fig. 2. The proposed services

4   Discussion

A major category of tools supporting argumentative collaboration provides the means for discussion structuring and user administration. *gIbis* [15], for instance, is a hypertext groupware tool that allows its users to create issues, make positions on these issues, and make arguments pro and contra these. *Sibyl* [16] a tool for managing group decision rationale. *QuestMap* [17] resembles to a "whiteboard" where all messages, documents and reference material for a project and their relationships are graphically displayed during meetings. *Compendium* [18] is a graphical hypertext system which can be used to gather a semantic group memory when used in a meeting scenario. *Araucaria* [19] provides an interface for the decomposition of text into argumentation premises and conclusions via a diagramming process. The *Rea-*

son!Able [20] argumentation tool provides a well structured and user-friendly environment for reasoning. Another educational software providing assistance in the creation and sharing of visual images of ideas is *MindDraw* (see http://info.cwru.edu/minddraw/), a thinker's tool that is useful for students and learners of all ages, from primary school through graduate training and professional practice.

The systems described above may be regarded as the most representative of a larger collection of argumentation systems. Nevertheless, a new generation of argumentation tools towards learning has emerged. For instance, in *Dialab* [21] is a logic game, aiming at assisting the development of the players' logic competency. The *Multiple Object Oriented* (MOO) [22] system is a synchronous, text-based environment where collaboration is established through the use of virtual spaces. Learning activities are modelled as problems to be solved through the scheduling of a virtual conference room. The *Collaborative Text Processing* (CTP) [23] system is a synchronous network-based word processor application. Activities take place through pairs of students that collaborate in this environment. An assignment which is given to the students ("task") and supporting information ("argument") are supplementary concepts that co-exist in the main word processor window. *CLARE* [24] is an asynchronous network tool aiming at supporting the task of collaborative knowledge construction. This task comprises two phases: *exploration*, which takes place individually and information is gathered to a common repository, and *consolidation* which takes place through evaluation, comparison and summarization of the information gathered. Finally, *Belvedere* [25] is a synchronous web-based learning tool designed for supporting learning activities. Belvedere provides an environment for constructing argumentation diagrams between individuals or groups of students. A special representation is used to declare the uncertainty level of the arguments submitted, whereas communication among partners is supported through chatting.

As derives from the above, existing tools facilitating argumentation primarily provide either visualization or collaboration functionalities, as they mainly focus on the expression and visualization of arguments. Argumentation tools developed for education support focus on the subject to be taught, not the learner. Existing approaches perceive users as static entities of the problem analysis, and even though they are efficient in terms of structuring a discussion based in argumentation, they do not provide personalized support, nor do they focus on collaborative learning activities taking place in such contexts.

5 Conclusion

In this paper we presented a set of services enhancing argumentation tools based on a generic Learner Profile. Our approach concerns an alternative form of on-line learning with different forms of interaction, and a new way of promoting community building. Its purpose is to aid researchers and developers in the development of *personalized argumentation systems*, i.e. tools that adapt their structure and services to the individual user's characteristics and argumentation behaviour. Our main goal being to support individual and community learning, the proposed set of services is

based on personalized features and functionalities. We argue that it can further support learning, as well as the achievement of learning objectives, as it can assist CoP members in the development of learning skills such as the interaction with other actors, growth of their autonomy and self-direction. Nevertheless, in order to be creatively adapted in CoPs' everyday practices, the proposed services must fit into the specific culture, norms and incentive schemes of the community. Our future work directions concern the appropriate handling of these issues as well as the full development of the set of personalization services and its evaluation in diverse CoPs.

Acknowledgements

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Awareness: An Enabling Feature for Mediated Interaction in Communities of Practice

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Abstract. The École Polytechnique Fédérale de Lausanne (EPFL) is currently using a Web-based experimentation environment to support laboratory activities in engineering education. The key service for the acceptance of the learning modalities and the appropriation of the environment by the students is a shared electronic notebook called the *eJournal*. This service is not only used by students to perform the required laboratory work; it is also used to sustain collaboration between students. Additionally it provides support for exchanges with other services integrated in the learning environment. By tracking the creation, the exchanges and the tagging of the digital assets stored in the *eJournal* database, awareness can be provided. This position paper presents how the *eJournal* and the associated awareness features are currently enhanced to effectively support interaction in laboratory-oriented communities of practice for members using either desktop or mobile client devices.

Keywords: e-Learning, Collaborative Learning, Awareness, Communities of Practice.

1 Introduction

Since the year 2000, the École Polytechnique Fédérale de Lausanne (EPFL) has been developing and deploying the *eMersion* Web-based environment to support remote and virtual experimentation activities in higher engineering education [1]. A shared electronic notebook called the *eJournal* turned out to be the key service for the students' acceptance of the proposed flexible learning modalities and for the appropriation of the Web-based environment. This service is not only used by the students to perform the required laboratory work; it is also used to sustain collaboration. Additionally it provides support for exchanges with other services integrated in the learning environment. By tracking the creation, the exchanges and the tagging of the digital assets stored in the *eJournal* database, real-time awareness regarding individual and group progresses can be provided. Consequently, the added value brought by the *eJournal* features is significant enough to compensate for the expected overhead necessary to learn its usage [2]. In addition, the flexibility given to the students to work collaboratively on campus or at distance using the same

environment helps in better coping with their social habits and with the learning constraints [3].

In the context of the *Palette* European integrated project (http://palette.ercim.org/) the *eJournal* and the associated awareness features are currently enhanced to effectively support mediated interaction in academic laboratory-oriented Communities of Practice (CoPs). Only distributed communities interacting through Web technologies or mobile devices are considered here.

Laboratory-oriented CoPs are group of people interacting freely to deepen their knowledge and know-how through interaction and experimentation in a specific domain where laboratory equipment is involved. As example, educators, teaching assistants and students involved in a laboratory course form such a community. Researchers and technicians working on shared equipment or studying samples form another one. Teams of engineers involved in collaborative engineering activities [4] are also laboratory-oriented CoPs.

The roles, rules and assets characterizing the communities evolve as interaction occurs and knowledge level increases. In laboratory-oriented CoPs, the assets produced, exchanged and manipulated by the members can be more volatile, dynamic and rich than the typical information media found in other contexts. In addition to text documents, images, and videos, the laboratory assets also include experiment-related data such as measurements, statistics, mathematical equations and annotations, simulation models or analysis scripts. It as been shown that awareness in general, and context-oriented awareness in particular [5], plays a key role in supporting CoPs.

This paper is organized as follow. Section 2 gives a short overview of the *eJournal* service developed at the EPFL to support laboratory-oriented CoPs. Section 3 defines the hybrid community composed by both the users and the resources involved in laboratory-oriented CoPs. It also details the current developments to provide synchronous awareness. Section 4 finally sketches some envisioned features to provide mobile users with dedicated and ubiquitous awareness. The paper ends with concluding remarks.

2   eJournal Service

The *eJournal* is a more than a digital asset management system [6], an ePortfolio [7] or an electronic laboratory notebook [8]. It can be defined as an assets-based interaction system. Its core feature is designed as a mailbox, a familiar metaphor for users. Instead of simple emails, the *eJournal* contains digital assets of various types. Contrary to a mailbox that belongs to a unique person, the *eJournal* is shared by members of a team. The team members can either tag or annotate the assets at creation or later. Some context-related tags and metadata are also automatically added when the assets are created.

In addition to the mailbox-like area (bottom-part in Fig. 1), the *eJournal* integrates context and awareness areas that are always visible (top-part in Fig. 1). The idea behind this design is that the users should not have to look for basic context and awareness information elsewhere [9]. They should not even have to think about finding such information. It should be implicitly obtained while manipulating assets.

As an example, the *Team* area provides awareness about the role and rights for the user in the given context, as well as indications regarding the possible presence of other team members. The *Activity* area provides information regarding pending tasks. The *Folder* area provides a means to filter the context-oriented assets to be displayed. The *Category* column in the *Asset* area is used to summarize user and system-defined metadata.
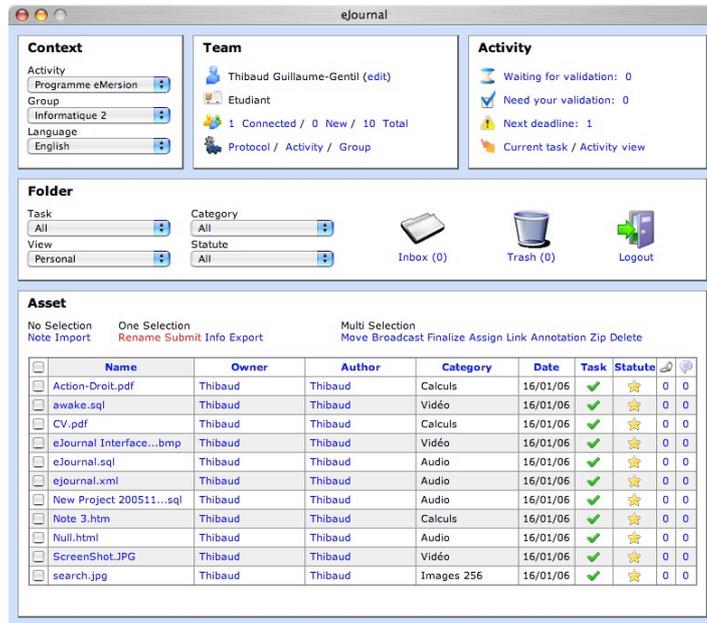
Fig. 1. The current *eJournal* user interface designed for laboratory-oriented CoPs.

The *eJournal* differs from typical digital assets management (DAM) systems in many aspects. First, the *eJournal* was initially designed for e-Learning applications where the process of creating the assets has more value than the assets themselves. DAM systems are typically designed for digital-repository applications (pictures, movies, documents, etc) where the value is only in the assets. In addition, the *eJournal* is a pivotal service to built more comprehensive systems integrating other asset-oriented components/services, while DAM are usually closed systems due to right management constraints. One could also compare the *eJournal* with forums or blogs supporting CoPs. Forums and blogs are driven by comments, some of those comments being possibly augmented by assets. The *eJournal* is driven by assets, some of those assets being possibly augmented by comments.

Interaction within the *eJournal* is mostly asynchronous since many of the actions performed do not required other components or users to be active or online at the same time. For this reason, the *eJournal* user interface only provides simple synchronous awareness indicators (as example, the current number of members online instead of the full list of their names). The state of these indicators may trigger

interest for more detailed or additional information in some contexts. Hence, a supplementary synchronous awareness service with richer visualization features detailed in Section 3 is currently developed.

3   Synchronous Awareness Service for Hybrid Community

In Laboratory-oriented CoPs, not only the members, but also the equipment plays an important role in the knowledge construction and consolidation. Hence, one can consider both the members and the equipment as entities belonging to the community and interacting together in some ways. We define such a community as a hybrid one.
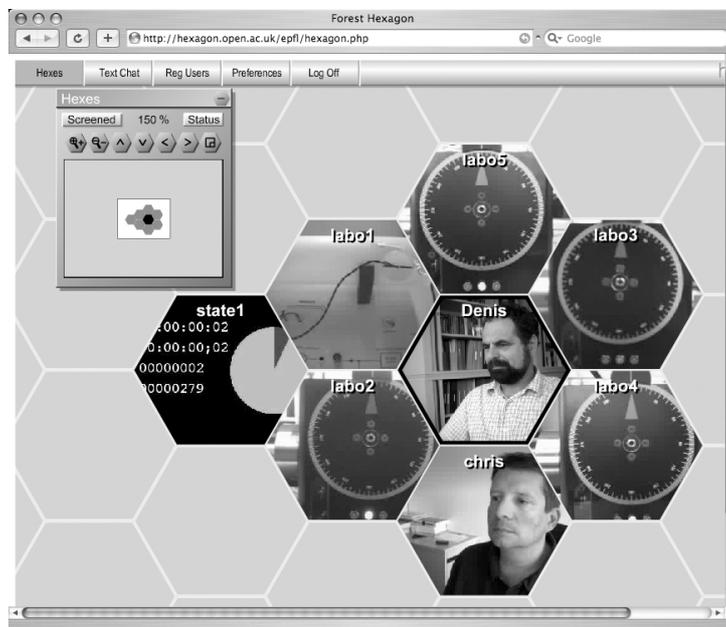
Fig. 2. Awareness about the people, the resources and the activities in a hybrid community.

Synchronous awareness in such a community may require knowledge about the presence of the members, the state of the equipment and the status of the activities. To provide this variety of information in a simple way, we have adapted the Hexagon tool (http://kmi.open.ac.uk/technologies/) developed by the Knowledge Media Institute of The Open University in the United Kingdom. The Hexagon is basically a virtual video chat room. The online members are visible and can be clustered or put away according to the user interests (Fig. 2). To be suitable for supporting a hybrid community, any relevant piece of equipment should also be considered as a member of the community. Hence, devices, such as the electrical drives displayed in Fig. 2, are visible in the virtual video chat room. To push further this idea of non-human entities joining the community, composite images are built using additional awareness

information and pushed in video channels of the room (left-hand side hexagon). This feature is implemented by using a special video digitizer.

This enhanced awareness service complement the simple information provided in the *eJournal*. It is relevant for members at their workplace. In the next Section, a lighter and ubiquitous awareness service supporting mobile members is described.

4   Ubiquitous Awareness Service

Providing ubiquitous awareness to mobile members of a community does not mean cloning what is available on a desktop computer. One should focus on the necessary and sufficient requirements for people on the move, as well as the actual capabilities and features of current and next generation mobile devices. In other word, the service should be designed for the Today high-end devices which correspond to what the majority of people will be using in a one or two years horizon. In terms of PDA, mobile phones, portable play stations and audio/video players; we should consider audio and video Input/Output, GPRS, WiFi and/or 3G networks as available features.

According to these features, the proposed solution to provide ubiquitous awareness to mobile members of laboratory-oriented CoPs is to implement a feed-oriented client interface instead of a traditional email, calendar or agenda-like one. This service should be always active. In fact, RSS (Really Simple Syndication) or Atom feeds displayed by the so-called *Feed Navigator* client have the necessary structure to support awareness broadcasting, knowledge dissemination or assets delivery. A feed can be updated right away when something occurs in the laboratory-oriented CoPs (creation, event, action, discussion). It has a creator, a title, a summary (annotation), metadata (tags) and possibly an attached file (asset) or the URL of an asset-oriented service. The *Feed Navigator* will be designed to display these relevant elements in the most convenient way for minimizing the users actions and maximizing context-awareness. Feeds navigation through scroll wheels like the one found on *Blackberry* devices (http://www.blackberry.com/), or even more advance *iPod*-like tactile wheels will improve usability. The main difference between the *Feed Navigator* and an email client is that the user subscribes only to the feeds he or she wants to receive. In addition, instead of being only classified by date, size, sender, etc, the feeds could be classified according to elements like action request, action report, asset request, asset received, comment request, comment received, priority or deadlines.

5   Concluding Remarks

This position paper first presented the *eJournal*, an assets-based electronic notebook designed to support laboratory-oriented communities of practice. In addition to the assets themselves, the *eJournal* displays awareness information about the members, the resources and the activities of the community through compact indicators.

Validation carried out within laboratory-oriented communities of practice involved in e-Learning has shown that awareness about the ongoing activities is as important as the assets themselves to develop and sustain mediated interaction.

Considering the above observation, dedicated solutions to strengthen awareness for members using either desktop or mobile client devices have been proposed. The desktop solution relies on a virtual chat room. All the human and virtual entities belonging to a laboratory oriented CoPs can join this room. As a consequence, the presence of the members, the state of the resources and the achievement of the activities are visible in a glance. The mobile solution relies on a *Feed Navigator* that enables ubiquitous browsing of selected assets and activity-related information.

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Tracking User Participation
in a Large Scale Team Collaboration Environment

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Abstract. All students of the Hellenic Open University (HOU) attend undergraduate and postgraduate courses at a distance. The lack of a live academic community is reported by many as a drawback in their studies. Systematic exploitation of new communication and collaboration technologies is desirable in the HOU but cannot be imposed universally as the average student's IT competence level is relatively low. In this work we present the methodology for the development of an integrated communication environment in which collaboration spaces serving as open communities play a key role in user engagement in the whole communication environment. To track and evaluate user participation we propose analytic metrics which, when combined with our detailed knowledge of the internal workings of user groups, provide concrete evaluation of the community online activity.

Keywords: team collaboration, user participation, distance learning technologies

1 Introduction

The Hellenic Open University (HOU) provides education at a distance taking into consideration a tenet for the universal access of students to educational res ources. HOU is thus formally based on traditional practices (by mailing books and educational material, by encouraging students to personally communicate with their tutor, and by organizing a small number of student-tutor consulting sessions attendance in a small number of common advisory meetings per year). Thus, the use of new communication and collaboration technologies is not mandatory for students to complete their studies. Still, such technologies are being systematically used for publishing announcements and information of a general nature, and for providing basic supplementary electronic material and sources for further study.

Moving from a model where web technologies are used for publishing information to a model where such technologies constitute a basic working tool in the everyday life of at-a-distance-learning students is a huge undertaking, which addresses both

technical and cultural issues. Both types of issues are closely linked to the diversity of the background of the students and of the tutors as well as the availability and ease of use of the underlying infrastructure.

As the only entry requirement of HOU students is the successful completion of high school studies, these students reflect the mean level of experience and competence in the use of electronic services in Greece which, to date, is not particularly high (2005: 59% of the population aged 25-54 has no basic computer skills [1]). This problem is aggravated in the uptake of collaboration or e-learning services, which demand the existence of a certain attitude by the users (beyond usage skills). Thus, planning for the development of electronic services should address the following problems:

- The need for universal access in services of *stratified* complexity (suitable for each team level in order for all to accept their use).
- The organizational aspects of scaling up in numbers and in complexity.

In this work we present aspects of our emerging methodology for designing the entire communication environment provided to the students and tutors as a supplementary service to help them in their everyday work.

The basic unit in HOU studies is the Thematic Unit (TU). One TU consists of one or more teaching groups (a tutor is assigned to each group, which must have at least 10 students, up to just over 30). Small TUs do exist with one tutor and just over 10 students. There are also some very large ones with about 1,250 students in over 40 groups. Currently ~200 TUs are offered and about 1,070 tutors are assigned to various groups in these TUs, encompassing in total about 28,000 students.

Collaboration spaces constitute a focal point in our environment. In those, users can engage in asynchronous communication, publishing content and opinions related to their work (content management and forum services). Given that access to these spaces is allowed for every student (and centrally managed) but that attendance and participation are by and large optional, these spaces function as emerging communities of practice.

Our aim is to define metrics to evaluate user participation in the communities. A comparative evaluation of the community online activity at the TU level will help us propose actions to promote user engagement and participation.

In particular, we explore aspects of a methodology for the quantitative and qualitative follow-up and evaluation of users' participation in combination with the participation of tutors who act as expert users providing advanced knowledge and guidance.

This rest of this paper is structured in five sections. Next, we offer a coarse description of the infrastructure. Following that, we elaborate on metrics for the role of the expert in communities of practice. We then analyze specific groups with respect to their comparative evaluation in terms of online collaboration and proceed to qualitative remarks on the impact of personal attitudes of tutors towards communication on the uptake of the collaboration infrastructure. We conclude by highlighting our research directions.

2 A High-Level Description of the Communication System

In HOU, a substantial part of the mandatory administrative procedures followed by students is done through a portal platform; a key example is the selection of TUs in which a student will be enrolled in the coming academic year.

Typically, such portal platforms do not support specialized services for educational purposes, thus paving the way for specialized LMS (Learning Management System) applications to be deployed. However, the latter tend to serve well advanced users only and are seldom harnessed to their potential.

Because of the (just) average level of IT literacy of students, the acceptance and exploitation of LMSs presents significant difficulties, when attempted at an almost universal scale. On the other hand, the exploitation of electronic services in organization and administration is more acceptable (experience in EU countries shows that the use of new technologies in the educational domain is first noticed for organizational purposes and later for educational ones [2]).

HOU tutors who manage to promote the emergence of student communities often rely on problem based learning as a constructivist learning instructional model [3] (even, subconsciously so). On the other hand the lack of a vibrant academic community in HOU constitutes an important problem for the students; in that respect HOU cannot match traditional campus-based universities. A high percentage of student drop out in HOU (at least, as far as the Informatics undergraduate program is concerned) is related to academic factors, especially a lack of confidence to pursue university-level studies and the perceived lack of adequate assistance (compared to what was initially expected) [4].

To address these needs, an integrated common communication environment was developed, based on a portal infrastructure. To-date it supports (see Figure 1) information services, content management services, and asynchronous team collaboration services, real time services and further education specific services.
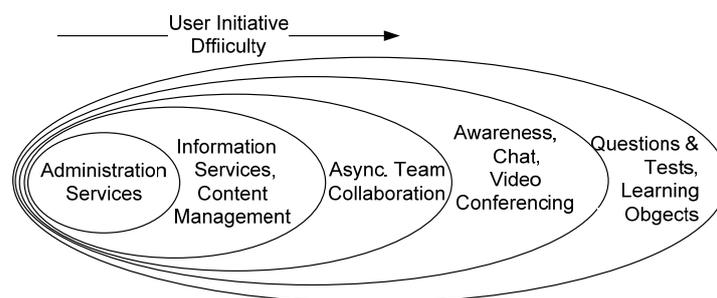
Figure 1: A hierarchy of services

All users and groups are updated in an LDAP server on an annual basis, with data drawn from the Student Registry MIS. Based on those user and group structures, working places were deployed for every TU, to support the communication and collaboration among students, with their group tutor, but also among tutors in the same TU. For each TU a content management space was created, along with a forum accessed by all TU members and a special forum accessed only by the TU tutors. In the collaboration spaces of large TUs additional spaces (*inner rooms*) were created to facilitate the private collaboration within one teaching sub-group (a tutor and all assigned students).

Videoconferencing services were initially provided by an independent application (with its own user and group management infrastructure). A new service has been installed and is now pilot tested to help users access and use the service in a seamless fashion, through the existing (unified) LDAP-based authentication scheme. The service provides video conferencing, chat and awareness services. Additionally, the (open source) Moodle LMS was installed and integrated; subsequently it has been extensively used by one TU to manage the submission and (automatic) grading of a large part of its homework assignments.

Note that all administrative services, content management, team collaboration spaces, teleconferencing and chatting services are hosted on different platforms but are all integrated through a common multi server Web Single Sign On domain to provide authentication. Figure 2 shows a high-level diagram of the overall infrastructure.
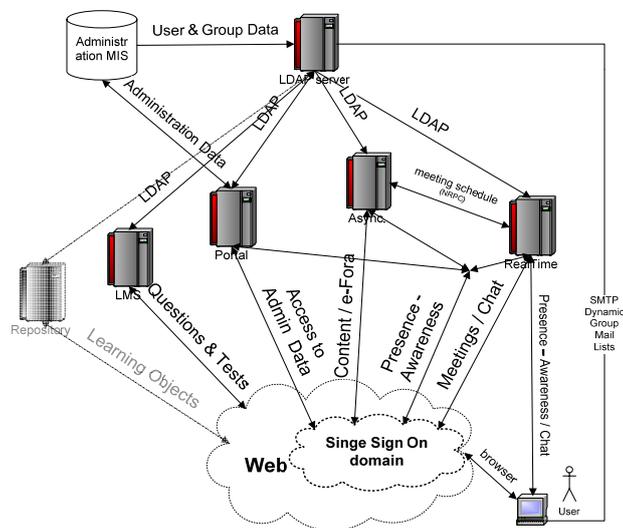
Figure 2: The server-services architecture

3. Measuring the Role of the Expert

We will start discussing some aspects of measuring the role of the expert by drawing on statistics generated by our platform. We will first introduce the concepts using a couple of examples before presenting the detailed results for all TUs.

Participation of group members is defined as the average number of visits per month per community member ($P_m = \Sigma\ V_n/n$), where a visit is defined as a sequence of successive page visits, with each page visit at most thirty minutes apart from the previous one.
While there is a substantial qualitative difference between passive and active user contribution in the community, we believe that such differentiation is only significant in the scope of individual user assessment [5]. When the focus is on the overall comperative evaluation of the community activity (as in our case), the total number of reads and posts is a sufficient metric.
Participation was examined in correlation with the activity of the expert (which is expressed as a percentage figure: *Exp_Activity = Exp_Visits* / 100* *All_Visits*).

For example, with reference to Figure 3, we note that the members of group G_{37} visit the workplace on average 20 times per month (roughly once per working day), whereas that rate is about 5 visits per month for the members of G_{188} (*y*-axis). A group index denotes the size of the group (as does the corresponding circle area). Furthermore, we also note that, within G_{188}, about 6% of its overall traffic was generated by the tutors whereas in G_{37}, this climbs up to about 9% (*x*-axis). Last, the dark filling of the G_{37} circle denotes a postgraduate group. At this point we urge the cautious reader to treat the above as a gentle introduction to the nomenclature and defer a comparative discussion (of groups G_{37} and G_{188}, among others) to Section 4.
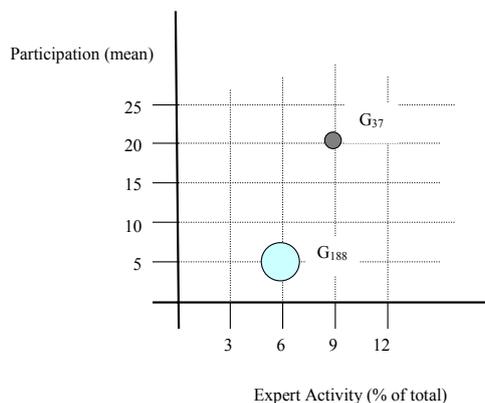
Figure 3: A measurement example

Figure 4 now shows the aggregate results. Data regarding an undergraduate program (consisting of 13 TUs) and an affiliated postgraduate program (5 TUs) were analyzed.

In 7 of those TUs the use of collaboration services was almost null and thus we analyzed the activity in the remaining 11 (6 undergraduate and 5 post graduate), accounting for a total of 2,086 engaged users.
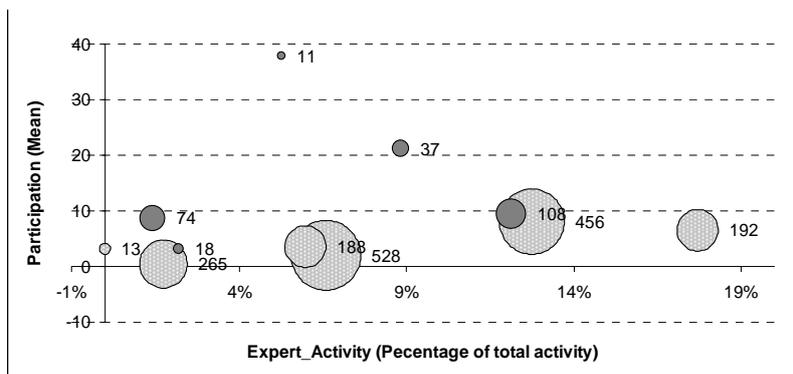
Figure 4: The measurement results

The distributions of visits within each group are not identical (not surprisingly). As a side-product we computed two standard statistical measures of these datasets, namely *kurtosis* and *skewness*. *Kurtosis* as a metric for tail size in a distribution provides a way to estimate the homogeneousness in the distribution of participation in each group. We report the *kurtosis*, in **Figure 5.**
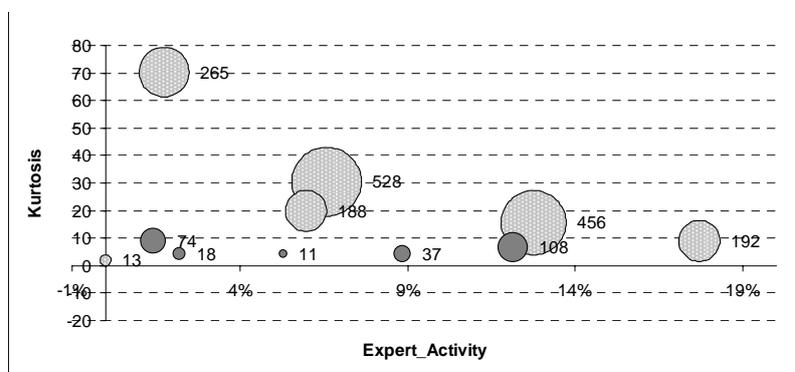
Figure 5: Data set *kurtosis* – small numbers indicate more even distributions

Skewness provides a direct way to estimate the relation between the number of users who are strong participators and those who are not. In all cases Skewness is positive, (ranging from 2 to 7) meaning that very active members are significantly outnumbered by the less active ones (especially in undergraduate groups). The differentiation here between groups is less pronounced than in kurtosis case, suggesting that this pattern is traced in all groups.

4. Discussion vis-à-vis a Detailed Analysis per Group

Before we discuss the results, it is useful to remind the reader that the systematic recording and analysis of activity in these spaces directly aims at tracking characteristic access patterns and at depicting problematic situations or highlighting efficient models of operation. In a working place, interaction between all the members of teams is desirable, particularly so for students. The role, however, of the tutor may be decisive since he, as an expert among other members, may be able to also open up new subjects and not simply respond to questions. Encouragement and participation by an instructor helps a community form more readily [6].

The interpretation of the particular results is facilitated by the fact that we have a detailed knowledge of the internal workings of the reported groups. Such knowledge is easily diffused among people who regularly share their tutoring experiences.

There are several axes of interpretation, which we will attempt to follow. Some finding will be recurring and we urge the reader to interpret these as non-orthogonal indications of the dynamics that exist in group collaborations. At this stage of our research, we seek to strengthen these indications by pointing out the common issues wherever they may be detected.

We start by discussing groups G_{108}, G_{74}, G_{11}, G_{37} and G_{18} (with reference to Figure 4). These groups all refer to postgraduate modules; we enumerate them in the respective expected order that a student would enroll in them. The figure reflects a strong indication that increased tutor activity raises student participation but group size adversely affects such participation (which is not unexpected since it is difficult to mobilize all group individuals when working at a distance).

It is intriguing that G_{74} and G_{108} are relatively close in the respective student participation axis yet so far apart in the tutor activity axis. We believe this is because tutors in the G_{108} are consistently active in their workplace involvement, both in terms of communicating between them and with their groups. Frequent communication raises issues which, from time to time, transcend the boundaries of a discussion forum and may re-appear in a neighboring forum, generating new rounds of collaboration.

A further, subtler, reason is that the study module related with G_{108} is the first module that these postgraduates take. This instills a community culture and when these students move on to the study module related with G_{74}, they are highly (and recently) aware of the benefits of community collaboration and presence is reinforced even without tutor involvement. This also refers to committed students who enroll in those study modules at the same year; they seem to be able to easily spot a good practice and stick with it. We thus note the flow of benefits from a module to another.

Such flow is also apparent, yet more subtly so, when analyzing the apparent strong student involvement of (senior postgraduate) groups G_{11}, G_{18} and G_{37}. It might be tempting to compare G_{11} with G_{18} based on tutor involvement (undoubtedly, measurably apart) but subtler issues arise. It is interesting to note that G_{11} is a module

with a heavy software project management component, where the successful carrying out of assignments sometimes dictates the collaboration between students. That those students were already aware of the benefits of workplace collaboration facilitated their electing of the workplace to communicate during assignments. Note that both G_{11} and G_{18} refers to one student group per module (and, hence, one tutor) and therefore there is no room for intra-tutor collaboration. This is in contrast to G_{37} where two tutors were involved in student tutoring and two further tutors are involved in developing educational material for the module, as well as communicating with the students as regards educational matters. So, a substantial part of the traffic generated by the tutor component of G_{37} does in fact refer to communication between tutors. In the G_{18} group, the tutor has not embraced workplace collaboration and, hence, the students have been consulting the workplace for relatively static information (for example, meeting dates and venues) and no academic discussions were made.

Summarizing the postgraduate case, a unifying theme seems to emerge. This theme is that having instilled a collaboration culture in earlier modules has been fundamental in sustaining student workplace involvement. It is reasonable to assert that we must invest as early as possible to educate the student population in workplace collaboration. Such indirect knowledge is only gained by example but is exploited in subsequent study years where tutors may ease their activity without a negative impact on student participation (allowing for obvious deviations in tutoring style); the system seems to have gained momentum. We note that the emergence of this common qualitative characteristic is best demonstrated by the kurtosis figure, which demonstrates that irrespective of tutor activity (after an initial investment), students' access of the workplace more closely resembles that of a normal distribution. Interestingly enough, the *kurtosis* figure also suggests that the postgraduate groups demonstrate a more balanced way of how they access the workplace.

We now turn to discuss groups G_{528}, G_{265}, G_{456}, G_{188}, G_{192} and G_{13}, which all refer to undergraduate modules (the first three ones being junior modules and the latter three being advanced modules). As observed in the postgraduate modules, the larger the module the smaller the student participation. However, in the undergraduate modules, which are on average substantially larger than the postgraduate ones, we also observe that the collaboration workplace is mostly frequented by tutors in advanced modules. The first year modules display erratic performance which can be also traced to their nature and educational content. For example, G_{265} is a mathematics foundation module where the near-zero student participation can be attributed to a number of factors. Most important and influential among these are, the lack of maturity in students' perception of the subject and of academic study requirements in general, as well as the limited know-how of students and tutors in collaboration technologies. That only 2 tutors (out of 25) engage in some collaboration activity is best captured, again, by the kurtosis figure, where that group is a clear outlier.

A similar behavior is also demonstrated by the G_{528} group which, again, contains students at the start of their academic path and contains informatics foundations subjects. From then on, two clearly different paths are obvious. The first refers to the G_{456} group. Students in that group have been typically exposed to the learning curve

(in terms of academic and attitude requirements) demanded by the mathematics and informatics foundations and coupled with a strong tutor investment in collaborative technologies display the relative emergence of a collaboration culture (with a healthy kurtosis figure) even at such a relatively large group size.

It is most instructing to see that such a culture is readily harnessed by the G_{192} group which has a reasonable participation index that is based on the majority of the student members. However, this is not the case with the G_{188} group and we are considering the possibility that this may be linked to the educational content of that module. The module covers theoretical computer science and it may be argued that modules with a relatively strong mathematics component are less suitable for collaborative work.

5. Qualitative Issues in the Tutoring Communities of Practice

Since HOU communication is traditionally based on Email and telephone, attendance in the working places is not obligatory. In HOU, the tutor has a mainly supporting and advisory role. However, HOU students are in general professionals that do not easily engage in activities which do not carry a direct practical profit. The emergence and the evolution of the collaboration spaces of TUs as communities of practice is closely linked to how much these can satisfactorily address the real needs of their users.
We have noted several problems that may limit user engagement and participation:

•   Access problems (lack of basic skills and/or adequate infrastructure).
•   Lack of time (full-time or part-time employment and family matters may limit the availability of time to study to just some time-chunks during weekends).
•   Lack of apparent activity in the collaboration space by others is aggravated by physical isolation [7].

In the previous section we offered some insight as to why some student groups seem to be more active than others. We will now slightly deviate from analyzing the above data based on numbers and will try to shed some more light into the qualitative aspects of why some groups seem to shun online collaboration. In doing so we again exploit our intimate knowledge of the internal workings of those groups, however, we urge the cautious reader to note that no part of our analyses does in any way publicize individual data about any participant.
The starting point for our qualitative discussion is group G_{74}. It is very interesting to note that this group has a very low tutor activity because one of its most active tutors is strongly opposed to the use of collaboration technologies due to his strong preference of Email in the organization and carrying out of tutoring activities. This was, thus, a negative result.
How does one counter such a negative stance? The answer might lie within deploying a symmetrically strong opposition. Such behaviour was first spotted in group G_{108} (but not in this particular academic year that these results are based on). Specifically, one of the most active tutors was strongly opposing the deployment of the portal-based collaboration spaces due to his strong preference to a then-existing open-source

system for forum discussions. That opposition was unfortunately aggravated by several "teething" problems in the operation of the portal, at that time. It took a very focused and sustained contribution by at least one other tutor, in terms of generating fruitful discussions in the collaboration place forum, to establish a culture of actually using the collaboration place for further work (coupled, of course, with increased system availability). As the portal gained credibility and opposition grew smaller, it turned up that group participation was sustained even if fruitful discussions were now forthcoming at a more relaxed pace compared to the initial phase.

6. Further Work Directions

There are a number of limitations in our approach. For example, we know that a small number of sub-groups frequently engage in collaboration based on technologies that have not been integrated into our infrastructure, apart from email (text or voice) chat mechanisms or virtual classrooms. Such collaboration statistics are much more difficult to collect reliably and we believe that this (pessimistically) skews our results. Our recent infrastructure upgrade that allows chat and meeting sessions to be organized tightly integrated with the collaboration software will increase the seamless availability of such services to our academic community and will also boost our ability to collect essential usage statistics. After all, we hope to use our detailed knowledge of some modules to progressively refine our indices to also reflect as accurately as possible the situation in all other modules (currently at about 200), without requiring us to invest in understanding all of them. Not surprisingly, we are approaching the problem of the technology uptake in a rather conventional fashion, first trying several approaches on rather receptive users before applying the new concepts to more reluctant (subconsciously so) ones.

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Towards a Holistic Personalised Support for Knowledge Sharing in Virtual Learning Communities

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Abstract. Virtual learning communities bring together people from diverse backgrounds and provide the basis for knowledge construction and sharing. Important processes for the community to function as a whole have been identified and examined through existing systems. Although existing systems attempt to support these processes, the absence of a complete community model, and the personalisation and adaptation to the individual rather than the community compose the main obstacles to their holistic success. A computational framework is proposed, to support the community to function as an entity rather than concentrating to the individual person.

Keywords: Virtual Learning Community, Transactive Memory, Shared Mental Models, Cognitive Centrality, Cognitive Consensus, Knowledge Sharing

1 Introduction

During the last decade, academics and practitioners have been searching for techniques to support knowledge expansion and sharing [1]. Online communities appear to be an exceptional approach which brings together people from diverse backgrounds, provides support for collaboration, and – through collective knowledge sharing – provides a basis for the creation of shared understanding [1, 2]. The term Online Community has been used in a broad context for Virtual Community, Community of Practice, and Learning Community. Authors coming from different disciplines vary in their perception of what constitutes a 'community' [3]. For this study, we consider Virtual Learning Communities (VLCs) that may exist in either organisational or educational context and have the following characteristics: common purpose, identified by the participants or a facilitator; commitment to the sharing of information and generation of new knowledge; shared resources; participants are more likely to be at different stages of their professional/academic life; high level of dialogue, interaction and collaboration; equal membership and leadership; knowledge construction. The above characteristics can be part of both Learning Communities [2], and Communities of Practice [2, 4]. Indeed, as shown by Lewis and Allan [2], many communities of practice function as learning communities, where learning is a result of interactions within a particular social context.

However, learning within VLC may be hindered by several technological factors (e.g. communication barriers, diverse technical background, technological constraints)

and social factors (e.g. different background, interests, and understanding of the problem). A common misconception is to believe that VLC will be effective when people and technology are present. As stressed by Fischer and Ostwald [5], appropriate support for the effective functioning of online communities is needed. This requires a good understanding of what is happening within a community, and what processes influence the success of knowledge sharing.

A review of existing systems that support VLCs will be presented here. We will examine how these systems facilitate knowledge sharing and effective functioning of a community as an entity. The discussion will be based on processes which are crucial in successful VLCs, and therefore should be supported by the computer systems. Based on the review, we will point at future research directions and will outline our plans for utilising techniques from user modelling and user-adapted interaction to provide personalised support for knowledge sharing in virtual learning communities.

2 Support for the Functioning of VLC

This section outlines processes identified by research in organisational psychology and considered as essential for the effective functioning of teams, groups, and closely-knit communities. We will show, with the help of scenarios, how these processes relate to integrating newcomers, motivating existing members, improving resource organisation, and facilitating collaboration in VLCs.

2.1 Processes which should be supported

Research in organisational psychology has identified that effective teams and groups operating in the boundaries of an organisation build transactive memory, develop shared mental models, establish cognitive consensus, and become aware of who their cognitively central and peripheral members are [6-11]. These processes can also be applied to a broader context to inform what support should be provided to a VLC.

Transactive Memory (TM) deals with the relationship between the memory system of individuals and the communication that occurs between them [11, 12]. The focus is on encoding, storage and retrieval of information. Therefore, a transactive memory system can provide the ability to recall previously visited areas and subjects, and to identify relevant knowledge [10, 11].

The notion of transactive memory and the development of transactive memory system has been proven to be very promising for the functioning of teams and groups [6, 7, 10, 11]. Wegner [11] points out that transactive memory is concerned with "the prediction of group and individual behaviour through an understanding of the manner in which group processes and structures information". Transactive memory helps group members to divide responsibilities for different knowledge areas and be aware of one another's expertise. The key for a transactive memory system to function is that the divergence of information held in members' heads must be known to the others. To illustrate, assume that member A's memory can act as an extension of member B's memory. If B is aware of what A knows, he/she should be able to get access to A's knowledge and the information A possesses.

Shared Mental Models (SMM) are defined as the "team members' shared, organised understanding and mental representation of knowledge about key elements of the team's relevant environment" [10]. Studies confirm that collaborative knowledge exploitation can be improved if group members have a shared understanding of the environment, situation and task at hand [13]. One of the main objectives of community formation is through knowledge sharing and communication to develop a shared understanding of the context in which community members act, and to create a shared understanding of the world [1, 14].

Cognitive Consensus (CCs) deals with shared conceptualisations between members and shared understanding of the meaning concepts encapsulate [10, 15]. The idea is for the members to agree, or be aware of the different definitions behind a concept and come at a compromise on how that term is used inside a given community.

Cognitive Centrality (CCen) considers the importance of the contribution of individual members with regard to the community's context [8]. Members who share a significant amount of valuable information for the whole community become cognitively central and play a vital role in the smooth functioning of a community. On the other hand, peripheral members can sometimes hold unique knowledge, and can also be important for effective knowledge sharing.

2.2 Support needed

The above processes can affect the functioning of VLC, and can point out what support may be needed. This will be illustrated here with several scenarios. We will show that support to a VLC has to be tailored to the community's needs and serve both newcomers and oldtimers [16]. Furthermore, personalised support should add value to the creation and sharing of knowledge between members and facilitate the functioning of the community as a whole.

Support to Newcomers
Newcomers are newly joining members who need to identify their role in the community and what they will gain from it. Support is needed to quickly integrate these members to the community's knowledge processes, which can improve their learning experiences and can have a positive effect on the overall functioning of the community.

For example, consider a person named Chris who is interested in social tagging for e-learning and is joining a VLC where members share information about technology-enhanced learning. Chris has no background of what was happening previously in the community, does not know about the interests and knowledge of other members, is unsure whether there are any relevant resources on the topic he is interested in, and does not know what he can contribute to the community. Chris should be helped to identify people or knowledge important to him in this community. Support should be provided also to introduce Chris to the community by identifying what he knows and making other members aware that he is holding valuable knowledge, which refers to *transactive memory*. Furthermore, because social tagging is identified as a peripheral topic for this community, Chris may be encouraged to elaborate on its relation with

personalised learning, which is the main focus, i.e. *cognitive centrality,* of this community. This will be beneficial for him (he may discover relationships he was unaware of and may become a more central member to this community) and for the community (new topic will be connected to the community's context which can improve the processes of knowledge sharing and construction).

Support to Existing Members

Existing members (oldtimers) should also be helped to integrate and become active participants in the community's knowledge processes.

For example, consider Jane who is an existing member of this community and is interested in intelligent tutoring systems. She is regularly uploading and downloading resources and is actively engaged in discussions with other members. Jane is one of the *cognitively central* members of this community. Assume that another member – Mark – is interested in student modelling which Jane is familiar with (because she has participated in discussions on the topic and has uploaded relevant resources). Support should be provided to help Mark and Jane discover that they have joint interests, so that they both, as well as other members of the community can benefit from combining their knowledge and extending the community's *transactive memory*.

Jane is now working on a new project and needs to find information on ontologies - a topic she is not very familiar with. She can be helped to allocate relevant resources within the community and establish contacts with members knowledgeable in the area, which is related to the community's *transactive memory* system. Jane may also be encouraged to upload more resources on ontologies and discuss the link of this topic with technology enhanced learning. If the new topic is of interest to many members, it will become close to the community's *cognitive centrality.*

The community has to adapt to changes in its environment which may lead to a shift of the central area of interest and transformation of participation. [16]. Consequently, active contributors may become passive members, while others who used to be peripheral participants may become cognitively central [8, 9]. For example, Jane may gradually reduce her participation or stop contributing to the community. If changes over time are detected, *cognitively central* members like Jane who are moving to the periphery can be encouraged to participate more actively in the community's knowledge processes.

Support to Improve Organisation of Resources

People categorise and organise their resources differently according to specific characteristics, different conceptualisations, searching habits, etc. [17, 18]. Confusions may happen and disagreements are inevitable [19], which can have an impact on the effective functioning of an online community [17, 20, 21]..

Consider for example several members of the community interested in the use of context in systems for technology-enhanced learning. Each member uploads resources important to them and relevant to the projects they are engaged in. Jane considers context from an Artificial Intelligence perspective and links it to encoding different viewpoints in an ontology. Chris associates context with the conditions in a learning environment, while Mark is engaged in a mobile learning project where context is used to represent location-based information. Appropriate support for effective

knowledge sharing would encourage members establish common procedures how to categorise and locate information, which can be part of a *shared mental model*. Furthermore, discrepancies in individual members' conceptualisations, which refer to the lack of *cognitive consensus*, and how they affect the organisation of resource (e.g. a paper may be belonging to more than one category or similar papers may belong to disconnected categories) should be detected and pointed to the community.

Support to Encourage Collaboration

People participating in a VLC share an information space and may be engaged in active communication. These are preconditions for collaboration, which is often associated with effective VLCs where members either work together on a joint project or share a common desire to produce better services [22]. Collaboration among community members can be encouraged in two ways. Firstly, support should be provided to help members build a common understanding of what the purpose of the community is, who is involved and what their interests are, what tasks people are involved in, what is happening in the community and how it progresses over time. These issues relate to building a *shared mental model* and developing a good *transactive memory* system.

Secondly, interaction between community members can be encouraged to create more opportunities for collaboration. Possible situations when members will benefits from communication with others can be identified. For instance, when a lack of *cognitive consensus* is suspected, members may engage in clarification interactions. Referring to the above example with different use of context, Chris, Jane, and Mark may be directed to discuss the different interpretations of the concept. Another possibility to encourage interaction is when members are found to share common interests or to have complementary knowledge. For example, Chris and Jane may be encouraged to discuss the similarity between folksonomies (linked to Chris' interest in social tagging) and ontologies (related to Jane's new project).

To sum up, TM, SMM, CCs, and CCen relate to the effective functioning of a community and are critical in defining personalised support tailored to the needs of the community. TM is important for quickly integrating newcomers to the community, improving the benefits of existing members to motivate their participation, and encouraging collaboration. SMM is a prerequisite for effective knowledge sharing and is directly linked with document organisation and information localisation; it is also an important factor for facilitating collaboration among community members. CCen can be helpful for relating the knowledge of newcomers and existing members to the community's context, and monitoring changes happening within the community over time. CCs can point at similarity and difference of individual members' viewpoints, which can affect resource organisation and can trigger interactions that may result in collaboration activities.

3   Existing Technologies to Support VLCs

We will now review what computational methods have been developed to address TM, SMM, CCen, and CCs, by using several representative systems:

- **Answer Garden** [23] supports the building of organisational memory by helping people find and share answers to questions they come across;
- **BSCW** [24] is built as a general tool for cooperation over the web and supports the main knowledge sharing activities, e.g. upload/download/search for resources, synchronous/asynchronous communication, version control;
- **Comtella** [25] is a small-scale application for sharing of class-related web resources among students, it focuses on motivating participation;
- **GIMMe** [26] is a web-based system that serves as a central repository for storage and access to email conversations within an organisation;
- **KSE/Jasper** [14] is knowledge sharing environment of information agents which are associated with each user and are capable of organising, summarising and sharing knowledge from a number of sources ;
- **MILK** [27] supports communities of interest within an organisation by integrating knowledge associated with people, communities, and informal knowledge, its core component is a metadata management system;
- **NuggetMine** [28] is an intelligent groupware application that facilitates opportunistic sharing of information nuggets (e.g. URLs, book titles, articles, information about an event) among a group;
- **OntoShare** [29] is an ontology based knowledge sharing environment which makes extensive use of advanced Semantic Web technologies to provide individualised support for members of a community of practice];
- **TeamWorks** [30] is a collaborative environment to support communities of practice which provides tools for communication, storage and capturing of data, and maintains document recommendation based on loyalty.

These systems are selected because they address, to a certain degree, the concepts presented in Section 2.

Transactive Memory

The building of transactive memory is supported, to a certain degree, by all systems. *A search facility* to help users allocate relevant knowledge and people is the most common technique used to facilitate the development of TM. BSCW [24] provides a standard search function through resource titles, while MILK [27] allows searching for experts or information in the community based on the information stored in people's profiles and on the metadata associated to resources. However, this approach is prone to inaccuracy: metadata is defined by members who upload the resource and the profiles are based solely on the users' interactions with the system. These problems are addressed in KSE/Jasper and OntoShare which provide enhanced search facilities based on keyword extraction from the entire documents [14, 29]. Moreover, KSE/Jasper and OntoShare enable users to search for other members with similar interests based on dynamically maintained user profiles open for inspection and change by the users. Answer Garden and GIMMe also illustrate the use of natural language processing techniques to provide support for the development of transactive memory [23, 26]. Answer Garden uses text retrieval engine to allocate "expert" answers to a user's question, and employs simple dialogue to clarify that question. Although identifying expertise can be related to TM, Answer Garden maintains anonymity of user contributions which does not allow allocating community members

who hold that expertise. GIMMe uses latent semantic indexing to facilitate search through a vast repository of email conversations, and extracts group categories based on previously visited issues, which can be important for TM,

While search relies on users pulling for information, *notifications and recommendations* are push techniques. BSCW notifies users every time changes are made to the community space (who uploaded what and who read what), which may implicitly help for developing awareness of who knows what. However, users may not notice important information because the notifications are not tailored to the user's current interests, as this is done in OntoShare based on simple content-based filtering mechanism. TeamWorks [30] also provides tailored notifications by recommending resources relevant to the current topic under discussion. While recommendations have been found as useful personalisation techniques, their current application in VLC focuses solely on support for an individual and the benefit for the development of TM is yet to be shown.

Semantic-enhanced technologies have also been applied to support the developing of TM. NuggetMine and MILK use metadata about resources to associate newly added pieces of information with old ones [27, 28]. However, this approach relies only on metadata and does not take into account information about people who shared/read the resources, which is crucial for the construction of TM. GIMMe and BSCW maintain a hierarchal structure of categories that can facilitate knowledge allocation. However, the categories are feely constructed by users and become messy, which may hinder resource allocation and expertise finding, and is not very helpful for the development of TM. OntoShare instead uses ontology of domain categories to identify knowledge and similarities between users.

Shared Mental Models

Making members aware of what is happening in the community considered important and supported by the majority of the systems in different ways and up to a level. *Visualisation* techniques to allow users become aware of what is happening in the community in general have been used for the development of SMM by two systems. The development of SMM is promoted in Comtella [31] by galaxies visualisations which illustrate the convergence of topics. BSCW also uses visualisation techniques to support the development of SMM. Users can explore a map of the information space which shows each folder and the activities in it, indicated with small rectangles. Another visualisation shows how many papers are in a folder presented as towers in a city. Visualisation techniques are useful for an overview of what is happening in the community but appear insufficient for a deep understanding of the conceptual processes within the community.

Semantic – aware techniques have been explored to support the development of SMM in Jasper II, MILK, and TeamWorks. Jasper II supports the creation of shared understanding by capturing the individual perspective in the form of annotations typed in by the users [14]. Similarly, MILK supports contextual awareness in the community based on meta-information users are typing [27]. However, meta-data provided solely by users may be inaccurate, incomplete, or contradicting. A shared ontology is used by MILK to allow users to associate documents uploaded to the terms on the ontology tree. In this way, users have to agree to a specific point of view represented in the ontology, which may not always be shared by all community

members. TeamWorks [30] facilitates the development of shared understanding by recommending resources to community members based on what others are reading.

Cognitive Consensus

A shared ontology has been used in two systems in an attempt to support CCs. OntoShare and MILK are both using an ontology from where users can choose words to assign to the resources they upload. If a relevant word cannot be found, users can enter a new work that is added to the existing ontology. Using a shared ontology dynamically expanded by contributions from community members can help the community establish cognitive consensus. However, understanding ontologies can be a challenging task for VLC users who are likely to lack knowledge engineering skills.

TeamWorks provides a *controlled vocabulary* [30] for users to categorise their resources. The interface is more intuitive and the users are not burdened with complex ontological structures. However, none of the approaches takes into account that subjective views that are not necessarily agreed within the whole community can be put mistakenly in the shared ontology/vocabulary. Moreover, both approaches appear to work at a surface (word, phrases) level, while CCs requires considering the understanding community members have about a concept [10].

Cognitive Centrality

Cognitive centrality is addressed partly in Comtella by a *reward mechanism* aimed at encouraging participation in online communities. Each member earns points based on how others are rating the resources he/she has uploaded [25]. Comtella uses *visualisation techniques* to present cognitive centrality. In a recent version of the system, stars with different size and brightness give an indication of who is contributing valuable resources (judged by the ratings). In an earlier version of the system, galaxies represent topics that may be of interest to the community. The closer to the centre of the galaxy a member is, the more central (judge by the number of papers uploaded) he/she is considered to be [31]. The mechanisms used for calculating cognitive centrality in Comtella are quantitative and do not take into account the cognitive influence of a member and the relevance of their contribution to the community's context.

Table 1 gives a condensed summary of the technologies reviewed.

4   Discussion

Although systems attempt to support TM, SMM, CCen, CCs, the absence of a complete community model, and the personalisation and adaptation to the individual rather than the community compose the main obstacles to their holistic success. Our research aims at the development of a framework for holistic personalised support based on a community model and using that model to support the building of TM, SMM, and CCs. The computational framework will consist of two major parts. The first will deal with the development of a community model, which will represent the whole community and will focus on the processes discussed in Section 2. The second will deal with offering adaptive support to improve the functioning of the community.

Fig. 1 illustrates the architecture of our framework following the general architecture of user-adaptive systems defined in [32].

Table 1. Summary of the technologies that support TM, SMM, CCs and CCen

Process	Technologies to support this process

TM	**Search:**
	    Basic search through document titles {BSCW}
	    Search through metadata using user profiles {MILK}
	    Extract keywords from resources and link with user profiles {OntoShare, KSE/JASPER II }
	    Text retrieval techniques based on keywords {Answer Garden}
	    Latent semantic indexing {GIMMe}
	Notifications and recommendations:
	    Notify about changes {BSCW}
	    Recommend resources and people on user profile {OntoShare}
	    recommend based on current task {TeamWork}
	Semantic-aware techniques:
	    Metadata to associate information {NuggetMine, MILK}
	    Category hierarchy {GIMMe, BSCW}
	    Ontology {OntoShare}

SMM	**Visualisation**
	    Clusters of common interests {Comtella}
	    Awareness of what is happening in the community {BSCW }
	Semantic-aware techniques
	    Metadata to identify common interests {KSE JASPER II, MILK}
	    Shared Ontology to create connections between people {MILK}
	    Recommend resources to be read by everybody {TeamWorks}

CCs	**Shared Ontology** {OntoShare, MILK} **Controlled Vocabulary** {TeamWorks}
CCen	**Reward mechanism** {Comtella} **Visualisation** {Comtella }

For the development of the community model, we will focus on the analysis of tracking data collected from an existing VLC application. Two year tracking data from an existing VLC with some 25 researchers with common interests working together on virtual research projects and sharing documents with the BSCW system that supports resource sharing and collaboration over the web will be used[1]. The BSCW data consists of information on who uploaded what resource on the community's space; who accessed which resource and when, who ranked and modified it; which members joined and left the community and when. This information is in an xml like format and is being processed with data mining tools. The tracking data is being analysed to see what information we can get to identify existence of TM, SMM, CCen, and CCs. Learning or knowledge construction, information sharing and collective efficacy (i.e. how much the group members believe that they can be successful as a group) will be examined in relation to the development of SMM, TM and CCs in the community. Having this done, we will enhance what we have with semantically enriched information such as metadata of the objects, considering the specialisation area of the person who posted that object

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[1] The tracking information is taken from the BSCW interface, available to all members of the community. The experimenter is a member of this community. Aliases have been used instead of users' real names to comply with privacy regulations concerning data analysis and presentation of results.

and keywords provided. We will also use existing ontologies of areas relevant to our community (for example, the VLCs we are analysing are focusing on issues related to the Semantic Web for which example ontologies have been developed[2]) to compare against the data that we have. Ontological reasoning techniques will be used to identify relations between topics and to decide what interventions from the system may be needed.
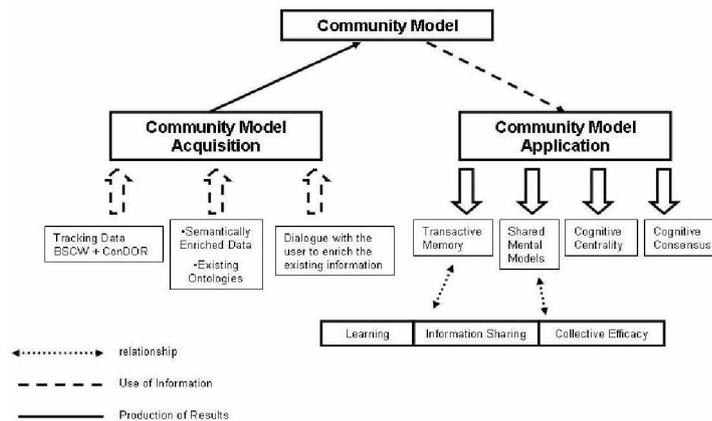
Fig. 1. General Structure of the Community Modeling and Adaptation Framework

Only analysing tracking data and ontologies will not be sufficient to find consensual knowledge and shared mental models. To model these, we will use in addition a system-user interaction to get additional information and complete the community model. The dialogue approach has been successfully used in our research group to gather knowledge of individual users [33] and can be adapted to capture and clarify aspects of collective knowledge.

As pointed by one of the reviewers, security of the system is an issue that inevitably will have to be dealt with. As the system has not yet designed or implemented, an initial thought is that registration and use of log-in names and passwords will be mandatory for users to enter the community's space.

Once the community model is developed, it will be used to provide support to the community and to help its members improve the TM system of their community, develop SMM and CCs between them and become aware of cognitively central or peripheral members. This will help us point at issues that support information sharing, learning and development of collective efficacy, and to help the community build a good TM system and a shared understanding of the domain they are working in.

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[2] For example, https://wiki-sop.inria.fr/wiki/bin/view/Acacia/KnowledgeWeb

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Informal learning theories and tools to support knowledge management in distributed CoPs

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Abstract. In this work *informal learning* theories and practices and *social networking* features are taken as starting points to build a reference collaboration model to support collaborative knowledge construction in Distributed Communities of Practices. Sample web 2.0 applications to fit the collaboration model purposes are then described. The provided model can give contribution to the design and to the improvement of a specific collaborative virtual environment to support knowledge management in DCoP.

1 Introduction

Communities of practices cover a central role in the processes of knowledge management [1][2] as they are "the heart and the soul of knowledge sharing"[3]. Since the purpose of the CoP is typically achieved through the understanding and continuous renegotiation of joint enterprises by its members, a crucial problem that must be addressed in the online environment is to devise methods and tools to support:

- expression, representation and sharing of practices
- development and exploitation of knowledge inside and outside of the CoP
- self/group-reflexivity and metacognition about the practices and about the life of the CoP itself

Indeed, these knowledge management functions have close relation with the collaboration features typically emerging in *informal learning* contexts since in the attempt to maintain a reciprocal engagement in the achievement of a common goal the

CoP members aim at acquiring *significant learning*; from this perspective, as it was pointed out by Wenger [2], a CoP can be seen as "shared learning histories".

This work is therefore framed and rooted in the background context of *informal learning theories* and *practices*.

Definitions of informal learning have been given in Cedefop glossary [4] and in the Communication of European Commision in 2001 [5][6]. In these documents *informal*, *formal* and *non-formal learning* are respectively defined as:

- *Formal learning;* learning that occurs within an organized and structured context (formal education, in-company training) and is intentional from the learner's perspective. Normally it leads to a formal recognition (diploma, certificate).

- *Non-formal learning;* learning embedded in planned activities that are not explicitly designated as learning, but which contain an important learning element. Non-formal learning is intentional from the learner's point of view.

- *Informal learning;* learning resulting from daily life activities related to work, family, or leisure. It is often referred to as experiential learning and can to a certain degree be understood as accidental learning. It is not structured in terms of learning objectives, learning time and/or learning support. Typically, it does not lead to certification. Informal learning may be intentional but in most cases, it is non-intentional (or 'incidental'/random).

In the new-born research context of *informal e-learning* theoretical reflection and applied research is still at the beginning and e-learning and knowledge management can derive a significant boost from these "social networking attitudes and practices". Informal learning is a highly natural practice because it is deeply rooted in our daily behavior; spontaneous relations, interactions and conversations support informal learning practices, contributing to the creation and transmission of knowledge [7]. In informal learning practices the social behavior and the support of technologies converge toward the "network"; a network made by people and resources, a *social network*, unified by personal needs or common goals, interaction policies, protocol and rules and telematic systems all together favoring the growth of a sense of belonging to a community.

In this paper we try to provide a reference model to support online collaboration accounting for new practices and technologies of social networking currently wide spreading in the Internet. The need to reflect and research on such a model is grounded in some critical issues: just to mention some as, reference literature points out [1] [8] [9][10]online collaboration suffers the mediatization of interaction context, has to face the problems of social grounding, is conditioned by trust and reputation, requires group culture development and must face the issues related to the representation and management of knowledge.

To this extent in paragraph 2 we analyzed background conditions for networks of subjects collaborating online deriving *enabling functions* in informal learning

contexts emerging in social networks. Then, in paragraph 3, we present the reference collaboration model which envisages a layered structure where the layers of "Organization" and "Collaboration Management" are supported by functions and conditions of an enabling layer named "Social Networking". In paragraph 4 we discuss tools and technologies which could support the collaboration model.

The model aims at giving suggestions to designer of online collaboration environment for CoPs in order to maximize the advantages deriving from the effective networking to enhance and improve knowledge management functions.

2 Enabling conditions for collaboration in Distributed CoPs

Collaboration in online environment is harder than in presential situation [1] [3]. This is due to the fact that the integration level normally achievable in presence is typically higher than in network-mediated environment where technology itself is erroneously considered to be capable of providing "group awareness". Actually, just to mention two underestimated problems that technology can bring, the difficulties of representing a group and the competences of its members in the technological environment as well as the lack of direct contact could weaken the sense of belonging and quickly lower the motivation to collaborate.
A crucial role is therefore played by designing a collaboration system (that is a grounding method availing of several tools) in its integrated aspects, accounting for subjects, technologies and environment.

Scenarios which become always more common highlight that through informal channels new learning and knowledge management spaces more easily are enabled, thanks to people and their ability to "networking" and reciprocally learn in a natural and spontaneous way [11]. The reference model for collaboration proposed in the next paragraph aims at fostering these potentialities. This model was inspired by the analysis of the strengths emerging in the context of informal e-learning in social network, to evaluate the integrability and/or transferability in other context, such as knowledge management in CoPs.
   From this perspective in Table 1 the main difference between social networks and CoP are schematized as fort their sharing/cooperation/collaboration characteristics.

Table 1. Distinctions among the CoP and Social Network, adapted from [1]

Entity	Social Network	CoP
Goal	Relation based on individual interests, debate, confront on specific topics; multiplicity and heterogeneity of joining interests and motivations	Create and expand knowledge; develop individual skill
Belonging	Spontaneous and autonomous motivation	Self-selection based on expertise or passion for the topic
Duration	Non-defined	It evolves and ends organically

		according to the relevance of the topic and of the reciprocal interest
Cohesion and enabling factors	High level of trust (relevance of reputation), sense of responsibility, high technological skills, distributed reflexivity and evaluation (non autonomous, nor heteronomous but socially spread)	Passion, trust, identification with the groups and their expertise
	Type of relation: share/evaluate	Type of relation: share/collaborate/cooperate

A model for collaboration in online communities should first of all satisfy some general "effectiveness conditions" (the term *satisfy* is on purposely adopted instead of *implement*, because the functions that follow are hardly hardcoded in a technical system; they are more likely enabled or supported by the implementation of specific functions whose analysis is beyond the scope of this paper but could be object of future investigation).

The effectiveness conditions are [1] [10]:

- to avoid non sustainable situations (ex. lack of technology expertise, non availability to collaborate, etc.)
- to reduce initial gaps as for contents as well as for technology
- to favour group creation
- to favour social interactions and development of sense of belonging
- to assume collaborative roles and tasks (timing, roles, interactions)
- to support self and group reflexivity and metacognition

These conditions can only partially be sought in tools and technical solutions, but can be enabled by a proper methodology [1][13].

Under these premises, in order to support expression, representation, development and sharing of knowledge in the CoP, we need to look for tools and methods allowing to represent, manage and value *interactions and connections among people*, *relations discussions and conversations*, *knowledge objects*.

3 A Model for Collaboration in Distributed CoPs

To comply with the objectives detailed in the previous paragraph, we hereafter propose a model for collaboration. This model is derived from a collaboration model presented by A.Calvani in [1], which we consider the starting point of our analysis. Indeed, the model in [1] accounts for effectiveness conditions and principles which are considered to be fundamental for collaboration as highlighted in reference literature [10]. However, while in [1] the model is conceived to provide useful steps to support an online collaborative group, the model is rooted in a *formal* educational context, thus being framed by a "technology alignment" external layer. In contrast the model we present is framed by a Social Networking external layer which accounts for the benefits of informal learning and collaboration contexts, as described before. Moreover, in [1] the purpose is to support generic "online groups", while the

reasoning here conducted is motivated by the analysis of the specific type of group (a Distributed Community of Practice). Although the model could be easily extended to other group types, we believe that the distinction in the analysis is crucial to the effective implementation of the collaborative functions in telematic environments [12]

The model in Fig. 1 envisages four concentric layers each of them implementing the conditions to support the effective realization of the functions of the contained layers.

The most external layer is the "SOCIAL NETWORKING" layer implementing the proper contextual conditions to create a social climat and a shared social grounding, supporting:

- *generation and support to motivation*: in informal e-learning contexts the *motivation* is *spontaneous*; it is often induced by *fun* and *pleasure* that individual have in their network activity; it is also rooted in the *positive interaction* among people (a subject can more effectively and efficiently pursue his objective if the other subjects pursue theirs);
- *group culture*: in informal environment the sense of belonging (*membership*) to a group is spontaneously supported by the intensity of sharing interests on a topic; regardless from the expertise – which can be widely disomogeneous among members – it is still the awareness of the positive interaction with others that sustain *mutual understanding* and *social grounding*;
- *social climat*: in informal contexts it is the awareness of being useful to other community members which increases the *self-esteem* and foster the *motivation* for a wider visibility (for instance being linked, have positive reputation, produce and/or proposed new contents); in this contexts the respect to others, the (often tacit) agreement of *respect*, and *socioquette* (rules for an aware conversation)[1], make the online relational environment a "*trusted*" environment.

In more formal context, such as for CoP, these conditions are certainly more difficult to attain.
Indeed, it is the very purpose of the Social Networking layer to constitute the effective condition for the activation of more structured collaborative activities such as those required in the life of DCoPs.
In order to borrow the potential above illustrated, the designer of the environment will therefore need to adopt technologies and methodologies to support:

1. *the perception of the meaning*: the subject must perceive as really meaningful (useful to himself) the objectives attainable in the DCoP activities and acknowledge that collaboration can derive real advantage;
2. *visibility/reputation/self-esteem*: the dialectic individual-group must enable activities to value the individual in the group and allow each member of the group being valued by others;

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[1] The term "Socioquette" has been used in applied research by the Educational Technology Laboratory of the University of Florence. It indicates a set of rules and behaviour criteria that should be followed by people engaged in online collaboration. See also [1]

3. *self-perception of usefulness*: the subject must perceive the significance of its contribution to group activities in order to consider himself a useful contributor to other's goals.

Putting emphasis on this dimensions will not only support sharing, cooperation and collaboration in Distributed Communities of Practices, but can indirectly promote participation of the individuals to other informal learning networks, which certainly is a uncontrollable but desirable and enriching side in this context.

 "ORGANIZATION" and "COLLABORATION MANAGEMENT" layers have the functions to support more specifically the activity of collaborative groups (also in more formal contexts). They must be implemented according to appropriate instructional methodologies [13], typically oriented to project work and based on a system of rules (objective, roles, etc.) to which the DCoPs members are required to comply. Both layers could consequently be implemented by a methodology and sustained by technological functions available in current collaborative learning environments.

Eventually the central nucleus of the model, the "RIFLEXIVITY" layer supports the fundamental function of the subject and the community in its capability of becoming aware of its collaboration and learning processes to this extent this layer must implement:
- self-representation and group-representation functions
- self-evaluation and group-evaluation-functions
- distributed-evaluation functions

In collaborative activities basing on Social Networking distributed-evaluation functions could also be envisaged through which the individual, the group and the community refer in specific moments of the collaboration process (for instance during the production of a product or a document or at a end of a given activity). Contacting external experts in the domain, receive feedback etc. are functions accountable to this purpose. The centre of the model brings thus back to its periphery of Social Networking.

Social Networking

ORGANIZATION

trust

pleasure, fun

tasks   respect

COLLABORATION MANAGEMENT

positive interaction

active tools selection

timing   socioquette

Reflexivity and metacognition

mutual understanding

spontaneity

social grounding

roles

self esteem

objectives

motivation

membership
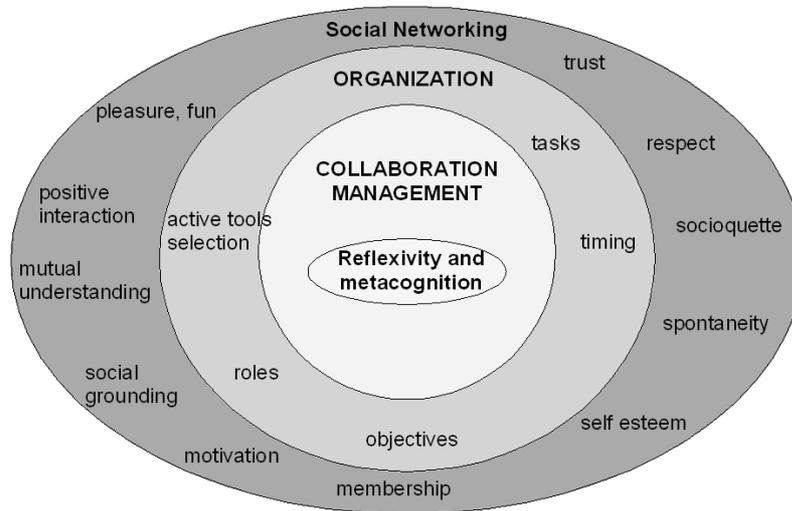
Fig. 1. Reference model to support collaboration in Distributed CoPs

4   Tools and technologies for the collaboration model

The further step in the analysis leads us to the problem of evaluating and devising if tools and technologies exist or can be developed in order to match the requirements and purposes expressed by the former model.

A possible answer can be given by the technologies and tools now referred to as *web 2.0* software [14] [15]. We acknowledge that web 2.0 is a term which is hard to define because of the amorphousness of the concept. However we share Paul McFedries [16] tentative definition according to which web 2.0 is "a second phase of the evolution of the World Wide Web in which developers create Web sites that act like desktop programs and encourage collaboration and communication between users"[2].

McFedries identifies the main characteristics of the Web 2.0 "movement", highlighting the social perspective of relation, collaboration and user-participated architecture:

  - *content is user-created and maintained* (peer production, user-content ecosystem)
  - user-created and maintained content require *radical trust*
  - *application usability* allows rich user experience
  - *combining data from different sources* leads to creation of new services (mashup)

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2   http://www.wordspy.com/words/web2.0.asp

- services get better as the number of users increases in an *architecture of participation*

With respect to the model depicted in Figure 1, for each layer we indicate technologies and tools which could serve to desired scopes.

SOCIAL NETWORKING layer

Conditions and functions of this layer can be widely supported by the use of web 2.0 technologies. Indeed, such technologies will provide useful functions for Collaboration Management and Organization layers, but their use, framed in a proper methodology, will provide the enabling conditions for *generation and support to motivation*, *group culture* and *social climat* development.

Social Networking layers and its contained layers will therefore be bridged by the adoption of technologies and methodologies. In Table 2 where we highlight McFedries [16] "social" characteristics of some sample web 2.0 tools which could support Social Networking layer needs.

Table 2. Sample web 2.0 applications: description and "social networking" characteristics

Web Application	Description	Characteristics
Social networking, online social networks	Category of Internet applications to help connect friends, business partners, or other individuals together using a variety of tools.	Architecture of participation
Social network search engines	Social network search engines are a class of search engines that use social networks to organize, prioritize, or filter search results.	Architecture of participation
Blogs	A weblog, (or blog), is a website where entries are made displayed in chronological order. They often provide commentary or news on a particular subject, typically combining text, images, and links to other blogs, web pages, and other media related to the specific topic.	User-created and maintained content
Blog guides	Specialized search engines for searching blog and news contents	Architecture of participation
Social tagging, (folksonomy)	Ad hoc classification scheme (tags) that web users invent as they surf to categorize the data they find online	Architecture of participation, trust
Social bookmarking	Saving and applying keywords to one's personal collection of Web site bookmarks on a site that enables other people to share those bookmarks	Architecture of participation, trust
Web Syndication, Web feed management	Web syndication is a form of syndication in which a section of a website is made available for other sites to use through to making Web feeds available from a site in order to provide other people an updated list of content from it (for example one's latest forum postings, etc.).	User created and maintained content, Content aggregation
Tag clouds	A list of tags user in the site with some kind of visual indication of each tag's relative popularity (ex. large font). Web sites that implement tag clouds functions	Architecture of participation

	allow both finding a tag by alphabet and by popularity. Selecting a single tag within a tag cloud will generally lead to a collection of items that are associated with that tag	
Peer production news	Websites combining social bookmarking, blogging, and syndication with a form of non-hierarchical, democratic editorial control. News stories and websites are submitted by users, and then promoted to the front page through a user-based ranking system	User created and maintained content, trust
Wikis	Collaborative web sites that allows users to add, edit and delete content	User created and maintained content, trust
Collaborative real time editing	Simultaneous editing of a text or media file by different participants on a network.	User created and maintained content
Content aggregation and management, Mashup (web application hybrid)	A website or web application that combines content from more than one source	User created and maintained content, trust, architecture of participation

ORGANIZATION and COLLABORATION MANAGEMENT layers

Functions needed for the services of these layers are typically supported by collaborative learning environments[3].

The purpose of the collaboration model here envisaged is that the functions of these layers be combined and supported by contextual functions of the Social Networking Layer. More specifically the virtual learning environments could evolve their functions according to the directions schematized in Table 3:

Table 3. Current and envisaged functions of a telematic collaborative environment

Virtual Learning environment macro functions	Typical	Extra collaboration-oriented functions in the direction of Fig. 1 model
User management	Roles (authentication, authorization, registration), workspaces, group management, portfolios, student tracking, etc.	User links (blog connections, web syndication etc.), representation of multiple presence of the users in different communities and groups
Content	Content edition and upload, document	Group content creation (es.

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[3] See for instance Edutools reviews and comparisons on available e-learning environments http://www.edutools.info/index.jsp?pj=1

Management	repository, learning object repository, whiteboard, journal, etc.	digg news, wikis,social tagging, social bookmarking, collaborative editing etc.), link to related contents (blog guides, social network search engines, mashups, etc.)
Communication Management	File exchange, forum, mailing list, chat, VoIP, etc.	Link to podcasting records, etc.
Organization/planning management	Calendars, todos,	Shared calendars, project management tools
Self-group evaluation	Quizz, assignments, etc	Support to self- and group-reflexivity (es. tag clouds, thinking types, connection to external experts, reflection boards [1] etc.).

REFLEXIVITY and METACOGNITION layer

The functions of this layer are at the heart and centre of the model in that they constitute the process of knowledge construction (reflection on the processes and products, self-reflexivity and self-evaluation); they are transversal to technologies but can find valuable support in web2.0 tools.

From one side the representation of the sociality which is typical of such applications already provides input which support awareness towards the objectives and aims undertaken by the participants; functions such as social bookmarking and social tagging are solutions encouraging confront and reflection and providing possible useful link to other information sources. Blogging and social networking functions favour self-narrative and conversational practices which imply self-reflexivity and "distributed" evaluation. Therefore, collaborative environment can be improved with "reflection" [1] tools and spaces which encompass the social dimensions and represent the subject scollaborating in the social network.

5 Conclusions

In this paper we provided a model for online collaboration which could meet the needs of collaborative knowledge construction in a Distributed Community of Practices.

The envisaged model aims at indicating enabling conditions to support "relation and interaction" in information sharing, learning, cooperation and collaboration for the members of a Distributed Community of Practice, basing on informal learning and social networking theories and practices.

The conditions highlighted for each layer of the presented model are the grounding dimensions to support the activities of the community itself. We believe that the provided model together with a collaboration methodology and available web 2.0

technologies (such as those here described as sample) can give contributions and to the realization and improvement of a specific environment tailored for a DCoP needs.

The analysis conducted in this work provides ways for further investigations aimed at defining a reference model where new social networking practices and attitudes and available and upcoming technologies could harmonize in methods and proper development guidelines to lead toward a situation of truly enabled collaboration and lifelong learning.

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Political, Dialectical and Conative Aspects of a Collaborative Decision Making Tool for CoPs

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Abstract. Designed for and evaluated by computer science researchers, medical doctors and civil and mechanical engineers, the Collaborative Decision Making (CDM) tool HERMES (Karacapilidis and Papadias, 1998, 2001) is about to be adapted for another kind of audience, i.e. the communities of practices (CoPs) under the name "COPE_IT!" (http://copeit.cti.gr/) and currently developed in the framework of the project PALETTE (Pedagogically sustained Adaptive Learning Through the exploitation of Tacit and Explicit knowledge). The aim of this paper is to suggest three directions of development that would provide new functionalities to this CDM tool having to take into account some essential characteristics of CoPs and that, like HERMES did, intend to "augment classical decision making approaches by supporting argumentative discourse among decision makers" (Karacapilidis and Papadias, 2001: 1-2).

Keywords: CoP; Collaborative Decision Making; Argumentation.

1 Introduction

Depending of its nature (its level of development), its field of interest, its size and its organizational mode, a CoP will use a CDM tool for different purposes related either to the life of the CoP (operational decisions) or to members' practice outside the CoP ("domain" decisions) (Künzel, 2006). So, we can at first sight identify at least four possibly essential differences with the situations for which HERMES has been developed:

1. the type of subjects to submit to a decision making process (technical and accurate vs pragmatical and large),
2. the type of arguments supporting decisions (scientific proofs vs probable opinions),
3. the recognized reliability of participants (experts vs more or less experts),
4. the number of participants (few vs numerous).

These four possibly essential differences are, in my view, sufficient to suggest that some aspects should specifically be taken into account when developing a comprehensive tool for CoPs. These aspects are, at least, three a) political (about the quality and quantity of participants), b) dialectical (about the quality of arguments and proofs) and c) conative (about the motivations and emotions of participants), and could lead to create some new functionalities for COPE_IT!.

I will argue in favour of the addition of new functionalities using a very short and simple discussion taken and freely implemented adapted from the COPE_IT!'s testing Web site where the issue is "Where to build a factory?".

2   COPE_IT!'s Basic Principles

Once an issue is proposed, each participant (the list of which is accessible to users and not closed) is invited to add alternatives or potential choices to solve the issue as well as positions in favour or against these alternative solutions during the predefined time allowed for discussion.
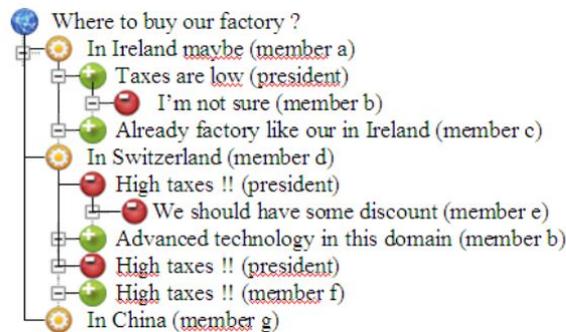

Fig. 1. An example of discussion.

Participants are invited but not obliged to comment or justify their interventions.

Fig.2: Complementary information about a position

Even if COPE_IT! is not conceived as an automatic decision maker (it is "only" a support for CoPs to make a decision), the arguments or reasons are weighted so that

"recommended" choices can appear. This supposes that the tool is equipped which algorithms that allow calculating which the strongest or most "recommended" alternative is.

In HERMES, the weight of alternatives and positions was calculated according to their level of activity: "an active position is considered as "accepted" due to the discussion underneath (e.g. strong supporting arguments, no counter-arguments), while an inactive position is (temporarily) considered as "discarded" or "rejected". So, according to the adopted proof standard, a position p is active if a) at least one active position argues in favour of it (Scintilla of Evidence), b) if there are not any active positions that speak against it (Beyond Reasonable Doubt), c) when active positions that support it outweigh those that speak against it (Preponderance of Evidence)" (Karacapilidis and Papadias, 2001: 7-8).

As it can happen that two alternatives receive the same score, HERMES offered the possibility to introduce constraints (also subject to discussion), i.e. preference relations of the type *x is more (less) important than y* or *x is of equal importance to y*. This functionality is not yet accessible in COPE_IT!, but there are good reasons to make it part of our tool.

In both figures above, we observe that all positions have the same weight, that all alternatives and positions can be supported by only one participant unless it is repeated, that one participant repeats one of his positions so that it is active again, that a very subjective position ("I am not sure") is opposed to a rather objective one ("High taxes"), that a same position is "against" for the president while it is "in favour" for member f, that none of the participants has commented nor justified his positions and, finally, that both alternatives received the same score.

Each of this observation raises a question about the efficiency of the CDM tool. Indeed, is it enough to propose a patchwork of opinions to make the decision making collaborative? Does the result really reflect the position of every participant? Does it really help to make a decision? The functionalities exposed below should help to ameliorate the way to calculate positions' activity as well as the quality of arguments and proofs. Some of them would probably require some short preliminary training on argumentation or lead to the creation of an Argument Builder Tool as the one proposed by Karacapilidis and al. (1997).

3   Some New Functionalities for COPE_IT!

3.1   The Political System of a CoP

Because most of the CoPs function as a democracy, the political system of COPE_IT! by default could be democracy. But perhaps some participants, if there are more expert (for a domain decision) or are more responsible (for an operational decision) should be sometimes enabled to enjoy an aristocratic status. COPE_IT! could then

have a functionality allowing a preliminary choice between several political systems that would determine the weight of some participants.

- ❑ Democracy (one person = one vote)
- ❑ Aristocracy (some persons have more than one vote)

Username	Number of votes
Username	Number of votes
Username	Number of votes

Add another username

3.2   A Support Function for Positions

Even if most of the CoPs function as a democracy, it is not enough to calculate the activity of an alternative only on the base of the number of positions in favour or against it. The number of participants supporting it is also important. So, each position could be followed by a button "Support" as well as by an indication of the number of votes in favour of this position. Of course, one and the same participant could only once support a position.

Other advantages of this functionality are that it would encourage participants to be more active in the discussion and that it will not be necessary to repeat a position to make it active again or to make it more.

Advanced technology in this domain | Support | | x votes |
High taxes | Support | | x votes |

3.3   Obligatory "Comment" Field or "Justification" Field

Depending on the argumentative culture of the CoP and on the argumentative skills of its member, positions will be argued or not, well-argued or not. It could be then useful to make the "Comment" field obligatory. The immediate effect of such a constraint is that it will be impossible to pitch a position without any justification and this will of course contribute to guarantee a minimal seriousness (and perhaps also the well fairness) of the discussion.

Making the "Comment" field obligatory is interesting for operational decisions; bur is not enough to evaluate the quality of an argument in the case of domain decisions. Indeed, in such a case, positions in favour or against an alternative could be either scientific proofs or probable opinions, subjective or objective. In the example above, it is clear that the position "I am not sure" is a very subjective position, but the position "High taxes" could also be very subjective (depending on the level of information of the participant that proposes it).

To give participants information about the kind of justification that is given to a position so that they can better evaluate it, it would be useful to replace the comment

field by an obligatory justification field where the proposer could choose between the following justifications (not exhaustive list):

- Scientifically proved and unquestionable fact
- Scientifically proved but questionable or questioned fact
- (Widely) recognized fact
- Observed fact by myself
- Observed fact by several people
- Common belief
- Individual belief
- Other

Of course, it is not enough to assert that a position is scientifically proved and unquestionable so that participants adhere to it immediately. The proposer keeps always the opportunity to refer to an URL or to attach a document to support his claim.

The option "Other" allows the proposer to write anything (s)he likes in support of his/her position, e.g. justification that are not at all intellectual but rather emotional (conative aspect).

Other advantages of this functionality are the following: first, it could favour the collaboration between participants, e.g. if I propose a position that I justify saying that it is a (individual or common) belief and that someone bring new information about it, saying that it has been scientifically proved or saying that it is a fact that I observed and that other people comment saying that they also observed this. Second, it would explain why a same position can be "against" for a participant and "in favour" for another one (i.e. because the justification or the point of view is different).

Should this distinction of justifications between domain decisions and operational decisions be adopted, it would be necessary to add a preliminary function determining the screen that will appear when a participant wants to add a position.

3.4   A Self-Weighting Function for Positions

For positions relying on probable opinions, probably the most frequent in a CoPs, as scientific theories are generally not their specific subjects of interest, it could be useful to create a function through which a participant could self-weight his own position by mentioning its degree of conviction on a scale from 1 to 5, for example.

This would not ensure that a position is truer nor more reliable, but it would give participants a better idea of what others believe and to what point they are ready to change their mind or not (conative aspect). Other participants could then, if the support function is developed, indicate if their share this position and at the same degree of conviction.

Advanced technology in this domain Support   x votes degree 1
                                                      x votes degree 3

4   Conclusions

The above proposed functionalities, some of which are to be placed before the discussion begins (choice of a political system, choice between domain and operational decisions), are all related to political, dialectical and conative aspects of a collaborative decision making process and quite simple to introduce. They are all about the way to better evaluate the weight of alternatives and positions so that it can really help CoPs' members to better evaluate the positions held by participants and to make a decision that reflects the positions as near as possible.

But it is clear that they should completed by other useful functionalities, perhaps more complex to develop, aiming at

- making the discussion more dynamic: e.g. allowing a participant to modify his (and only his) interventions while keeping a review of all the changes made so that one can later analyze how the discussion evolved;

- making the discussion more ethical: e.g. determining the role and the prerogatives of a moderator towards disruptive or disrespectful participants), etc.;

- targeting the scope of the discussion. Indeed, anyone who gets into a decision making process (individual or collaborative) aims at making the best choice, but the best is relative to several aspects: the best for whom? In terms of what (truth, pleasure, usefulness, beauty, efficiency, time saving, costs, etc.)? If this objective is not clear and explicit at the very beginning, discussions can become very long, misleading or upset - of course a lack of accuracy of the issue would lead to the same effects. It would be then useful to develop functionalities such that both the issue and its "orientation" are or can be negotiated before getting into the discussion as such. Unless this should be the occasion of a discussion in itself, this could be done either through, like in HERMES, the possibility to introduce constraints in the course of the discussion or through a preliminary function giving the choice between the several options of the best solution sought-after;

- keeping tracks of the previous discussions and decisions so that the CoPs' members (especially for CoPs where there is a high turn-over) can refer to it in the future (Knowledge Management functionalities).

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Evaluation of Virtual Learning Environments Using Logs and Social Networks

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Abstract. The paper presents an evaluation method for e-learning platforms, based on different types of measurements collected in logs of interactions during learning sessions, and on the analysis of collaborative learning activities performed using social networks visualization of the relations established among users during the experiments. The evaluation was used to highlight the ease of access to different platforms' resources in two case studies: Sintec and Moodle. Problems encountered during the evaluation and possible solutions to be considered in future work (in the FP6 Cooper project) are also presented.

1 Introduction

In order to evaluate the environments to be used for e-learning, a number of criteria have been defined (e.g. [9]). Two major approaches may be identified: evaluate the platform's capabilities [4], [5] and evaluate its actual usage in a real working environment by analyzing the learners' behaviors and results [11], [13], according to given benchmarks [12]. The second approach is very important in the context of communities of practice and collaborative e-learning environments, where the evaluation should mainly determine the ease of access to shared resources, and the support offered to collaborative activities. Following these ideas, the paper presents a comparative evaluation of the usage of two learning environments, based on analysis of time and frequency aspects and logs and on visualization of social networks. The first is the rather well known Moodle environment (http://moodle.org). The second is the knowledge-based collaborative learning system Sintec [15], developed at the National Center for Information Technology (NCIT) in the University "Politehnica" of Bucharest (UPB).

The paper is organized as follows. Section 2 presents the evaluation of the two platforms using logs analysis from time and frequency perspectives. The analysis

aims to find how effectively are the learners using the platforms and to possible identify some improvements. Section 3 presents an evaluation of platforms' collaborative tools, based on visualization of social networks. The problems identified during the experiments, some possible solutions, and several conclusions for improving the evaluation method are reported in Section 4.

2   Evaluation using time and frequency-based log analysis

In our experiments, we were interested to evaluate the ways actors (students, teachers, editors) are using the Sintec and Moodle platforms, and to derive some reference results that could be used in the comparative analysis with other platforms. We will firstly consider the differences between the way Sintec and Moodle were used for reading the learning documents on the web. These differences are due to the following factors: (1) in Sintec, the learning materials were all uploaded from the start of the class, while in Moodle, the materials were uploaded gradually; (2) in Moodle, students and teachers used also the collaborative tools, while in Sintec they did not. Using the log records of the activity of 69 students for Sintec and 248 students for Moodle, several indicators (discussed also in [10]) were computed. It is remarkable that, even if the number of indicators was not high and some of them were not available on both platforms, several conclusions can be drawn about the way platforms were used.

Table 1. The most important evaluation indicators for the Moodle and Sintec experiments ("NA" – not available – means that the indicator couldn't be calculated because the logs weren't explicit enough or because the feature wasn't used for teaching that course)

Indicator	Moodle	Sintec
Average time spent / page (seconds)	61	21.24
Median of the times spent per page	45	NA
Average time / session	297	1635
Median of the times spent / session	NA	952
Average time spent on the platform (seconds)	13571.5	4466
Relative frequency of the home page	33%	23.3%
Average number of hits / page	409	284
Percentage of users that posted in forums	0.564	NA
Number of posts / user	2.02	NA
Number of posts / topic	1.74	NA
Length of reply (words)	28	NA

The **average time per session** was influenced by the way course materials were loaded on the platforms. It reflects the fact that, in Moodle, where the materials were uploaded incrementally, the students accessed more often the web site. They logged once a week to download or read the newest materials, while on the Sintec platform they mostly downloaded all the materials at once. This indicator together with the

number of logins can suggest how to improve the process of posting resources on the learning platform. It is better to post resources periodically in order to encourage students to log in more often, be more active in the class, use more intensively the communication tools, and easier stay in touch with the latest news posted by the tutors.

The **time spent** per page was strongly affected by the **relative frequency of accessing the home page**. The value of this indicator (relative frequency) is extremely high. It shows that users had troubles with using the interface, because they had to return too often to the home page in order to find another page of interest. This is also showed by the combination between the **average time spent per page** and the **median of the times spent per page**. This difference shows that there are many intermediate pages browsed very fast by the user just in search for relevant pages. These indicators also suggest possible improvements in the platform. For example, the results show that the resources need to be re-organized in a different way. One solution would be the use of a tree-menu to allow most of the resources to be accessed from one page or from a few pages. Another way to improve these indicators is also the integration of a recommender system to lead directly to the page of interest.

In the experiment with Sintec, no logs of the collaborative tools were recorded and, therefore, no such indicators were computed. In the case of Moodle, the forum collaborative tools were available to students but their use was not mandatory or even rewarded. The very small number of posts per user and especially the number of replies shows that the students preferred alternative communication channels. Even so, the average length of the posts shows that the replies given were rich in content.

In conclusion, even if users have used the 2 platforms differently, by using the methodology and the proposed indicators, we could draw an important number of conclusions.

3   Evaluation of collaborative tools using visualization techniques

Several techniques may be used for analysing the activity of the users in a forum, for example, sorting messages by author, date, and subject. Another approach is focusing on the convergence of the multiple threads that characterizes the weaving messages (this model is used in the Moodle's forum).

Graphical visualization techniques are extremely useful in various domains. Such an approach may be used also in the evaluation of collaborative tools. The idea is to generate a graphical view representing the social network [14] of the collaboration starting from the usage logs of a VLE (Virtual Learning Environment).

The social network depicts actors' relationships and presents a perspective of their social context. The nodes of the network represent actors (teachers and students) and the arcs represent the interaction between them. This type of network is essential for understanding social dynamics [14].

In our approach, the graphical representation of the social networks was generated from the Moodle logs using the Graphviz tool (http://www.graphviz.org/). Figure 1,

which illustrates the social network of one of the forums, represents some actors who interact through messages: they initiate a thread or post reply-messages in that thread. There are five actors that had at least three reply-messages from the others. Their nodes are grey-filled. In our scenario, the actor with the id "2" is a teacher. He started a thread and many other actors responded to that message. A reply message from an actor to another actor's message is represented through an oriented edge from the first one to the second one.
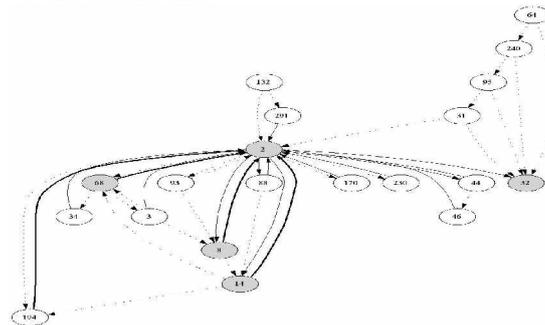

Fig. 1. View of a part of a social network, generated from the logs of the Moodle's forum. Dotted lines represent one message (reply), normal lines represent two or three messages (replies), and bold lines represent a number of messages (replies) greater than four.

For analysing the social network generated from the Moodle's logs, we considered several indicators. First, we used the "location" of the actors in the network, measuring the **centrality** of a node [2]. This feature helps to determine the importance or prominence of an actor in the network. In our scenario, the node with the id "2", which is a teacher, has an important role in the graph. He initiates threads, posts messages and reply messages to the others. There are other nodes, coloured in grey, which have an important activity in the forum. We will see below how centrality and centralization help to analyse if there are "strong" connected teams among the students and the important role of the teacher in the communication process.

Table 2. The most important indicators for the actors in the social network in Figure. 1

Indicators/Actors	2	8	14	32	68
Centrality	17	3	3	5	3
Density	0.85	0.15	0.15	0.25	0.15

Density represents other indicator, describing the general level of cohesion in a social network or the number of different people the actor interacts with [2]. The average density being low shows that students do not interact within the platform. Density is higher for the teacher meaning he keeps in touch with his students.

Another aspect of social networks that we found useful for our evaluation is **network reach** [1]. It is important for social aspects to see if an actor gets the information directly from the main actors (teachers, project managers) or if this information is got indirectly from peers. In our scenario, the length of the largest path is two, but

the predominant path has the length one. This means that students interact directly with the teacher, and that, either they do not ask questions to peers, or there is no other competent peer to answer their questions or problems.

One challenging task is to select the most relevant peers and their appropriate answers for an actor, which has a problem to solve. In [6], problems like "what is relevant?" or "to how many peers should we send the query to achieve optimal results?" are studied and three criteria of selection rose: connectivity-based selection, reputation-based selection, similarity-based selection.

To achieve the goal of selection of a competent peer, we need to compute another indicator, **centrality eigenvector** [3]. This metric, used in [8] for web page ranking, and studied in [7] for trusted e-mail addresses, is very difficult to apply to the actors in our approach. For example, if a page links to a good (trusted) page, it is a candidate for having a high rank as well [8], but in our case, if an actors replies to an actor with a high rank (maybe teacher) means nothing. However, if a highly ranked actor replies to a normal actor, he might be a candidate for achieving a greater rank. In our future work, we will include in considering these replies a semantic context, which it will help actors to receive a greater rank and to become a competent peer. As we have seen above, the teacher has the highest rank in our scenario and this rank is built on the ranks of the other actors.

The centralization [16] of the network shows that the teachers communicated well with the students but also shows that there aren't strong teams in the group of students because the network is centralized around the teacher. This is confirmed by the cohesion [16] indicator which shows that we can't identify groups larger than three people, one of them being a teacher. That shows that the learning process wasn't team-oriented or, if it was, the teams were not working well together or they were not using the platform features.

In conclusion, the social networks can provide a large numbers of indicators that offer information about the way students and teachers collaborate in the learning process. These indicators can and might be correlated with indicators obtained from questionnaires and logs.

4 Conclusions and future work

This paper presents the results of an ongoing research on the evaluation methods for e-learning platforms. The evaluation proposed here is based on different types of measurements collected in logs during learning experiments, and makes use of social networks. The method could be used in the design and evaluation of e-learning platforms. It is thought to be used in evaluating the Cooper platform that is a collaborative, project-oriented e-learning environment under development in the STREP EU project with the same name (http://www.cooper-project.org). In this respect, one important aim of our research is to establish a proper evaluation methodology, and to gather data from other systems for a comparative analysis.

Another purpose of evaluating the usage of several e-learning platforms is to establish some benchmarks for the indicators we will measure in the Cooper platform,

and to identify what other logging mechanisms are needed in order to obtain more significant evaluation indicators.

An important aim of the evaluation is the improvement of e-learning environments by eliminating the detected drawbacks. As discussed above, one of the major issues concerning Moodle is the long length of the paths that users followed to reach a useful web page. The use of a Recommender Service (also a main idea of the Cooper project) would be extremely useful in providing shortcuts to different resources.

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Virtual Action Learning: Experiences from a study of an SME e-Learning Programme

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Abstract. This paper presents the findings from a project investigating management development for SME managers using an action learning programme, combining both face-to-face workshops and a virtual action learning environment. The project aimed to address 3 main objectives: reworking results from previous European projects to disseminate to a wider audience, creating a learning network/ community amongst the project partners and to undertake 3 learning trials with SMEs in UK, France and Italy. This paper principally addresses the findings from the UK trials, which ran between February and April 2005, and provides valuable learning to all those interested in developing future learning programmes aimed at SMEs.

Keywords. e-learning, action learning, management, development, programme, SME

1 Introduction

1.1 Why consider Virtual Action Learning for SMEs?

SMEs (small and medium-sized enterprises) represent 99% of all businesses in Europe and account for more 50% of the employment and turnover figures in the UK. Small businesses in the UK (employing less than 50 people) represent 47% of employment and 37% of turnover. (Small Business Survey, 2004). However only 24% of SMEs provide vocational education and training compared to 80% of large enterprises (employing over 250 people). SMEs play a key role in generating employment and creating economic wealth, but skill deficiencies in SMEs are adversely affecting their ability to reach their growth potential (British chamber of commerce Surey, 2002). By their very nature, SMEs are small, constrained by time and budget and reluctant to engage in learning programmes, therefore the purpose of research projects such as ENSeL is to investigate how SMEs can be engaged in appropriate learning interventions to address this major challenge. Action learning has previously been successfully used with SMEs on earlier projects and this study aims to investigate the effectiveness of virtual action learning to engage SMEs.

1.2 ENSeL Project Organisation

The ENSeL project, coordinated by Henley Management College (HMC), aimed to share the learning from five EU funded projects/networks all of which contained a core e-learning element. The projects being integrated included the **PeLM** project

(Programmes in learning through e-learning for managers), **eLIVE** (eLearning and Knowledge Management for European SMEs), **ESeN** (European SME e-Learning Network), **ROCKET** (Roadmap to communicating knowledge essential for the industrial environment) and **EQUEL** (e-quality in elearning, the EQUEL Virtual Centre of Excellence).

The initial project tasks culminated in a review of the learning frameworks emerging from EQUEL and the other represented EU projects. These were then formulated to make them suitable for European SMEs. These principles of learning for SMEs were drawn on prior project experience with SMEs and have been reviewed in light of the results of the ENSeL project. During the review, an approach to the SME trial design emerged that was similar to action learning (Revans, 1980), but also included a virtual environment. Action learning is certainly not a new development in the education of managers. Indeed some of the early approaches to management development (Wilmott, 1994) saw an emphasis on sharing experience and less on content. The Syndicate or 'Set' method was devised for this purpose with the rationale of helping managers to 'help themselves' via practical problem solving around real life issues. Some of the advantages of virtual action learning directly address the needs of SMEs: flexibility, cost benefits, location is not a barrier, freedom to work at own pace, less disruption to work schedules and an opportunity to shape the learning agenda or content.

Based on the characteristics of the target audience for the trial, namely SMEs, ENSeL has elaborated some learning principles to inform the use of sustainable networked learning in SMEs. These principles are grounded in the position papers about e-learning in Higher Education, which are the final output of the EQUEL project, and draw mostly on theories supporting social learning, socio-cultural approach to learning and social constructionism (Hodgson and Watland, 2004).

1.3 ENSeL Learning Principles

The following principles informed the design of the SME trials at the beginning of the project. These were later revised in view of the findings, as discussed in the final section of this paper:

1. Our focus is on learning and learner-managed environments.

2. Learning is better supported in collaborative settings and dialogue plays a major part in the collaborative learning process.

3. Social interaction allows for co-construction of knowledge, which promotes engagement of learners in work based and problem-based learning.

4. The role of the facilitator/animator is essential for collaborative e-Learning.

5. Critical reflexivity is an important part of the learning process for evaluating and examining both the learning process itself and the resultant actions taken.

6. Learning is situated and context dependent.

2   Literature Review

2.1 Learning in SMEs

Specific considerations with regard to learning place certain requirements on any learning programme for SMEs, as summarised in Figure 1 (Alexander, 2006).

Considerations	Programme Requirements
Increasing competition and development of markets are major concerns for small businesses (Bolden, 2001). There is a high 'churn' of SMEs in the UK (SBS, 2003a).	Involvement in competence development activities has a positive effect on the individual SME's competitiveness and performance (Observatory of European SME's 2003, No.1 'Competence Development in SME's').
Formal methods of teaching and learning are not necessarily the most appropriate way of engaging, motivating and transferring knowledge to today's workforce (Williams, 2003). Formal training is not the best way of learning for SMEs (Atwell, 2003).	Non-formal (informal) learning constitutes the most important way of acquiring and developing the skills and competencies required at work (Eraut, 2000)
The primary concern within SME's is keeping the company running on a day-today basis (Cranfield, 2005). Enmeshed in the practicalities of running their businesses, SME leaders have lost any interest they may once have had in theoretical issues (Inglis, 1994).	Training has to be focused on the specific needs of the enterprise (Unisys, 2005). Active learning focuses on solving real problems and the learner's experience 'accounts for as much as the teacher's knowledge' (Knowles, 1984)
The SME leader's own negative attitude to change and learning (Observatory of European SME's 2003, No.1 'Competence Development in SME's'). Time devoted to learning is considered by many as lost time (Unisys, 2005)	When individuals are involved in the learning process dealing with issues of relevance to their careers they become motivated learners (Bray, 2002). To get effective motivation the learner should be put in the centre of learning, 'the starting point must be a question from the learner'. (Unisys, 2005)
SMEs are driven primarily by profit (Hilton & Smith, 2001) SMEs expect impact on bottom line (Unisys 2005, LSDA, 2002)	Promotion – no matter how good the training and support material, It has to be carefully promoted and delivered to be effective. It must go to considerable lengths to highlight the commercial benefits of business improvement (non – commercial benefits can be promoted as secondary benefits once the main commercial message has got thought). The aim is to make SMEs actually want to take part in the initiative and to make them see management development as integral to good business practice (Hilton & Smith, 2001).

Learning is a cost, and the SME owner does not always consider it as an investment for the future (Unisys, 2005).	The programme should have a measurable impact within the organisation and should be affordable and value for money (Bolden, 2001).
SMEs use a short term approach, they only set up a training action plan when they face real problems (Unisys, 2005) Just-in-time (JIT) learning fulfils SME short term information needs (Unisys, 2005)	Approaches to learning, training and development in small firms needs to take account of the shorter planning time frames they use by relating learning opportunities and benefits to these shorter time frames.(Stanworth *et al*, 1992).
Time pressures (Bolden, 2001)	SMEs like courses to be flexible and modular so that they can dip in and out, taking 'bite-sized' pieces (a few hours at a times) as they see fit and as their workload permits (Unisys, 2005). Due to time pressures close locality of programmes is also important (LSDA, 2002; Kirby, 1990)
eLearning is beginning to have an impact on learners, and particularly those demanding flexibility, accessibility and connectivity (Bisoux, 2002) Growing pressure in many industrial societies to identify the most constructive and cost effective ways of using ICT as a resource for learning (Guile, 1998).	Some of the advantages of e-learning directly address the needs of SME's: flexibility, cost benefits, location is not a barrier, freedom to work at own pace, less disruption to work schedules. (Unisys, 2005)
Much of the knowledge developed, often by the owner/ manager, remains tacit and unshared. The new kinds of knowledge are *'tacit'* and '*developmental'*, and are practical as opposed to being theoretical as they are derived from action and experience. (Williams, 2003)	Communities of practice could support inter-firm collaboration (Van Winklen, 2003). Learning can be better supported in settings of collaboration, where they interact with each other and learn from each other (Esnault & Ponti, 2004)
Learning has increasingly become seen as dependent on the activity of the learner (Knowles, 1984, Williams, 2003). SMEs are generally action orientated and learn by doing (Kirby, 199	The Action learning method requires that the problems to be solved are real ones. They are not manufactured for the learning situation. Action learning is a method for individual and organisational development… people tackle important issues or problems and learn from their attempts to change things (Pedler, Brook & Burgoyne, 2003).

Isolation of the enterprise owner is a barrier to learning. Learning is a social activity (Esnault & Ponti, 2004)	An informal environment should be built to aid networking. The network should provide a forum for exploring ideas with peers, and give support to individuals (Birchall *et al,* 2004). Network learning broadens access and participation of SMEs in real-life learning environments (Ponti, 2004) Network technology offers the opportunity to facilitate, strengthen and connect SMEs in order to build and enhance networks of business at the regional, national, or international level (Esnault & Ponti, 2004)

Figure 1: Considerations to SME learning and programme requirements

2.2 Action Learning

Taking into account recent theories on situated learning and the programme requirements outlined in Figure 2, a learning approach based on Revans' work on action learning (Revans, 1980) is likely to be the most appropriate for SME owner/managers. "*Action learning is a method for individual and organisational development. Working in small groups, people tackle important issues or problems and learn from their attempts to change things*" (Pedler, Brook and Burgoyne, 2003). There are four elements:

1. Each person joins in and takes part voluntarily.

2. Each participant must own a managerial or organisational problem on which they want to act.

3. Sets or groups of action learners meet to help each other think through the issues and create options.

4. They take action and learn from the effects of that action (Pedler *et al*., 2003).

There are a number of requirements for action learning: the set, the project, the set adviser, set meetings, and workshops.

2.3 E-learning in SMEs

Although action learning addresses many of the requirements of learning programmes for SMEs, it may be that a combination of e-learning and action learning may be even better. Some of the advantages of e-learning directly address the needs of SMEs: flexibility, cost benefits, location is not a barrier, freedom to work at own pace, less disruption to work schedules. However, there are some disadvantages, such as self-discipline, loneliness, and dealing with large quantities of electronic materials. When adapting an action learning programme to e-learning, Bray (2002) warns that the pedagogic baggage that both tutors and associates carry is clearly a barrier that needs to be overcome, as is developing different interpersonal tools of communication and style. Ingram et al. (2000) also warn that care must be taken with both hard (hardware, software, administration, financial support) and soft (human relationships, communication, goodwill) critical success factors. This has implications for the set members, set meetings and workshops, resources, and the set adviser.

2.4 Networked Management Learning

Hodgson and Watland (2004) defined networked management learning as learning that is supported by ICT used to connect learners with other people (learners, tutors, mentors, etc.) and to learning resources and information of various kinds. Network technology offers the opportunity, through the use of computer-mediated communication and/or via the internet, to catalyze, strengthen and connect SMEs in order to build and enhance networks of business at the regional, national, or international level. Among the other aims, technology holds the potential to connect individuals/groups/organizations to resources they need for their work activities; to create a sense of community where people can share knowledge but preserve diversity; to organize events that bring business and other institutional actors to support a collaborative and cooperative approach to learning. The ENSEL project can be most closely defined as a trial in networked management learning.

3   Methodology

3.1 The Research Design

The design of the research can be considered as a case study or three individual case studies, if dealing with one trial at a time. This was an empirical investigation aimed at understanding the different ways in which SME managers described their experience of networked management learning. The purpose of the study was not testing hypotheses but exploring what participants thought and felt about their participation in the trials by asking questions that led them to relate their experiences and explore their attitudes to networked management learning. Qualitative data was collected using registration forms, one-to-one interviews, focus groups and facilitated face-to-face workshops, in addition to questionnaires. Quantitative data was collected using participant questionnaires, completed at the beginning and the end of the trial.

3.2 Participants

The trial included a total of 56 SMEs in UK, France and Italy. The 29 UK trial participants included healthcare professionals, financial services managers, IT and telecom consultants, manufacturing and engineering company owners and managers, recycling business managers, providers of educational services, music publishers, website developers and suppliers of social and leisure services.

3.3 The Trial Design

The trial was designed as a blend of face-to-face and online activities, coordinated by facilitators, as shown in the ENSeL Roadmap (Figure 2). The trial design aimed at moving away from traditional pedagogical and didactical approaches by allowing participants to learn through the group process. Throughout the trial, the participants were encouraged to keep track of their learning and to develop their capacity for reflection.
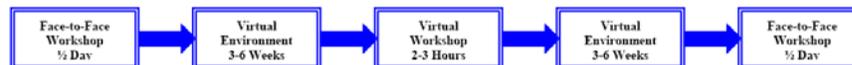
Figure 2: Roadmap of the SME trial design

The virtual action learning was facilitated throughout the programme, with one facilitator allocated to each learning set of between 5 and 8 participants. The learning sets worked through a schedule of activities agreed at the first workshop, with each product being reviewed by the set members at weekly intervals. The groups decided on the nature of the products and these were typically short documents or presentations, which evolved to summarise their challenges and actions (An example is shown in Appendix A). These virtual reviews consisted of questions being posed and stories and experiences shared to support each participant with their specific business issues. The facilitator was available to provide additional resources as requested by the group and entered the virtual discussion area at least every 48 hours.

3.4 The Initial Workshop

The first workshop was successful in many ways. The groups worked well together and there was very positive feedback on the action learning approach. The groups identified their challenges and started in different ways to agree their approach to the interim working using the virtual learning platform. The time spent on coffee breaks and lunch involved much sharing of experiences between the group members, generally described as 'feeling that they were not alone with their problems – there were others in the same boat'. Informally they offered help and suggestions to each other.

However, there were some aspects of the workshop that did not go as well as expected. For many, there was a lot covered in one morning, and the pace was too fast. Secondly the technology was not available for the training session and the short demonstration given was not sufficient to give the participants any confidence in being able to use the virtual learning platform after the workshop. Finally the participants were not all comfortable with the vague nature of the proposed tasks. This was particularly evident amongst the more traditional industry groups, who really wanted clear tasks, explicit delivered course content and a precise structure to their learning programme. This was least evident amongst the group of entrepreneurs, who quickly grasped the idea of defining tasks, allocating work amongst the group members and appointing one group member as co-ordinator.

3.7 Virtual Learning

Following the initial workshop, the groups were registered for the discussion forum and expected to continue their group activities on-line. However there were significant technical problems that meant that this could not happen. Different groups resolved these technical problems, in different ways. One group decided to abandon the discussion forum within the first week and communicated entirely by email. This group had also appointed a co-ordinator and went on to collaborate very successfully. Another group moved onto a very structured tool based approach where they worked individually on a one-to-one basis with the facilitator. The other groups persevered longer with trying to use the discussion forum, but unsuccessfully. This led to a complete lack of collaboration between the group members. Thiswas one of the reasons that caused the interim workshop in the UK to be changed to allow a face-to-face session, as well as on-line presentations. Email communication was continued

throughout the trial, but as discussed, only one group worked collaboratively and the other groups worked on individual tasks as guided by their facilitator.

3.8 The Interim Workshop

The primary deliverable was intended to be a presentation of the group's activities and results from the first half of the trial and these presentations were to be reviewed by the other groups. All the presentations were published in the discussion forum and sent by email. A small group of UK participants met face-to-face for an afternoon and the presentations were reviewed constructively during the session. The French SMEs adopted 'Skype' for their interim workshop to supplement the discussion forum. The groups also raised the issue of needing more structure to the learning programme, and this resulted in the UK group generating (in the face-to-face session) a diagnostic tool, which they then worked through on a step-by-step week-by-week basis. They also decided to include their individual learning reflections with the weekly summaries.

3.9 The Final Workshop

This event was scheduled as a morning and lunch session, as discussed earlier. The groups' task was to present their summaries of challenges, activities and action plans to each other and then summarise to the other groups in the plenary session. They spent almost the whole morning working in their learning sets, with only about one hour in large group presentation and discussion. The groups spent a significant amount of this time considering their reflections on the programme and their learning.

4   Summary of Results

4.1 SME Perspectives of the Trial

The participants recorded their experiences in groups and individually on the post-trial questionnaires. Analysis of the questionnaires resulted in 73% stating that they had met at least some of their objectives, and 67% stating that they would be able to apply their learning in their personal and professional life within 12 months. There were 90% of participants who agreed that it had been useful to share with others and 77% felt that they had become more effective managers. It was interesting to note that whilst there was a poor response to questions about the on-line collaboration area, 73% of participants found the help of the facilitators very useful. Some of the SME comments are summarised below:

	SME Comments
What was successful?	Very enjoyable and useful face-to-face sessions – encouraged virtual collaboration Encouraged further thinking on management issues Personal (one-to-one) discussions over drinks / lunch Structured tools and templates very helpful, especially the Challenge Diagnostic

	Facilitators helped to push it along during the virtual learning phase
	Access to facilitators and group members by email
	Face-to-face sessions preferred, maybe due to 'age' of participants (felt virtual learning may be more easily adopted by younger people)
	Collaborative aspect was great
	Learning from others was very worthwhile
	Realising shared issues (it can be lonely as an SME)
	Generation of insights
	Access to resources (e-Library) was valuable
	Really helped to reality check the business and re-focus on the basics and essential of business
	Realised that interpersonal development was more important than academic learning
What was NOT so successful?	Technology was very slow and not intuitive
	Lack of collaboration following face-to-face sessions
	Wanted more structure and direct content (some) in the programme
	Disappointed in the lack of commitment of other members of the group
	Difficult to schedule time for remote learning and give up if it doesn't work easily or quickly
Recommendations for Future	Clearer structure at the beginning and more tasks with deadlines
	More face-to-face sessions
	More time spent bonding as a team, rather than group
	Get the right virtual learning platform (fast, intuitive, simple)

4.2 Facilitators' Perspectives

Following the trial, the facilitators held a small workshop to review the trial and produced the following reflections. In view of the comments from the SMEs, identical comments are not reiterated here, and only additional comments and observations are included. The trial facilitators agreed the following:

• The initial workshop and marketing information should have contained more detailed information on the structure and expectations of a virtual action learning programme

• Successful virtual collaboration was also supported by informal communication such as telephone conversations, one-to-one emails and meetings in pubs etc.

• The scheduling of face-to-face events at about every 4 to 5 weeks was about right to maintain interest in the virtual action learning

In summary, the facilitators considered that there are constant opposing challenges to running such programmes, such as structure, timing, numbers of participants, and technology. The participants expect clear objectives, tasks and outcomes to varying degrees depending on their preferred personality type and learning style. Some want a lot of detail, and others will require only high-level information. Too much detail can be restrictive and too little creates uncertainty. The group size of between 4 and 8

people is good for action learning sets, whereas a larger number, over 30 is better to create lively virtual discussions. It was essential to build trust between the participants themselves, as well as in the programme providers.

5   Conclusions and Implications for Further research

The overall conclusion of this study is that it is possible to successfully engage SMEs by using an engagement strategy that communicates in terms of meeting by SME needs and addressing their current business problems. The combination of face-to-face and virtual action learning worked well on this project, and helped to encourage the SMEs to join the programme. The need for a clear structure to the programme was underestimated and in the future more attention should be given to informing potential participants of the structure, tasks and the expectations of their involvement.

The facilitation of the trial was successful in many aspects, however, possibly due to the technical issues; this role took significantly more time and effort than expected. There was a need for facilitators to be in communication almost on a daily basis and use a flexible style to motivate the participants. There were times when a 'light touch' of facilitation was sufficient and also times when the participants looked for clear directions and guidance. In light of these experiences and following a careful reflection of the findings, the ENSEL project partners revised the initial 6 learning principles to the following 8:

1. Our focus is on learning which has a perceived value to the learners

2. Responsibility for the learning process is shared (between all actors in this process)

3. Learning is situated and context-dependent

4. Time has to be allowed to build relationships

5. Learning is better supported in collaborative settings and dialogue plays a major part in the collaborative learning process

6. Social interaction allows for co-construction of knowledge, which promotes engagement of learners in workbased or problem-based learning

7. The role of the facilitator / animator is essential for collaborative learning

8. Critical reflexivity is an important part of the learning process for evaluating and examining both the learning process itself and the resultant actions taken.

5.1 Implications
This study raised several interesting points for further research. Firstly, there was a tendency by both participants and facilitators to blame many of the problems with virtual learning on the technology problems. It would be valuable to investigate how much this masked other issues about using a virtual action learning approach. Some of the participants expressed the view that their lack of collaboration and motivation in using virtual learning was down to their age (average in 40s) and stated that a younger generation brought up with the internet and web-based learning at schools and colleges would be more accepting of virtual learning environments. The findings of these trials indicate the possible model, below:
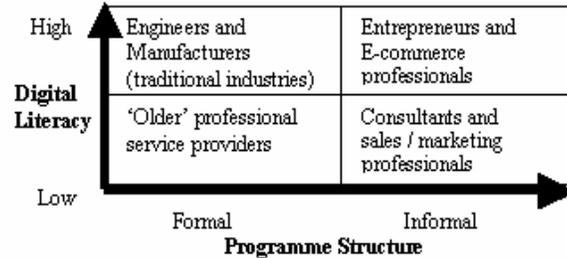
Figure 3: Structure / Digital Literacy Matrix (Stewart and Alexander, 2006)

The above model attempts to illustrate that those with a higher digital literacy and greater acceptance of the more informal problem-based action learning tended to come from businesses of entrepreneurs, with innovative new products and services, often exploiting new technology. Many of these were providing complex information technology products and offering unique web-based services.

Those with a higher digital literacy that preferred the more traditional formal type of programme, tended to be from the more traditional industries and were often initially educated in engineering and science based disciplines. For many of these, this was their first experience of an action learning programme. Whilst the majority of the participants realised benefits at the end of the programme, they tended to be very suspicious of a programme with a facilitator, rather than a teacher.

The participants with lower digital literacy were very reluctant to use technology. The requirements for participants attending the ENSEL programme had been stated as they needed to be able to use email and access the internet. There was one example of a participant who met these criteria, but his first email was written in the style of a very formal business letter. This indicated challenges in the attitude towards the technology, not just the technical skills of sending emails.

Those that were reluctant to use technology preferred both formal and informal structures. Some, who referred to themselves as an 'older' generation, stated that they had come from a tradition of formal, structured education at school and college, where you were taught to read books, learn facts and listen to the teacher. This group reflected that a younger generation brought up to question and challenge, research on the Internet, complete online examinations, and use technology for study and leisure, would have more easily accepted virtual action learning.

The group of people with low digital literacy but a preference for informal learning emphasised their satisfaction at the face-to-face events and appreciated the opportunity to discuss quite loosely-defined problems with the others in the group. Comments were made concerning trust, especially when there was the potential that the other members of the group might be competitors. This was particularly evident in the Italian trial, which resulted in a reluctance to collaborate and share knowledge, apart from at face-to-face events. This category of participants was particularly emphatic on the need to spend time getting to know the people in the group first. The above model indicates the challenges in engaging SMEs for virtual action learning programmes and the need to provide programmes that either encompass all

approaches or, alternatively, are targeted at a particular group. For those that fall into the category of lower digital literacy, this would need to be addressed, prior to engaging them in action learning programmes supported with technology.

The type of challenges the SMEs worked on in this programme often involved revealing aspects of their businesses and personal effectiveness that they were comfortable to talk about in face-to-face meetings but were reluctant to submit to on-line discussion forums. There needs to be a more in-depth investigation on to how to facilitate trust, collaboration and open communication in a virtual learning environment. The constant tension between the business pressures on SMEs to be totally dedicated to their companies and the benefits of taking time out for learning and reflection should be investigated further, to attempt to identify ways to allow the participants to develop trust and simultaneously does not involve them spending several days away from their business.

Overall, this project has made some interesting findings and provides valuable insights into developing effective virtual action learning programmes for SMEs.

The digital literacy matrix above provides an indication of how action learning sets might be set up to reflect both the differing needs for structure and the variation in digital literacy. This trial has indicated that virtual action learning was most effective in the low structure/high literacy quadrant. Those in the low structure/low literacy quadrant could benefit from either traditional face-to-face action learning programmes or alternatively, they could start the programme with a well-designed, succinct training programme to help develop their digital literacy skills. The facilitator for such a group would also need to be able to address and resolve technical queries and therefore should possess technical competencies, in addition to facilitation competencies.

Those that are in the high structure quadrants could be allocated into action learning sets containing similar participants and the set facilitator should pay particular attention to ensure that there are people in the set with specific knowledge and expertise to encourage rich action learning experiences in the group. Once the group appreciate the action learning process, this group would then be able to move to virtual action learning. This implies that it would take longer and more face-to-face meetings would be needed before this group could move onto virtual action learning. Those that are in the formal structure and low digital literacy quadrant would also need to spend additional time on a training programme to help develop their technical skills. Therefore this group would be the least appropriate group to engage on a virtual action learning programme.

This research project was designed to investigate the potential benefits of virtual action learning to engage SMEs in learning programmes, in order to address the major challenge of developing skills in SME owners and managers. The learning principles originally drawn for prior projects and literature were refined to reflect the insights gained during the project. These can now be used to design SME learning programmes. The digital literacy matrix can be used to assist selection of participants to both action learning programmes and virtual action learning programmes, taking into account the dimensions of structure and digital literacy. For those in the low structure / high literacy quadrant, benefits of the ENSeL virtual action learning programme were described as follows, and appropriate use of this model should bring similar benefits to many other SMEs.

'The ENSEL Programme enabled me to gain greater awareness of my personal limitations – I have since promoted my more able staff and am learning to tolerate less perfectionist standards which are really quiteadequate for the job. This was important and is helping me to trust my staff more'

'I have a much clearer understanding of what I can delegate and more importantly, the tasks I must not delegate, such as leadership and communicating my vision to the staff'.

'I can now articulate the values of my company and communicate my passion for our products and our people'.

'I have been trying to decide whether I should offer a broad range of services or just specialise in a few, and I have recently tailored an offering for a specific customer, with the help of the learning group. I am also encouraged to build better relationships with my existing customers.'

'All the people in our learning set faced some very similar challenges. We were concerned about how we could grow the business, but still preserve the special nature of our products and people. I now feel more confident about my ability to do this.'

'Even though the project has finished, our group still meet and communicate virtually. There is a real comfort in knowing other people facing the same sort of problems and working it through together.'

This study has also indicated several challenges for future research and important practical issues to address, such as the low level of digital literacy in the SMEs involved in this programme. Despite the relatively small number of participants in the ENSEL trial programmes, the findings can be seen as making a significant contribution to this field of research.

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Appendix: A

Peter's Challenge (names have been changed):
One of my business challenges is Leadership, particularly leading the company through a period of change. During my short corporate working life (redundant twice, sacked once) I never got to a position of leadership. I have no leadership training, no role models, no mentors (the attraction of the course?). As the business has grown from wife, husband plus one (now 10 of us this week) then my role has become one of leader. The more the company grows and changes the more this will become my role. So what skills do I need? How do I get them - are they inherent or can they be learnt? What are the leadership issues? Should I bring someone else in to lead? How do I communicate my deep vision for the business? Of course I have a view on each of these questions but how do others deal with them and are there examples of good leadership from which we can all learn? So this is the second area of focus for The X Company.

Feedback from other set members:

ISSUE	FROM	FEEDBACK
Leadership	**Karen**	I would recommend paying for and attending a training programme specifically for leadership development and self-awareness of leadership strengths/areas for development. Mentoring also good. Would suggest Peter looks to his own skills prior to bringing in another person to lead.
	Jerry	You've probably got a lot of skills already but just don't know it. Is there anyone you know who could mentor you? What about a non-executive director to help you work through many of the

		growth issues including leadership? I learnt my management skills on the job and was lucky in so far as I had some fabulous role models. The skills I most admired in my leaders and tried to embody were trust, authority, leading by example and conviction. In terms of communicating your vision, (this leads on from my previous comments); Define it - you may well be able to do it in-house, but an external resource would be more objective and find it easier to research employees and customers. Communicate it - share it with all stakeholders (not in a cheesy way) Live it - ensure it's expressed clearly and consistently in everything you do and say.
	Alex	If I could answer this one I might be able to help myself more. My instinct is that as a business grows, the leadership skills required change. Paradoxically the very skills required to start from zero become counterproductive in later growth. Once again, I am relaxed about the 'vision thing', which is what most business founders are ultimately remembered for. Finding training, mentors, networks (like this) and consultants seems a way forward where resources are available. In the end, delegation (ouch – I said it) to others with complementary skill sets must be the answer.
	Amir	I also face a similar issue regarding no formal training and no mentor to help exercise my business idea. Have you considered applying for a Leadership course? You may find this article somewhat interesting: http://www.businesslink.gov.uk/bdotg/action/ It gives a very brief description of management team skill sets.
	David	What is it you REALLY want to do because your contribution is likely to be greatest in this area. Promotion to the point of incompetence does not work. Many courses do exist if leadership is necessary and can be learned and practised. Communicating vision is believing and living it. Does this make sense?

Emergent Knowledge Artifacts for Supporting Trialogical E-Learning

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Abstract. This paper elaborates on scenarios for collaborative knowledge creation in the spirit of the trialogical learning paradigm. According to these scenarios the group knowledge base is formed by combining the knowledge bases of the participants according to various methods. The provision of flexible methods for defining various aspects of the group knowledge is expected to enhance synergy in the knowledge creation process and could lead to the development of tools that overcome the inelasticities of the current knowledge creation practices. Subsequently, these scenarios are projected to various knowledge representation frameworks and for each one of them the paper analyzes and discusses related techniques and identifies issues that are worth further research.

1 Introduction

Classical learning theories are based either on the *knowledge acquisition* metaphor (i.e., a learner individually internalizes a body of knowledge) or on the *social participation* metaphor (i.e., a group of learners collaboratively appropriate a body of knowledge). Although widely accepted, these theories do not sufficiently capture innovative practices of both learning and working with knowledge (i.e., knowledge practices). Only sharing of knowledge in action, i.e., sharing the process of learning itself, is a reliable base for developing a shared cognition (seen both as a group and an individual characteristic). In this context, the emerging theory of *"Trialogical Learning" (TL)* focus on the social processes by which learners collectively enrich/transform their individual and shared cognition. According to TL, knowledge creation activities rely heavily on the use, manipulation and evolution of shared knowledge artifacts externalizing a body of (tacit or explicit) knowledge [29]. By representing their cognitive structures or knowledge practices under the form of artifacts, individual learners can interact with themselves as well as with external tools (e.g., computers, information resources) to negotiate the meaning of concepts and signs embodied in these artifacts and thus,

finally reach a common understanding of the problem at hand. We could therefore consider as cornerstone of trialogical learning the notion of shared objects of activity, a notion that is quite general to accommodate the requirements of various application contexts. For instance, a video that records how group members carry out their tasks, could be considered as a shared knowledge artifact which the group could annotate (with free text or with respect to an ontology), analyze and further discuss (e.g. for capturing tacit group knowledge). Moreover, and more interestingly, a knowledge artifact could take a more formal substance (e.g. for capturing explicit group knowledge) as in the case of documents (e.g. a survey paper), conceptualizations (e.g. a data/knowledge base), or even software code exchanged within a group. Hereafter we shall use *knowledge artifact* to refer to what is being created and/or shared by a group of learners (and could be a set of words, documents, concept maps, ontologies, annotations, etc).

It is worth mentioning that the paradigm of Trialogical E-Learning can be very useful within Communities of Practice (CoPs) as it can facilitate the negotiation of meaning and it can contribute to the development of explicit and innovative knowledge inside a CoP [9].

In order to communicate and meaningfully interpret their individual viewpoints, cooperating learners need to agree on a common conceptual frame of reference. Models and techniques that allow diversification and flexible amalgamation of different world views are still in their infancy. In this paper, we investigate various ways to build emerging knowledge spaces. We have used the trialogical learning paradigm for eliciting the functional requirements. In particular, we focus on the various methods to form the common knowledge of a group by combining the individual knowledge of its members. The provision of flexible methods for defining various aspects of the group knowledge is expected to foster knowledge creation processes and could lead to the development of tools that overcome the inelasticities of the current knowledge creation practices.

The rest of this paper is organized as follows: Section 2 describes a TL scenario for collaborative knowledge creation, and Section 3 discusses the underlying principles and interactions. Section 4 describes various ways to build emerging knowledge artifacts from individual group knowledge (of various forms), and identifies knowledge management requirements. Finally, Section 5 summarizes and concludes the paper.

2 Motivating Scenario for Trialogical Learning

2.1 Collaborative Literature Review and Annotation

A set of N research papers, say $P = \{p_1, \ldots p_N\}$, is given to a set of K learners $A = \{a_1 \ldots a_K\}$ who could be students, researchers, or co-workers in a company. The goal of this group is to understand the topics discussed in these papers and to build an ontology, say O, that represents the main issues discussed in these papers. Moreover the group has to annotate these N papers according to the derived ontology, i.e. specify $d(p)$ for each $p \in P$ where $d(p)$ denotes

the description of p with respect to O. We could also assume that there is an additional constraint saying that the ontology should not have more than C concepts. The learners, hereafter *actors*, have to collaborate (synchronously or asynchronously) in order to carry out this task.

Note that various combinations of (N, K, C) values describe different real-life scenarios. For instance, $(50, 1, 20)$ could describe what a MSc student should do in order to write the state-of-the-art of his MSc thesis. Of course, this scenario does not fall into trialogical learning, but is rather an instance of monological learning (acquisition metaphor). Values like $(150, 2, 50)$ might describe the collaboration between a professor and a graduate student for finding a topic for a PhD thesis. Values like $(100, 10, 10)$ may describe a group (comprising 10 members) of a research lab that is trying to join a research area by studying the 100 related papers that have been published the last 5 years and trying to identify the 10 main topics of the area (subsequently each member of the group would be responsible for one topic). Finally, big values for K, say 1000, could model the effort for developing an international standard.

2.2   Grading and Progress Assessment of Individuals and Groups

A related rising question is whether the "quality" of the result of this collaboration (i.e. of O and $d(p)$'s) should be measured and if yes how. We can identify two broad cases. According to the first, there is an external (human or machine) observer who can grade the result, while according to the second there is not any external party. For instance, we may assume that there is a certain "solution" ontology (ideal or criterion), denoted $O^{(i)}$ that is unknown for members of the group. For example, $O^{(i)}$ could have been provided by a tutor if there is one (or the tutor might have provided a set of admissible ontologies instead of one ontology). Subsequently, appropriate metrics could be employed in order to measure the "distance" between $O^{(i)}$ and O_{s_i} and at every point in time (state s_i), so that the members of the group can judge if they progress or not. Of course not only the group work but also the individual work could be graded. Recall that according to [30, 13], for effective collaborative learning, there must be "group goals" and "individual accountability"[1].

In the case where there is not any external party we could probably only measure the degree of agreement between the members of the group. If O_A expresses the knowledge that all members of A accept to be correct, then the bigger O_A is, the better the group goes (assuming there is not any other constraint like C in the previous scenario).

3   Emergent Knowledge Artifacts Spaces

This section discusses issues that are important for supporting the previous scenario. In particular, Section 3.1 introduces personal and shared knowledge

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[1] Based on the successful results of experiments reported in [13]: fifty percent of each student's individual grade was based on the average score (of the group members) while the remaining fifty percent of each student's grade was individual.

artifacts and clarifies their relation, while Section 3.2 shows how a set of learners can interact on the basis of their personal and shared knowledge artifacts. It also discusses synoptically additional issues.

3.1   Personal versus Shared Knowledge Artifacts

To abstract from representation details we shall hereafter use the term knowledge base (KB) to refer to an ontology or to an ontology-based information base (i.e. to a set of objects annotated with ontological descriptions).

Although trialogical learning focuses on shared artifacts, learners should be able to construct and evolve their own models. Let KB_a denote the knowledge base of an actor a. Now let KB_A denote the "shared" (or common) knowledge base of a set of actors A. The important issue here is the relation between KB_A and KB_a (for $a \in A$). Below we identify three broad cases:

– *UNION-case.* Here KB_A is obtained by taking the union of the KBs of all participants, i.e.: $KB_A = \cup\{ KB_a \mid a \in A \}$. Note that KB_A could be inconsistent if there is a notion of consistency. For example, if the task is to annotate a video with argumentative maps, then consistency is not a very strict issue. If on the other hand the task is to develop an ontology (for subsequently building a bibliographic database) or a software module, then consistency is a very important issue.
– *INTERSECTION-case.* Here KB_A is obtained by taking the intersection of the KBs of all participants, i.e.: $KB_A = \cap\{ KB_a \mid a \in A \}$, so it comprises statements "accepted" by every participant.
– *QUANTITATIVE-case.* Here KB_A is defined by a quantitative method, e.g. it may comprise all sentences that are accepted by at least a percentage of the actors. Obviously, UNION and INTERSECTION are special cases of this case.

3.2   Interaction through Knowledge Artifacts

Suppose that we want to design and develop an application for supporting various forms of collaboration (e.g. asynchronous and synchronous) and supports personal and shared knowledge artifacts. Figure 1 sketches a possible UI[2] for that application that could serve as a proof of concept and as a gnomon for identifying and analyzing the associated technical requirements and challenges.

The UI is divided in two main areas: the left area allows managing the personal space, while the right area allows managing the group space. In the left area each learner is free to do whatever she wants, so everything is editable in that area. The right area shows the shared artifacts and this area is the key point for collaboration and for supporting trialogical e-learning. For instance, and assuming the scenario described earlier, each user may develop her own ontology at the left area, while the right window shows the group ontology O (according to the method that O is derived from the personal ontologies).

[2] This sketch is by no means a proposed UI design.
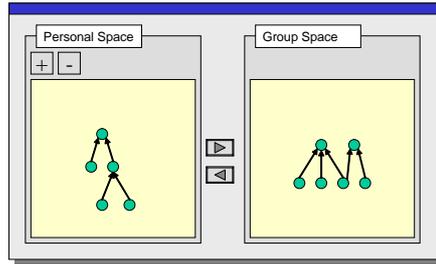
Fig. 1. An indicative UI for trialogical E-learning

The relationship between personal space and group space is very important. The button labeled by "→" allows a user to copy the desired parts from her ontology to the group space. The button labeled by "←" allows a user to copy the desired parts from the group ontology to her personal space.

An option that keeps the button "→" permanently pressed would allow synchronous collaboration in the sense that every change at a learner's ontology is immediately reflected (propagated) to the group ontology (e.g. blackboard-based collaboration). Symmetrically, an option that keeps the button "←" permanently pressed would propagate the changes on O to the personal space[3]. Deletions are handled analogously and are discussed in Section 4.2. We could call systems (and UIs) that allow this kind of collaboration/interaction *synodic*[4].

Above we have sketched the basics of a trialogical e-learning scenario. Of course, the scenario (and the UI) can be enriched with a plethora of auxiliary functionalities. Below we identify the most important ones according to our opinion:

- The *group space* view could be *customizable*, e.g. instead of showing the group ontology, one participant may want to see the ontology derived by considering the ontologies of only a *subset* of the participants. In general, the shared knowledge base could be defined with a set theoretic expression over subsets of A. For example, $K_{(\{a_1\}\cap\{a_2\})\cup(\{a_3\}\cap\{a_4\})}$ could capture the scenario where two groups (a_1, a_2) and (a_3, a_4) collaborate in the sense that the joint work of each group is integrated. Moreover, the group space could be *optionally managed* by a person whose role would be to accept or reject the changes that the participants forward to the group ontology.
- The *provenance* of every statement should be saved and be available at any time (e.g. this link was added by learner a_2). Moreover, the participants should be able to *annotate* every element of their personal or group space. The annotations could be textual or ontology-based.
- *Usability* is always a very important issue. For instance, by placing the mouse on top of an element of the group ontology, a balloon should open showing who provided this info (or what percent of the actors agree with this). More-

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[3] This is not reasonable if O is defined by union, but it could be reasonable if O is defined by intersection or quantitatively.

[4] Of (or relating to) a synod, where *synod* is a council or an assembly.

over the *visualization* of knowledge artifacts is a very important, challenging and open issue (some related issues are discussed in brief in [24, 35]).
– The UI could be enriched with *teleconferencing* services allowing the participants to discuss in real-time while using the system.

4 Synthesizing Knowledge Bases

To support the scenario described in Section 2, we need to support the formation and evolution of A, of P, of O, and $d(p)$'s. In order to identify the distinctive knowledge management requirements for supporting e-trialogical learning, we will first present an approach for supporting personal and shared knowledge artifacts and then we will investigate various forms of knowledge bases starting from the very simple ones. The reason for trying to identify the key knowledge management requirements (that originate from TL), is to investigate how we could support them by extending accordingly the core knowledge management technologies (and not by developing yet another e-learning application).

4.1 Supporting Personal and Shared Knowledge Artifacts

Now we will divide the personal space of an actor into two spaces: one private and one public. The group (shared) space is derived from the public personal spaces of the actors.

Each actor a_i has two unique *identifiers*: one *private* and one *public*. The first, denoted by a_i^p, is associated with every "statement" (e.g. construct or update operation) concerning his personal space. The second, denoted by a_i, is associated to every statement he has forwarded to the group space. Let KB_i^p denote the knowledge base comprising all statements with identifier a_i^p, and KB_i denote the knowledge base of statements with identifier a_i. Normally, it should be $KB_i \subseteq KB_i^p$, that is the public personal base of a user should be subset of the personal private base of that user. However, in social life sometimes persons forejudge or "pretend" that they accept facts although they don't really believe them (e.g. because all other persons do, or for strategic reasons). In such cases the relationship $KB_i \subseteq KB_i^p$ does not hold. For this reason, and in order to leave learners free, we shouldn't impose any constraint among KB_i and KB_i^p.

The important point here is that the synthesis (or amalgamation) of all KB_i's forms the shared artifacts of the group (i.e. the shared artifacts according to trialogical learning). Let's now return to our application scenario, and suppose the case where there is one tutor who has also provided to the learners a preliminary version of the ontology O_{pre} (on which the learners should work on). We could capture this case by considering that initially it holds $KB_i^p = O_{pre}$ for each $i = 1..K$.

4.2 KB = A Set of Words

In order to identify the distinctive knowledge management requirements for supporting trialogical learning (if any), we will start from very simple forms of knowledge bases.

Suppose that a knowledge base is just a set of words (i.e. a set of strings). In our application scenario, this corresponds to the case where the ontology (that the learners have to create) has the form of a set of keywords.

For every actor $a_i \in A$ we have two knowledge bases: KB_i^p and KB_i. The first is a set of pairs of the form (w, a_i^p) while the second (KB_i) is a set of pairs of the form (w, a_i) where w is a word. At the beginning of a learning session it could be $KB_i^p = KB_i = \emptyset$ for each $i = 1..K$, although this is not a necessary constraint.

Consider now an actor a_i who uses the left area of the UI and creates a KB_i^p. Now suppose that he selects some elements of KB_i^p, say a word w, and presses the "→" button. One reaction to this event can be:

1. A new pair (w, a_i) is created.
2. The group KB is updated according to this information (depending on the way that the group KB is defined).

Now suppose the user selects some elements, say a word w, from the group space (rightmost area), and presses the "←" button. One reaction to this event can be:

1. A new pair (w, a_i^p) is created. This step makes the assumption that the user agrees with w. In other words, we treat this case as if the user had added himself the word w to his private base.
2. The private base of the user is updated accordingly.
3. Probably (or optionally) a pair (w, a_i) should be created.

Let's now suppose that the user *deletes* one element w of his private knowledge base. If the user had "published" w in the past, i.e. if a pair (w, a_i) exists, then the system should ask the user if the pair (w, a_i) should be deleted or not. This case suggests that it would be more informative if the UI for each actor a_i were divided into 3 areas: one showing KB_i^p, one KB_i, and one for KB_A, as it is depicted in Figure 2. This would allow monitoring and controlling the contents of KB_i.
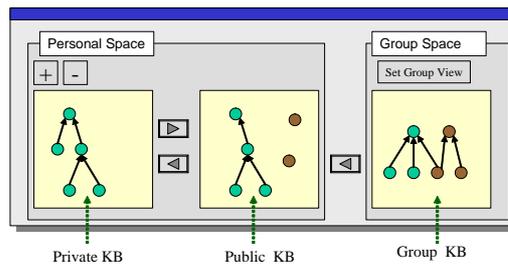

Fig. 2. An indicative UI for trialogical E-learning

Let's now investigate how the "shared" knowledge base might be defined. Let KB_A denote the KB obtained by taking the union of the public bases of all actors, i.e. $KB_A = \bigcup_1^K KB_i$. We can define the *support* of a word w, denoted

by $for(w)$, as the set of ids that correspond to actors who have included w in their public KB. So KB_A can also be considered as a set of pairs of the form $(w, for(w))$ where $for(w) = \{\ a_i \mid (w, a_i) \in KB_i\}$. Notice that this view is quite generic as it allows defining at run-time the group KB by various methods (by union, intersection or any other) as shown below.

– The UNION case comprises all words w such that $|for(w)| \geq 1$, specifically:

$$KB_{\cup A} = \{\ w \mid for(w) \subseteq A\}$$

– The INTERSECTION-case comprises all words w such that $|for(w)| = K$, specifically:

$$KB_{\cap A} = \{\ w \mid for(w) \supseteq A\}$$

– The z-PERCENT case comprises all words w such that $|for(w)|/K \geq z$, specifically:

$$KB_{z\%A} = \{\ w \mid \frac{|for(w) \cap A|}{|A|} \geq z\}$$

– The case where a user wants to see the group ontology as derived by considering only a subset A' of A can be captured by the above formulas (by replacing A with A').

It has been made evident that by considering a KB as a set of pairs of the form $(w, for(w))$, we can compute "whatever shared knowledge base" we want. So such a representation could be adopted for the physical layer of the repository.

Grading (assessing progress)

Let W and W' be the set of words stored in two knowledge bases KB and KB' respectively. We can define the distance between two knowlebge bases KB and KB' on the basis of W and W'. For instance, we can use the symmetric difference, i.e. $dist(KB, KB') = |W \setminus W'| + |W' \setminus W|$, the Dice coefficient, i.e. $dist(KB, KB') = 1 - \frac{|W \cap W'|}{|W \cup W'|}$, or any other metric.

4.3   KB = A Binary Relation

Now suppose that a KB is a binary relation R over a set of elements T i.e. $R \subseteq T^2$. Let r denote an element of a R, e.g. $r = (t, t')$ where $t, t' \in T$. In our application scenario, this corresponds to the case where the ontology (that the learners have to create) is a graph of keywords.

We can define the personal and group knowledge bases as we did earlier (e.g. $KB_{\cup A} = \{\ r \mid for(r) \subseteq A\}$). The only difference is whether the set T is considered to be known by all actors (and thus is not part of the created knowledge), or not. If T is considered part of the created knowledge, then the KB of an actor could be characterized by R_i and T_i (of course $R_i \subseteq T_i^2$). It follows that we can define shared knowledge bases (e.g. $KB_{\cup A}$ and $KB_{\cap A}$) not only for R but also for T.

4.4   KB = A Binary Relation with Second Order Properties

Here we consider the case where a KB is a binary relation R over a set of elements T ($R \subseteq T^2$), with the extra rule or constraint that this relation satisfies a property (e.g. that R is reflexive, symmetric, antisymmetric, transitive, etc). These extra properties can be seen as derivation rules (inferences) or constraints. For instance, note that the case where R is a preorder (i.e. a reflexive and transitive relation) captures the case of taxonomies. So in our application scenario, this corresponds to the case where the ontology (that the learners have to create) has the form of a taxonomy. Supporting this scenario is actually supporting collaborative (and trialogical) taxonomy construction.

We could model inferences (e.g. transitivity) as follows. We can consider a KB as a set of sentences S and we make the assumption that there is a consequence operation $Cons$ that models inference services ($S \subseteq Cons(S)$). Also note that axioms could be modeled by the notion of consistency.

It follows that for each $i = 1..K$ we have KB_i, KB_i^p, $Cons(KB_i)$ and $Cons(KB_i^p)$. A "shared" knowledge base can be defined on the basis of KB_i or on the basis of $Cons(KB_i)$. The resulting shared knowledge base can be different in each case, as shown in the example of Figure 3 where $KB_{\cap\{1*2*\}}$ has been used to denote that $Cons(KB_1)$ and $Cons(KB_2)$ were used for the definition of $KB_{\cap\{1,2\}}$.
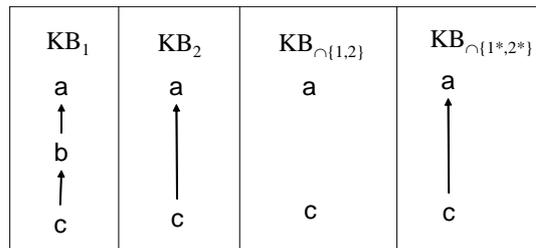

Fig. 3. Local Reasoning and Group KBs

Total Order Consider now the case where R is a total order. For instance, consider the case where learners have to rank a set of available options T in order to come up with some decision. For example, the learners may have to rank a set of keywords or a set of papers according to their significance or importance. In addition, suppose a questionnaire comprising multiple choice questions where more than one choices are correct for each question but the tutor asked from the group to mark only one choice (the most appropriate). Also notice that the case of total orders captures the selection process of peer-reviewed scientific conferences and journals. Here the shared (group) knowledge base can be obtained by aggregating the "rankings" of the learners. For doing an aggregation of this kind, we could adopt various techniques (mainly coming from the area of Social Choice), like plurality ranking, Borda [7] ranking, Condorcet [8]

ranking or Kemeny Optimal Aggregation [20], but we shouldn't forget the Arrow's impossibility theorem [2]. A Borda-like technique for aggregating weakly ordered subsets of a set which could be used for our purposes, is described in [33]. Collaborative Selection and Filtering (i.e. the provision of prediction and recommendation services) is also related to this case (and also useful for collaborative knowledge creation and learning). The difference with the Total order case is that now actors do not rank a set of objects but they rate (using a numerical scale) a subset of the objects (e.g. instead of rankings of the form $\langle o_1, o_2, o_3 \rangle$ meaning that o_1 is preferable to o_2 which is preferable to o_3, we may have input of the form $\{score(o_1) = 5, score(o_2) = 3\}$).

In the above scenario the set T is not part of the created knowledge (in other words, it preexists). A scenario where T does not preexist but is rather part of the created knowledge follows. Suppose that a group of persons (e.g. the authors of the current paper) would like to collaborate in order to specify the structure of a research paper to be submitted to TEL-CoPs'06. Each one proposes a structure, i.e. a total order of strings (here a string can be the title of a section or a short paragraph indicating the contents that this section should have). The collaborative system should aid them to come up with some decision, i.e. with one structure either accepted by all of them or by most of them. As it wouldn't be realistic to expect that two persons will propose exactly the same title (or paragraph) for a section, a text similarity function could be employed (meaning that two texts with degree of similarity greater than a certain threshold could be considered to denote the same section). As each participant will be able to see what the others do (using the right area of the UI), they are expected to refine, improve or change the pieces of text they have provided (and their relative order) while interacting with the system. After some interactions the group will hopefully reach to a structure that is probably better than what each one could do by himself (of course aposties may occur). An alternative method to support this scenario follows. Suppose that the paper to be submitted should have exactly 7 sections. Let T be the pieces of texts that all actors have provided (i.e. $T = \cup_1^K T_i$), e.g. if $K=3$ then $|T| \leq 21$. The group KB (group paper structure) could be the result of applying the K-Means clustering algorithm (here 7-Means) on T, resulting to a set T_A (each element of T_A would be a set of texts). The ordering of the elements of T_A could be derived by first mapping the participant's rankings to rankings of T_A and then applying a rank aggregation method. We have just described a collaborative (or cooperative) document authoring scenario.

4.5   KB = An RDF-based Repository

Suppose now the case that the learners have to create an ontology-based repository (ontology plus ontology-based metadata). A repository of this kind has the form of a conceptual graph. According to RDF [27, 4], this graph can be seen as a set of RDF triples which actually defines a directed graph consisting of 3 kinds of relations (instanceOf, isA and property). So we could write

$KB = (R_{in}, R_{isa}, R_p)$, where R_{in} comprises instanceOf relationships, R_{isa} comprises isa relationships, and R_p comprises property relationships. Note that the *isA* relation (R_{isa}) models a transitive relation so the issues discussed in Section 4.4 apply here as well. It follows that the semantics of the RDF constructs should be taken into account when applying operations (i.e. union and intersection) on various KBs. Such issues for RDF are discussed in [17].

Notions of consistency could arise in such a setting. If inconsistency arises in one individual (personal) KB, then the user is responsible for making what is necessary for reaching a consistent one[5]. However, one can easily see that although each individual personal KB may be "consistent", the group ontology may be not. Who and how should react in that case? Should the system allow such cases and if yes is there anything it could do for aiding actors to overcome this problem? One first remark is that it wouldn't be flexible to forbid inconsistent group KBs. So the system should allow inconsistent group KBs but it should be at least able to detect incosistenscies and indicate them to the actors. If we allow inconsistency also in the personal KBs, then another interesting case may occur: the individual KBs could be incosistent while the group KB is consistent [6].

For tackling inconsistency at the group level, a powerful knowledge manager could try to derive (and present) consistent subsets of the group KB. It could also probably adopt a quantitative notion of consistency (instead of the dichotomy of KBs to consistent and inconsistent). Let's use the notation $\models KB$ to denote that KB is consistent. If a KB is inconsistent ($\not\models KB$), then the system could try computing $KB_{A'}$ (specifically, $KB_{\cup A'}$, or $KB_{\cap A'}$, or $KB_{z\%A'}$) where A' is the maximal subset A' of A such that $\models KB_{A'}$ (resp. $\models KB_{\cup A'}$, or $\models KB_{\cap A'}$, or $\models KB_{z\%A'}$). Notice that if there is no inconsistency, then the above definitions of group KBs coincide with the original ones.

Similarly, we could define a notion of *ranking* (or *priority*) that could be attached to each RDF triple in the repository. This ranking would encode the relative strength (reliability) of each triple in the learner's mental state and could be either qualitative (i.e. encode the ranking through a full or partial order) or quantitative (i.e. encode the ranking through a numerical assignment of a priority to each triple, which implies an ordering). This refinement facilitates the definition of a quantitative notion of inconsistency, as well as the process of aggregation using techniques from Social Choice, as mentioned in Section 4.4. Furthermore, it allows the adaptation of works related to belief merging [21], [23], [22] in our aggregation context, by facilitating the formal description of notions like "weakening", "conceding" and "negotiating" [21], the development of *arbitration* or *majority* merging operators [23] and the definition of distances and aggregation functions [22].

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[5] The problem of maintaining consistency after updates have been studied in the Database & KR literature (e.g. see [32]) but mainly for the single actor case.

[6] This could be one answer to the *learning paradox*, i.e. to the classical problem of explaining how something new and more complex is created using existing knowledge.

Note that unlike traditional approaches conceiving ontologies as thorough engineering artifacts issued by strict design process and policies, in TL ontology creation and evolution can be seen as a social process where learners collectively improve their individual and shared understanding through social interaction. In this context, the individual interactions of group members would lead to global effects that could be observed as *emerging* knowledge artifacts (related somehow to emergent semantics [1]). Ontologies would thus become an emergent effect of open-ended interactions within or across groups of individuals as opposed to be a firm commitment of a small group of domain experts (for more see [26]).

Further Issues As we step up the expressive power of the representation framework additional issues arise:

– For instance, knowledge change and evolution raises various issues e.g. the distinction between *update* and *revision* (in the sense defined in [19]), as well as the applicability of belief revision theories to ontology evolution (e.g. see [11]).
– Measuring the distance between two knowledge bases (e.g. for grading as described in Section 2) may not be enough. It will be also important (e.g. for learning purposes) to compute and show the difference, or *delta*, between two knowledge bases. Some approaches for computing deltas of RDF graphs are described in SemVersion [36], PromptDiff [28] and [3].

Furthermore, as the number of actors scales up, additional issues arise, e.g. the need for social network analysis. It is worth mentioning here that the Web is probably a case of collaborative knowledge creation of a very primitive form. The actors of the Web can only create and update their own KB_i's (interlinked web pages) and the only method to combine the KBs of different actors is to add one-way links between them. Despite this simplicity, the growth of the Web was (and remains to be) astonishing, especially because no one ever tried to impose a structure or any form of control on that. It follows that link analysis techniques (either applied on social networks, or on articulated knowledge bases [5, 15], or on large knowledge bases [34]) are also expected to be useful in large-scale collaborative knowledge creation. The provision of personalized services is also very useful in large-sized knowledge bases [31].

As a final remark, note that the need for defining separate knowledge spaces and for combining them has been identified in several contexts also in the Semantic Web as this would be useful for data syndication, for restricting information usage and for access control, among others. Several approaches have been proposed (like [38, 10, 16, 14]), and the more recent one is that of *named graphs* [6, 37]. In this paper we go one step further and we stress the need for synthesizing such knowledge spaces.

At last, we should remark that workflow issues are orthogonal to the issues we discussed so far. The issues we elaborated so far are raised in almost every step of a workflow process if that step should be carried out collaboratively.

5   Epilogue

This paper described a specific scenario for collaborative knowledge creation in the spirit of the trialogical learning paradigm. According to this scenario the group knowledge base is formed by combining the KBs of the participants according to various methods. The provision of flexible methods for defining various aspects of the group knowledge is expected to enhance synergy in the knowledge creation process and could lead to the development of tools that overcome the inelasticities of the current knowledge creation practices. An indicative UI was sketched enabling us to scent the most important issues that are raised for its realization. Subsequently, we focused on knowledge management and we projected this scenario to various knowledge representation frameworks and for each one we outlined related application scenarios, techniques and issues that are worth further research.

Summarizing, trialogical e-learning requires advanced knowledge management services, probably more advanced than those that have emerged in the database and KR area (including the Semantic Web). Database and KR technologies have provided stable solutions mainly for the case where there is a commonly accepted conceptualization and world view. Methodologies and technologies that allow diversification and flexible amalgamation of different world views have not emerged so far. Areas of knowledge management that are related (in principle) to trialogical e-learning include modal logics, quantitative methods for aggregating knowledge and belief revision theories.

We are currently investigating and experimenting with these issues in the context of the Knowledge Practices Laboratory (KP-Lab) project (co-funded by the IST programme of the EU 6). The implementation will be based on Semantic Web technologies specifically on the RDF Suite [12, 18, 25].

Acknowledgements

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Community Based Software Development
– the Case of Movelex

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Abstract. The paper provides an overview of the elaboration, testing and improvement of Movelex, a complex virtual learning environment (VLE) supporting the establishment of self-regulated learning and shared knowledge building space in the classroom. The development and continuous improvement of the software has the aim to form *communities of practice* of teachers and students to co-operate with software programmers in the creation of new functionalities and widening of the array of pedagogical options. Therefore, the VLE called Movelex is not just a product; it is tool and a digital learning content development platform at the same time – and in both capacities, extremely user-friendly and supports building a community of practice for technology-enhanced learning. The paper refers to the *Knowledge Practice Laboratory Project* (KP-Lab), to elaborate new models for in-service teacher training aimed at assisting future teachers in the *co-evolution process* of technical and pedagogical skills development through a VLE enhancement exercise.

Key words: Self-regulated learning, collaborative learning, VLE, communities of practice, Movelex

1. Theoretical Foundations

Virtual Learning Environments have decades of developmental history. Still, they fail to yield educational results promised by their developers – an impressive improvement in the quality of teaching and learning that would justify investment in their development. Teachers, irrespective of the quality and quantity of infrastructure and training courses offered, are still reluctant to use them [1]. According to case studies in 21 OECD countries ranging from school cultures of Mexico to Finland, those who make optimal use of ICT technology are innovative teachers who have been equally successful in "non-digital" educational innovation [2].

Teachers complained that learning management systems (LMS) may have a search functions may convey pedagogical message, but the whole environment represents an "HTML logic" – it does not alter the logic of a book. (Many LMS systems actually contain digital versions of textbooks.) Learning Object Repositories offer independent units that may be interrelated in numerous ways, but teachers find it difficult to match them with curricular content and requirements. Collaborative learning environments (CSILE), for example Knowledge Forum involves co-construction of knowledge – however, text and images are imported into the system from outside sources and re-

quire considerable investment in time and effort. These tools may also be quite difficult to handle for teachers who soon develop anxiety and avoid the whole ICT culture [3].

Movelex was developed to offer a solution for Hungarian teachers trained in basic ICT literacy but reluctant to use pre-packaged digital material. Movelex invites teachers to act as co-developers: customize and expand an easy-to-use, flexible, still well-structured learning environment. This feature is considered especially beneficial for matching curricula and VLE-s [4].

This VLE focuses on two main pedagogical goals:

- To support *individualised instruction,* self-regulated and cooperative learning;
- To help teacher communities to produce well understandable learning materials supporting the previous goal.

In order to realise these objectives, educational methodology, information technology and the organisation of the use of the system have to be considered in synergy. Movelex differs from most other VLE-s in the following key features:

- Movelex reflects teachers' teaching methods – may be used flexibly for various teaching and learning styles;
- It does not require technological skills – teachers do not have to deal with technological problems and may learn the usage of the system to its;
- Even basic knowledge about this software results in functional learning solutions that teachers can use at once at school;
- The conceptual framework of the curriculum may be directly translated into a set of Movelex learning objects and their relations.

1.1 A Barrier of Self-regulated Learning

A key problem of self-regulated learning is that students have difficulties in identifying their own learning problems and state that it is the "whole" material that they cannot grasp [5], [6]. Lacking easily applicable diagnostic tools, teachers cannot help localising the knowledge deficit or skill development gap because the ruling paradigm in Hungary, frontal education leaves no room for motivation or detection of individual handicaps. Frontal teaching results in a loss of control over individual learning processes by the teacher while learners also loose motivation.

In order to help students identify problematic parts of a learning material and furnish teachers with identification resources, we built our LE on the mastery learning principle. Bloom's model that was based on principles of Morrison and Carroll aims at a profound acquisition of the learning material. Preliminary knowledge is revealed through a pre-test, the remedial learning process is supported by formative assessment and a post-test proves in-depth acquisition of knowledge [7].

Mastery learning became obsolete as an educational paradigm largely due to the amount of work needed for the elaboration of tasks, exercises and testing tools for each learning unit and skill level. Adaptive teaching and testing was in fact extremely time consuming in the era of hierarchically constructed, paper based learning materials. Before the introduction of ICT solutions in education, it was very difficult to sep-

arate information from its pedagogical context. When compiling a textbook, the author had to make a final decision about the sequence of the learning units and also the level of difficulty of the material that ultimately pre-selected prospective audiences for the textbook. A printed teaching aid as an object may not be restructured, and additional materials may not be inserted on its pages. Individual differences in interest or learning problems can only be taken into consideration through typography, the separation of core and additional content through colours or printing styles. If another author intends to offer a different methodology, he / she has to write a whole new book, however the information content of this volume will be not much different from the previous one. The two books, however, will be difficult to compare as methodological differences overshadow content similarities.

An example for hidden knowledge: only a few learners will remember what happened in North America in the times of the French Revolution. Both events are there in the history textbook, but on different pages, chapters apart. A history teacher will have learnt so much about different epochs and nations that he / she is likely to be able to forge that link in his / her head. The relations between these two sets of data are hidden knowledge that never becomes apparent for the learner. Teachers, however, find it difficult to understand why these two knowledge elements remain separate in students' minds. Similarly, teachers of physics will be puzzled to find that mathematical knowledge is very hard to activate. Discipline based learning results in compartmentalized knowledge fragments. *The transfer of knowledge* does not occur spontaneously – it has to be constructed through adequate pedagogical means – or a well-designed VLE.

1.2 Learning Objects versus Structured Materials

Learning objects (LO-s), core elements of e-learning material design aim to solve reusability and variability by not containing references to other LO-s. Even these basic units, however, contain a set of concepts that are not explained but may need further clarification. Even if we omit any hints on previous knowledge, it is still there, inherent in the text and / or image of the LO. Therefore, teachers will always have a decisive role in the design of the learning process – even through the selection of the LO-s to be used in the VLE. Both teachers and learners will be in need of help while constructing their individualised knowledge content from what is seemingly a set of reusable learning objects.

Research on *conceptual maps* or Bruner's theory on the importance of "*structure*" both emphasize "interrelationships" as a key design aspect that provides usable knowledge [8]. Even knowledge transfer depends on the ability of the learner to acquire structures and identify special occurrences of a general phenomenon [9]. Our conclusion is therefore that a real educational software solution cannot neglect handling references and structures. Thus, the challenge for educational software specialists is to provide a *dynamic learning platform* with a wide range of learning paths and content options that, at the same time, provides well-designed learning steps and adequate scaffolding for the learner and constant supervision for the teacher.

It is generally accepted that ICT may play a beneficial role in the realisation of contemporary educational paradigms. However, computer technology can do more

than that. It can offer a *model for learning as intelligent information processing* that is not attached exclusively to the computer-supported environment. The traditional role of the textbook developer – gathering, structuring and interpreting information – and the major task of the teacher – facilitation of information retrieval, processing and utilisation for learners are concepts well-known in the world of information technology. All these activities centre around the *arrangement* of information – with emphasis on selection, organisation and structuring. E-learning materials, however, often fail to perform this important task. They provide no more than e-books, digitized versions of traditional, linear, paper based textbooks. Even though these transformed texts contain links and images, they have little to do with conscientious arrangement of information and often result in information overload.

The real solution should integrate texts and visualization with database-like internal structures and thus reduce cognitive load [10]. This is the major technological novelty of Movelex, detailed description of this however doesn't fit into this paper.

2. A Trialogical Model for the Development of Learning Materials

Traditionally, teachers "commission" (express a need for) a digital tool or teaching aid and at best, adapt the finished product – if it is customisable at all [4]. Software developers receive a – transcribed by educational policy makers of marketing specialists – description of the functionalities the product is required to have. Learners are also not entitled to take part in the developmental process – all they can do is to select features and content that seems to suit their learning styles, previous knowledge and interest best. The problem is lack of a common frame of reference. Teachers and learners cannot reflect on a VLE in a meaningful way if they have not seen such before. However, if a prototype is prepared for piloting, a large amount of work has to be invested before the product is testable – and understandable – for future users. Making changes is slow and requires vast financial and human investment [11].

The traditional method of educational software development is based on *parallel monologues* – those of the teacher and learner, expressing their need for a digital learning tool, and those of the software developer and producer, expressing their special viewpoints and interests. Learning materials developed as a result can only be used for traditional, authoritative "*learning dialogues*" [12].

The EU-funded Knowledge Practice Laboratory defines an innovative model for the co-construction of knowledge that educational software development also has to consider: *trialogical learning.* "Those forms of learning where learners are collaboratively developing, transforming, or creating shared objects of activity (such as conceptual artefacts, practices, products) in a systematic fashion. Trialogical learning concentrates on the interaction through these common objects (or artefacts) of activity, not just between people ("dialogical approach"), or within one's mind ("monological" approach)." (from www.kp-lab.org, the official Website of KP-Lab: KP-Lab Wiki / Trialogical Glossary) Consequently, the realisation of this learning model needs *communities of practice*. On the one hand, it involves learning in self-regulated student groups ("knowledge building communities"), on the other hand, teachers' communi-

ties that co-develop learning content to support and guide self-regulated student learning also have to be formed [13].

2.1 Movelex: a New Type of VLE

In order to realise the trialogical learning model, a new type of VLE is needed that enables teachers and learners to interact with learning content directly, through an easy-to-use and flexible environment and thus act as developers themselves. In an ongoing effort, the teacher and learner community develops *both a VLE and new content to be used within this VLE*. Movelex is more than handy software – it is the catalyst of a new teaching methodology thanks to its structure to be explained below. It is based on the active partnership of the teacher (and, at times, the learner) as a provider of content, and the developer as a provider of technical framework for the formulation of content types (texts, images, assessments, animations, sound bites etc.)

This co-evolutionary process has involved hundreds of teachers who take part in the testing educational functionalities of the software environment and learning materials produced within this environment as well. Trialogical development means here to harmonise the didactic needs, background knowledge and school culture of *educators* (teaching professionals), *software engineers* (ICT development professionals) and *learners* with a deep understanding of their own motivation and interest. These groups do not normally work together on a learning material design task as their roles never overlap.

The Movelex Virtual Learning Environment was constructed on the principles described in this paper and have already six years of practical experience. (Its name generates from the English words "moving" and "lexicon".) Below we will describe the basic components of the system:

- *Digital lexicon:* a knowledge repository that makes the implicit structure of the learning content, in the mind of the teacher, explicit. Several innovative features enrich this digital lexicon:
  - Items are not represented as text, but are marked as definitions, remarks, examples and symbols. Teachers may attach categories like age group, school type, target population etc. and the system will filter the items according to the preferences of the teacher.
  - It is also possible to write different interpretations representing levels of difficulty or professional viewpoints for the same concept.
  - *We can differentiate between new and* (supposedly) *known concepts.* This way we can construct a network of concepts that mutually rely on each other. Thus, necessary preliminary knowledge for a certain unit may be defined and the logical hierarchy of learning items may be clearly identified. Therefore, we can avoid the inclusion of non-defined, new concepts on the network.
  - In the lexicon, links not only denote one lexical item, but always refer to the meaning of a word that is needed for the given learning unit. In the lexicon, *every meaning is listed* – with the respective illustration.
  - Among the concepts in the lexicon, *several types of relationships* may be indicated. Apart from subordination (like furniture – table) you can specify syn-

onyms, antonyms, or such intricate sets of relationships like the table of Chemical Elements, a chain of historic events or the origin of species. The material can be arranged according to different structures, for example, make a list of historic events happening in the same period in different parts of the world. (In a printed book, these would be found in different chapters.)

- The links themselves may also wear tags that associate them with different relationships, therefore even plain text may reflect different relationships. Links are symmetric, which means that their source may also be searched for.

- *Test bank:* several item types make practising and testing more enjoyable (e.g. matching tasks, selection of the right answer, special linguistic and mathematical tasks, inserted images and other multimedia elements). Tasks and tests may contain references to the lexicon, thus facilitating the learner's work with items to be practiced.

- *Image and graph bank:* there is an inbuilt animation software available to produce animated images that may be used both in the lexicon and the test bank.

- *Virtual Communication Environment:* provides a platform for learners' and teachers' dialogues and for the integration of materials developed by users (teachers and learners alike).

2.2 Using Movelex in the Learning Process

In the Movelex VLE exercises (test or practice items) are produced in a word processor, may be corrected at any time, and will be formatted automatically by the VLE. All the user has to do is to save his / her product as a web page and open it with the Movelex Presenter program which can be downloaded from this web-page: www.perfectstudy.org.

The *basic learning unit* may comprise the elements listed below. (These are options provided by the VLE and do not necessarily have to be used in all by the teacher.)

- *Test of necessary preliminary knowledge:* in case of insufficient solution of these items, it is not advisable to start with the new learning material.
- *The learning material.* It consists of three types of units. The definition of their sequence and elaboration is the task of the author:
  - *Background material*: description of the material to be taught in the form of a *lexicon*. Concepts and facts may be illustrated by images and animations.
  - Pages containing *new content* (series of frames that can be viewed in a definite, didactically designed order).
  - *Tasks and exercises*: explanatory and practice items and illustrations (images, animations) attached to them.
- The unit is concluded by a final test. The results of this test help both the teacher and the learner decide if the learning process was successful or more exercises and / or explanations are needed.

A typical Movelex unit consists of the new content as front page material and the lexicon as well as the tasks and exercises are "linked" to its parts. The lexicon helps

interpret the concepts of the new learning content, while the tasks and exercises facilitate its elaboration. Practice items offer immediate feedback. Thus, they may be used as formative tests and facilitate knowledge acquisition through repeated testing opportunities with items provided in a random order.

The above elements may be combined in a different fashion: a new knowledge area or theme might be introduced by simulations and problem solving tasks (to be solved in small groups). After these, the learner may go to the new content pages to overview and structure his / her newly gained knowledge [14].

2.3 Integrating Text and Visualization

The central idea of the VLE is, that *visualisation* leads to easier and more profound understanding. If the teacher intends to use a simple illustration, it is enough to mention the file name of the image in the text description of the learning material. However, if we want to connect the text with the images (for example, we intend to insert an inscription on the picture or caption it), then we have to use the Movelex *animator (drawing)* component. This functionality is also suited to the level of the user.

Captioning an image can be learnt in minutes. The simplest form is to insert words on an image, sometimes through arrows pointing at different parts of the image. An image thus captioned, may also be used as a test item with students having to connect concepts and pictures through arrows. More sophisticated drawings can also be applied on images: for example, the borders of a country may be paired with its name. This requires a little more practice. To create an animation needs more advanced skills, but even this function can be mastered within a few hours. The animation technique is very simple but amazingly effective at the same time. A photograph may be animated as easily as you move a Barbie doll. Children may use their favourite images to make an animation based on a thematic unit, and thus approach a set of scientific problems with more motivation (the downloadable sample task sequence also contains such animations).

Even the advanced level of the animator function may be used by a 12-year-old computer fan, and enables young users to realise a set of interesting visual tricks. The optimal use of this function is through pair or group work, where different skills and knowledge backgrounds may create a synergy.

The aim of the advanced-level *editing programme* is to integrate LO-s and images, animations etc. in a unified learning system. The content integrated in the Movelex VLE is a specially structured knowledge repository that has substantial additional functions. To produce such a repository file you generally need a special editing solution the educational relevance and organisational requirements of which we briefly describe here.

Learning content may be structured in a List of Contents page, similar to the File Manager of Windows. This list may be organised into different rank orders and subgroups (and thus be used differently in different classes.) The program is able to list, based on links in the tasks and among the items of the lexicon, those concepts that are misinterpreted or not known by learners. At the end of the test, the software gives an advice to the learner on previous knowledge he / she has to repeat. Thus, Movelex performs a *developmental evaluation* function and can be used as a formative test. Im-

ages may easily be turned into test items, because illustrations are linked to concepts of the lexicon.

2.4 Simplicity as a Key Factor of Feasibility

On the basic level of the Movelex VLE adding new tests or practice items does not require more than word processing skills, only discipline based educational knowledge is necessary. On the advanced level, if a teacher intends to integrate his new test with other learning materials he / she developed or identified in the Movelex learning content repository, more advanced user skills are needed, but even this can be acquired in the course of a two-day training sessions. This training, however, includes more professional (educational) activities than software skills development. Members of a new learning material development group have to analyze the teaching content they intend to transform into digital content in order to create a coherent semantic web of concepts and facts that cover the whole area to be taught and / or tested in the VLE. Software developers are offered the role of technical advisors and invited sometimes to solve special technical problems. Besides they refine the framework according to the needs of pedagogical experts.

3. Results

The first development of learning material (databanks for seven disciplines) for Movelex VLE was launched in 1991. By now, its digital content repository contains about 8000 tasks, based in a lexicon of 7000 items. About 300 teachers have been trained, and 100 of them take an active part in the development of the Movelex repository and tools. *One third of those teachers trained became developers and have been involved in this community of practice ever since.* This community building capacity is considered especially important for improving teachers' educational strategies [15]. As a result of assessment of teachers' ICT skills, two levels of Movelex facilities are offered: Beginner and Advanced, as described before.

In-service teacher training courses organised in small village schools with modest infrastructure and unskilled in computer use teaching staff proved that Movelex is user friendly enough to be employed by students and teachers alike [16].

The *inclusion of learners* in the process of digital content development in this project also served the purposes of talent development. Student skills were put to use in the production of visualisations: the production of graphs, charts, still images and animations and their harmonisation with the accompanying explanatory text. This process involves the processing of verbal information and its transformation into visual signs, symbols and text and image combinations. Talented students will arrive at a deeper understanding of the learning material through this complex process.

Working with Movelex means the harmonisation of interests, experiences and skills of different stakeholders of the learning process. The system of digital content production consists of a set of activities that need to be co-ordinated and monitored. Teachers, university staff members or educational researchers may act as moderators

of Internet based developer communities. This process is also included in the co-operative educational project of ELTE MULTIPED and Viola Software Ltd. as a pre- and in-service teacher training experiment and is described in some detail below. In order to provide a *learner centred arrangement of the learning material*, we realise the following objectives:

- Separation of the learning content, learning paths and evaluation.
- Collection and grouping of concepts according to higher order categories and thematic units.
- Based on the *concept repository*, creation of concept maps that facilitate the identification of learning gaps and misunderstandings. The role of the concept map is to make sure the learner does not omit important parts and does not ignore the learning sequence designed by the author of the material.
- To facilitate flexible use – besides ensuring the *coherence of the concept map* – alternative explanations are needed that represent different levels of sophistication and may serve the needs of experts and novices. While accessing explanations and tasks at their own level, they will still experience the concept map as a unified whole.
- Organisation of information in a *database* that enables different ways of connecting, arranging and filtering facts, data and concepts.
- *Integration of visual elements* (images, graphs, charts and animations) with textual descriptions and concept maps.
- *Provision of different learning paths* enable the learner to go through them till the end or choose a new path during learning. The concept map ensures logical sequence and prevents the omission of important parts, as described above. Still, the learner is able to spend more time at any given thematic focal point to ensure deeper understanding.
- *Support for cooperative learning* through the coordination of simultaneous access to information.
- Ensure an easy *follow-up of the learning trajectory* by teacher and learner.

4. Conclusion: VLE as Organiser of Communities of Practice

Self-regulated learning involves the active participation of students, therefore, the environment should also enable learners to generate new content and adapt existing one for individual needs. *Community based content development and assessment* is inevitable to realise the aim of this VLE: to provide a comprehensive and constantly expanding digital learning content repository [17].

Members of this community are not only educationalists, but also civic associations and companies. The technological framework for the functioning of this community of practice (CoP) is a VLE that offers tools for content development and a sophisticated platform for teaching, learning and assessment. The relatively simple content development component assures that Movelex is used by expert and novice ICT using teachers and students alike. This feature is especially important in Hungary

where the level of ICT knowledge and skills of educational stakeholders is extremely diversified.

According to the diversity of ICT skill and interest of stakeholders communities have to be organized as Communities of Practice on multiple levels [6]:

- Basic level development is done in small local groups – as described above – using a word processor. The simplest way – suitable even for novices in ICT – is sending the document to each other by e-mail and writing corrections directly into the text.
- Group work for designers on advanced level may be facilitated by a special *networked mode:* here, the software and database is running on the PC of every group member and all of them are linked through the internet. Modifications done by any of them are synchronised and seen by his / her peers.
- The integrated database of LO-s is offered for testing to the final users (teachers and students) who still have a special technique to give feedback to the designers. They can make remarks on any point of a screen layout as if sticking a ticket on it. Designers get back all these remarks integrated, make necessary corrections and issue a new release of the material.
- At advanced level, this response system works as an integrated shared space, as group members can reflect even on each-other's remarks. These are logged by the system in a searchable database documenting this way the evolution of the trialogical developing process.

The next phase of the project is the testing this trialogical software development model in teacher education. As members of the Knowledge Practice Laboratory (KP-Lab) team, ELTE and Viola Software Ltd. will explore the potentials of this software development model both in in-service and in pre-service teacher education. The course incorporates a combination of knowledge practice models:

- Knowledge creation in small and large peer groups;
- Knowledge creation in an online, "ask the expert" context;
- Micro-teaching;
- Synchronous / asynchronous online forums complete with whiteboard functionality for real time co-operation through drawing.

These features represent collaborative knowledge creation [18] and serve as an example of trialogical learning. Elaborating existing knowledge practices will be an important feature of the course. Design expertise of art education students will be used to form a generally shared knowledge base for learning about the role of visualisation in teaching and learning processes. Missing animation options of Movelex will be highlighted by students and their tutors. Staff of the software development firm invited to discuss online, how these, necessary for teaching features could be included in later versions of the software. Thus, a trialogical approach to software development is realised.

The pre-service group will comprise of art education students in Budapest who will focus on the visualisation potentials of Movelex, while in-service teachers cooperating in Hungary and Romania (Cluj) will represent a wide range of school disciplines and professional interests and will experiment with all features of Movelex.

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