O'CoP, an Ontology Dedicated to Communities of Practice

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Abstract. The Palette project dedicated to learning in Communities of Practice (CoPs) aims to offer several services for CoPs, in particular Knowledge Management (KM) services based on an ontology dedicated to CoPs, the so-called O'CoP. Built from information sources about the Palette CoPs, O'CoP aims both at modelling the members of the CoP and at annotating the CoP's knowledge resources. The paper describes the structure of O'CoP, its main concepts and relations, and it reports some lessons learnt from the cooperative building of this ontology.

1 Introduction

CoPs are "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" [1].

The objectives of the Palette IST project (`http://palette.ercim.org/`) are to develop services for CoPs: information, knowledge management (KM), and mediation services. Eleven pilot CoPs are involved in the participatory design of the Palette services. These CoPs, located in various European countries (Belgium, France, Greece, Switzerland, UK), belong to three different domains:

- Teaching: e.g. @pretic, a CoP of Belgian teachers playing the role of resources-persons to support the use of Information and Communication Technologies (ICT) in schools;
- Management: e.g. ADIRA, a French professional association gathering executives from medium to large IT companies in Rhône-Alpes region);

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- Engineering: e.g. UX-11, a CoP composed of 150 IT engineer-students practicing GNU/Linux.

The CoPs' size varies from less than ten members to more than a hundred.

KM services aim at supporting CoPs' management of their knowledge resources, so as to improve: (i) the access, sharing, and reuse of existing knowledge, and (ii) the creation of new knowledge. A knowledge resource can be either a document materialising the knowledge made explicit by CoPs' members when cooperating, or a person holding tacit knowledge. The KM services will be based on Semantic Web technologies: they will rely on an ontology (describing concepts useful about a CoP, its actors and their competences, its resources, its activities, etc.) and on the semantic annotation of the CoPs' knowledge resources w.r.t. this ontology. In [2], we proposed generic models useful for understanding a group activity, collaboration, competencies, learners' profiles, and lessons-learnt. A CoP being a specific kind of a group, the CoP-dedicated ontology, so-called O'CoP, is based on these generic models. It consists of CoP-relevant concepts and relations with which the CoPs' resources can be annotated. These CoP-relevant concepts and relations are specialisations of the high-level ontology constituted by the generic concepts used to represent the generic models. The CoP-oriented KM services will rely on the O'CoP ontology.

So what kind of CoPs' KM problems may the ontological approach help to solve, and how? Let's give two real examples from Palette CoPs. The first example concerns a knowledge capitalizing problem reported by the @pretic CoP. Members of this CoP met great difficulty in capitalizing the contents of the practice-related messages they exchange via the mailing-list of the community. These messages are under-exploited because they are poorly indexed, or because they are not expressed in a synthetic form: the yet useful information they contain is hardly retrieved when needed. The ontological approach we propose can contribute to solve this problem by enabling a semi-automatic indexation of the messages performed by a semantic annotation service using linguistic analysis techniques. An ontology-based tool annotates the messages with the concepts and relations of a reference ontology. This semantic annotation enables then a semantic navigation through the base of messages, and a semantic search providing the @pretic CoP's members with more relevant answers more easily [3]. The second example concerns a knowledge structuring problem encountered by the Did@ctic CoP. Members of this CoP need to better structure the notes they take during the meetings where they discuss their educational practices. These notes are very informal, and their underlying structure often varies from one CoP member to another. This lack of formality and of homogeneity impede the exchange of practices at a distance in time. A way of structuring the notes is to explicitly impose a predefined structure both to the note support (leading, e.g., to a template), and to the note-taking process. Another structuring way is to implicitly superimpose a more formal structure to the non-formal notes. The ontological approach allows us to implement these two ways. In the first case, an ontology may be

used to elaborate a template. In the second case, the ontology may be used at the retrieval step, or between the note-taking step and the retrieval step, to annotate the non-formal notes using a commonly agreed annotation structure. These two examples illustrate the kind of KM problems encountered by Palette CoPs and possibly solved through our ontology-based approach.

After summarising our ontology development method and the ontology structure (section 2), we will describe its main concepts (section 3), the lessons learnt from its building (section 4), before concluding (section 5).

2 Ontology Development Method and O'CoP Ontology Structure

Our method for developing the O'CoP ontology includes the following steps:

1. *Proposition of generic models* enabling to define multiple semantic axes corresponding to the key notions of the O'CoP ontology [2]. Each semantic axis will be undertaken by an ontologist through a sub-ontology.
2. *Information sources collection:* selecting three main sources to be used either as corpora where picking out candidate terms, or as grids for extracting candidate terms: (i) Rough-data documents (audio records/files of CoPs' interviews, transcriptions and minutes of these interviews; the interviews were performed by Palette members that played the role of mediators between some specific CoP and the knowledge engineers); (ii) Analysed-data documents (e.g., syntheses of interviews, vignettes and scenarios structuring the CoPs' activities); (iii) Methodological and theoretical documents (e.g., our generic models and existing ontologies or thesaurus). For cooperative building of the ontology, the different ontologists analyzed the same information sources for performing steps 3) to 6), but each one focusing on his/her generic model so as to build the corresponding sub-ontology.
3. *Contextualised lexicon construction:* selecting from the corpora and w.r.t. the grids (i) the terms relevant for describing the CoPs and (ii) their respective contexts (i.e. the text surrounding the terms) to help understand the terms.
4. *Vocabulary identification*: refining the contextualised lexicon once validated by the CoPs' mediators and producing, for each term, a definition and some examples of use.
5. *Hierarchy building:* (i) identifying the terminological concepts and relations, and (ii) structuring them, and eventually adding new higher-level concepts.
6. *Formalisation of the sub-ontologies* in RDF/S, the formal language agreed in Palette.
7. *Integration of the sub-ontologies* by solving the conflicts among them and by integrating them into a single, coherent ontology.

Fig. 1 summarises the steps of the development process. A tool, called ECCO, supports these iterative steps and provides the user with mechanisms enabling to keep the traceability of the sources of the candidate terms.

The resulting O'CoP ontology is structured into three main layers (see Fig. 2):

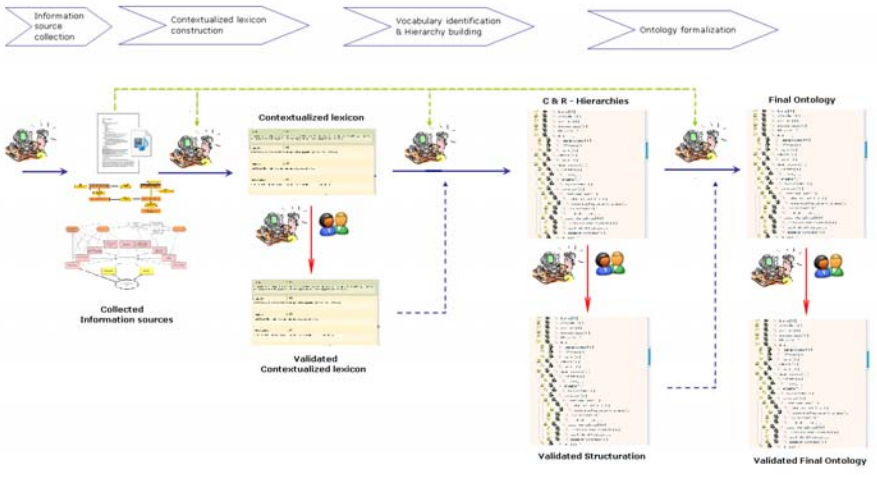

Fig. 1 Ontology development process

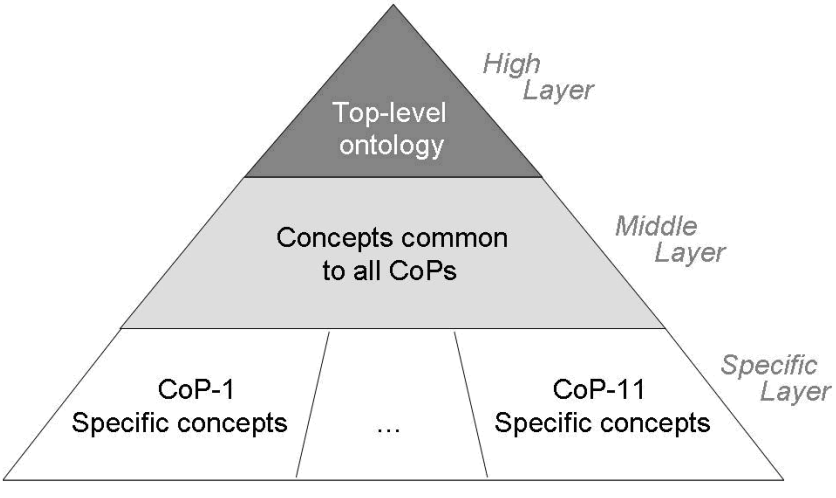

Fig. 2 Structure of the O'CoP ontology

- A *high layer* (or top-level ontology) including the concepts and relations needed to represent the generic models presented in [2]; they served as a grid for analysing the corpora and building the other layers of the ontology.
- A *middle layer* including the concepts common to all CoPs. These concepts correspond to terms confirmed by the mediators as common to all CoPs. They are specialisations of the high-level ontology concepts. Note that some concepts stemming from literature on CoPs, such as the concept of *Animator* detailed in [4], could be included in this common layer, provided that they are attested by at least the CoP corpora.
- A *specific layer* including the concepts specific to each CoP: these concepts correspond to terms confirmed by the mediators as specific to a given CoP or to very few CoPs.

3 Description of the Main Concepts of the Ontology

3.1 Community

The main concepts related to the community in the O'CoP ontology are:

- *Community*: it can be a community of interest, a community of learners, a goal-oriented community or a community of practice. In the interviews, interviewees acknowledged that the group of persons they belong to (be it so-called a community of teachers, a network of teachers, a resource-persons community, an association of companies, etc.) is a (kind of) CoP.
- *Domain* and *Field*: as defined in [5], the *Domain* is the area of knowledge that brings the community together, gives it its identity and defines the key issues that the CoP's members need to address. It is the "focus" of the CoP and evolves over its life span in response to new, emerging challenges and issues [6]. As for the *Field*, it is the "context" of the CoP; it can be referred to as the "discipline" or the "branch of knowledge" of the CoP's members (e.g. the *Domain* of ePrep[1] is the Educative use of ICT and its *Field* can be Mathematics, Physics, etc.).
- *Objective*: related to the CoP as a whole, or to a part of it (a group, a project, a team, etc. depending on the CoP's organisation and functioning modes), an objective can be Permanent or Temporary.
- *CoP's characteristics*: the CoP's identity is characterised by (i) the *Membership*: is the CoP open to any person interested in it or are there some conditions (e.g., competency, cooptation, etc.) for entering the CoP? (ii) the *Cultural Diversity* (from homogeneity to heterogeneity) of the CoP's members w.r.t. the nationality, profile, organisational culture [7].

[1] A CoP gathering teachers of French "Classes préparatoires aux Grandes Ecoles" interested in ICT (cf. `http://www.eprep.org`).

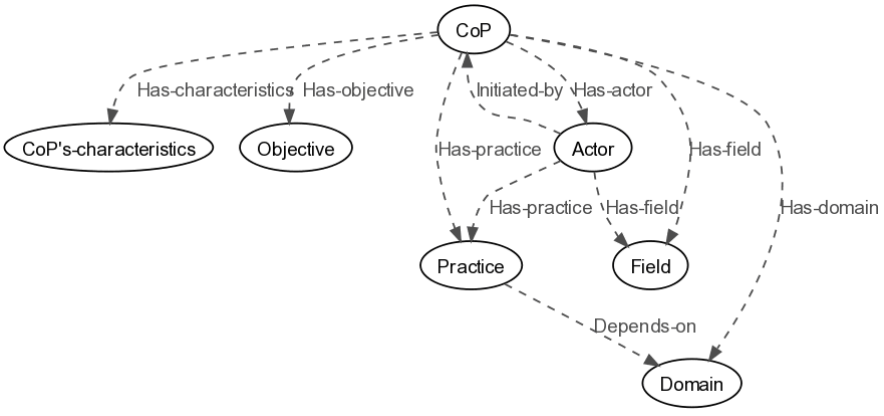

Fig. 3 Relations concerning a community

- *Organisational structure*: the organisation of CoPs varies from formal and structured (e.g. the CoP ADIRA[2] which is based on a "board of governors") to informal (e.g., the DL[3] which is based on "informal subgroups").

  Fig. 3 shows some relations concerning communities.

3.2 Actors

We define an *Actor* as "an Individual or a Legal entity intervening in the CoP". The Actors of a CoP are not only the CoP's members, but also the entities interacting with the CoP (also called the CoP environment). A *Legal entity* can be a *Professional organisation* or an *Institution* (Companies and Educational institutions). Actors can be involved in the CoP as *Members*, *Contributors* (Individuals participating in particular activities or during specific periods of the CoP's life) or *Partners* (Legal entities supporting the CoP).

Moreover, the Actors of a CoP can be defined according to their:

- *Role in the CoP*: it represents the Actor's position in the CoP, which can divided in two types:
  - *Governance role*: in order to interact, learn and share knowledge effectively, the CoP's actors (e.g. the members) need a support, which can be provided by:
    - *Facilitator*: s/he encourages the participation of the members, facilitates the interactions among them.

[2] *L'Association pour la Promotion et le Développement de l'Informatique dans la région Rhône-Alpes*: `http://www.adira.org/`

[3] Doctoral Group Lancaster : `http://domino.lancs.ac.uk/`

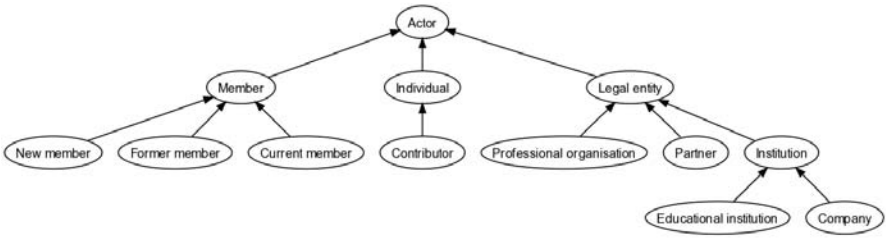

Fig. 4 Concepts describing Actors in a CoP

  - · *Coordinator*: s/he organises and coordinates the activities and events of the CoP. We distinguish between Individual coordination (ensured by one main coordinator) and Collective coordination (in the case of a CoP organised per groups or teams, where the individual local coordinator belongs to a coordination group or team).
  - · *Animator*: s/he guides and manages the community, ensures its development, relevance and effectiveness. An Animator thus plays both roles of Facilitator and Coordinator.
- *Peripheral role*: represents knowledge providers and receivers. They are more or less involved or active in the CoP, their participation depends on the Actors who play these roles (personality, motivation, period, activity, etc.).

- Their *Individual profile*: identifies a CoP's Individual inside and outside the CoP. It comprises the concepts of *Competency* and *Occupation*.
- Their *Practice*: CoP's members are practitioners in an Institution, outside the CoP. They meet physically or virtually, through the CoP, which constitutes a channel for them to exchange experiences about their shared Practice (e.g. teaching practice).
- Their *Behaviour*: the *Attitude* of the member towards the CoP gives more information about his/her degree of engagement in the CoP.

3.3 Competency

A *Competency* is defined as a set of Resources to be provided or to be acquired by an *Actor* (who plays a particular *Role* in some *Environment* or *Situation*) so that the *Actor* can perform, or help some other *Actor* to perform some *Activity*. Fig. 5 gives a partial view of the *Competency-Resource* component and shows some relations concerning the *Competency* concepts.

Table 2 summarises some other relations concerning the *Competency* concepts.

Table 1 Actor-related relations

Relation	Domain	Range	Description
has-practice	Actor	Practice	An Actor of the CoP has a Practice outside the CoP.
has-field	Actor CoP	Field	A CoP, as well as an Actor has one or more Fields of knowledge.
interested-in	Actor	Domain Field Activity	An Actor can be interested in a Domain, a Field of knowledge, an Activity performed inside the CoP.
has-profile	Individual	Individual profile	An Individual has a profile, which defines him/her.
has-occupation	Individual	Occupation	An Individual has an occupation outside the CoP.
part-of-individual-profile	Occupation	Individual profile	The occupation an Individual has outside the CoP, is part of his/her profile.
employer-of	Actor	Individual	An Actor of the CoP can be the employer of another actor (an Individual) of the CoP (e.g. ADIRA).
contestant	Company	Company	A Company can be in competition with another one (both being Actors of the CoP - e.g. ADIRA)
colleague	Individual	Individual	Two Individuals of the CoP can be colleagues in their occupation outside the CoP.
has-attitude	Actor	Behaviour towards the CoP	An Actor of the CoP has a given behaviour, considering his/her motivation, satisfaction and involvement degree towards the CoP.
ordered-by	Activity	Actor	An Activity can be ordered by an Actor (a particular Role or an Institution, etc.).
assesses-activity	Actor	Activity	An Actor assesses an Activity performed in the CoP as being interesting, motivating, boring, etc.
possesses-competency	Actor	Competency	An Actor possesses a Competency linked to his/her personal characteristics and profile.

3.4 Resources

The Resources handled by a CoP are subdivided into:

- *Tools* defined according to the needs of community and their functionalities. A hierarchy describes the categorisation of these tools answering recurrent needs of a CoP including knowledge capturing (Knowledge portal), knowledge storage and sharing (Repository), collaboration (Workspace, Agenda, etc.).

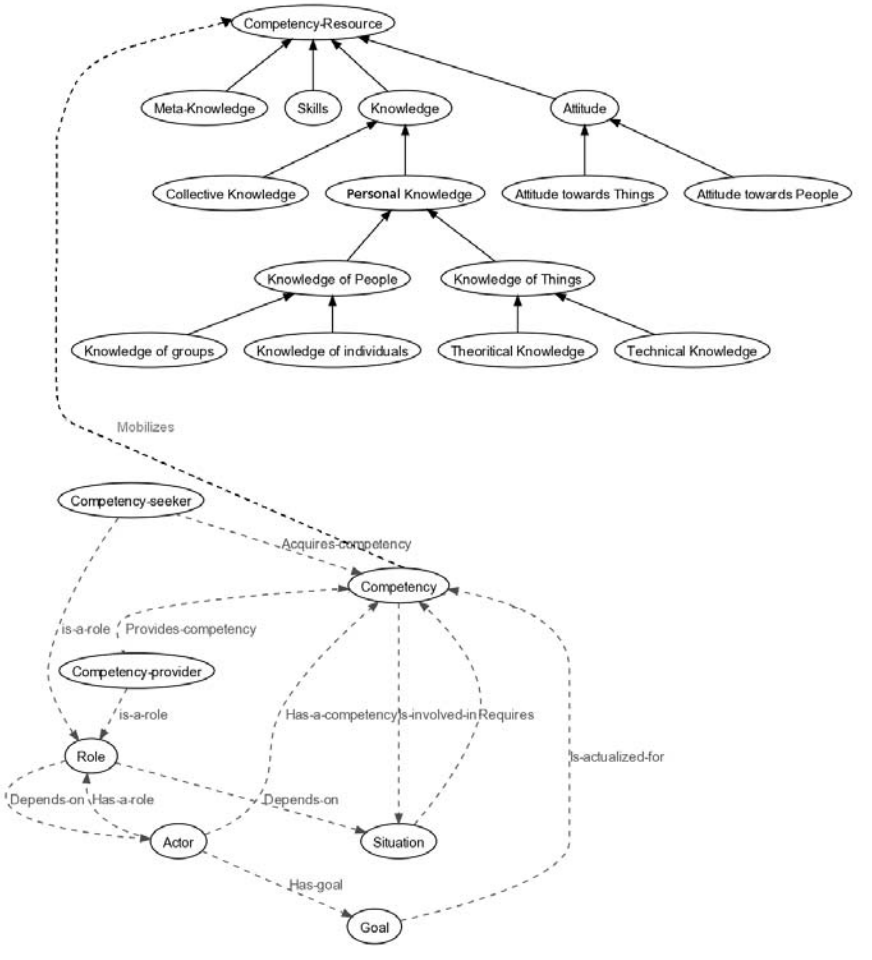

Fig. 5 Excerpt of Competency concept hierarchy and some relations describing it

- *Materialised resources* including documents or discussion. This last type of resources in the CoPs is associated to the interactions that hold within the CoP. These discussions can be synchronous (chat, audio and video conferences, etc.) or asynchronous (mail, forum, etc.). Almost all Palette CoPs are interested in easy access to these interaction traces and in archiving them.

We also characterise resources in a CoP w.r.t. the following dimensions:

- the *nature of resource*: we distinguish Documents, Tools and Interactions;
- the *access rights to a resource*;
- the *ownership of a resource*;
- the *temporal properties and versioning of a resource.*

Table 2 Some relations concerning the Competency concepts

Relation	Domain	Range	Description
is-related-to	Skill	Experience	A Skill acquired by an Actor of the CoP can be related to some Experience lived by the Actor.
is-acquired-by	Skill	Practice	An Actor acquires a Skill by Practice.
is-put-into	Knowledge	Practice	Some Knowledge acquired by an Actor can be put into practice by this Actor.
has-competency-level	Competency	Competency-level	A Competency (and consequently the Actor possessing it) has a Level (of Competency).
is-expressed-through	Practice	Practice-representation	An Actor can express a Practice through some concrete Representation of this Practice.
rises	Situation	Problem	A Problem is originated by the Situation in which an Actor is involved.
requires	Problem	Solution	A Problem occurring in some Situation requires a Solution for an Actor to achieve some Goal.
provides	Competency	Solution	A Competency is one of the resources that (can) provide a Solution to some Problem. The solution found depends on the Level of the Competency.

Fig. 6 shows some of the concepts needed to deal with the ownership of resources in a CoP.

A CoP uses and produces a number of documents of different types. Some of them are specific to CoP's life: for example, organisation policies that describe the rules organising the community life, or specific charter for the usage of the CoP's information system (e.g. in ADIRA). From a resource point of view, knowledge capitalisation takes different forms: several Palette CoPs produce (final or intermediate) reports, associated to CoP's activities. Another type of report is the logbook that can be individual or collective (e.g. in Did@ctic, where the collective logbook is called the "Meta-journal").

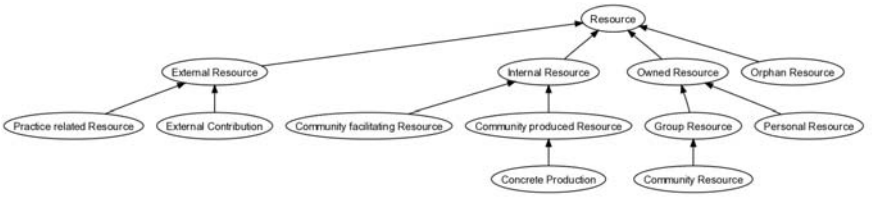

Fig. 6 Categorisation of resource ownership

Fig. 7 Excerpt of hierarchy of concepts describing documents

The CoPs' members can also produce documents related to their practices (Training reports in UX11) or scientific documents (Doctoral Lancaster). The collaboration in the production or use of documents can take the form of annotations that can be either textual or semantic depending on the tools used to produce them. Some documents are associated to a specific domain: e.g. Pedagogical documents in the education domain (Learn-Nett, Did@ctic, UX11), or Official documents useful in management domain (ADIRA).

Fig. 7 gives a global view on the hierarchy of concepts describing documents.

4 Lessons Learnt from the O'CoP Ontology Development

Concerning information sources collection, the relevance of the terms extracted from the corpora strongly depends on the relevance of the corpora. CoPs' mediators had focused their interviews on the organisation of CoPs, and had scarcely asked questions about CoPs' practices. As a consequence, the transcriptions of interviews contained very few terms related to practices. This leads to an ontology in which concepts related to practices are not very numerous.

During the terminological analysis, we found several terms common to some CoPs but used to evoke different concepts depending on the CoP: e.g. the term "platform" was used to designate a website, a workspace for the CoP, that may contain its documents and where the discussions of members are hosted, or yet a dedicated software e.g. e-learning platform. Some terms were also used ambiguously to designate concepts: e.g. CoPs use different terms to designate the persons in charge of particular tasks in the CoPs ("coordinator of the project", "local coordinator", "manager", etc.), whereas these tasks are not well described and identified. Finally, some CoPs use different terms to designate the same concepts, these synonyms must be associated to the same concept in their ontologies in order to avoid redundancy. For example, the terms Journal and Logbook are used to designate the record of activities or practices of a CoP's member. More generally, the synonym terms (either in the same CoP or in several CoPs) were recognised by the validators, during the phase of vocabulary identification and term validation. In the implementation of the ontology, the synonym terms corresponding to a given concept were indicated through the RDF/S label of this concept.

The different CoPs adopted different terminologies, sometimes quite specific to the CoP and rather different from the terminology usually found in literature on CoPs. Therefore, we did not include in the common layer of the ontology the concepts offered by literature (e.g. the taxonomy of facilitation tasks for CoPs proposed by [8]) if they were not attested by the Palette CoPs' information sources.

The O'CoP ontology building was a distributed, cooperative process between: (a) 6 ontologists focusing on different parts of the ontology since each one was guided by one generic model, (b) 11 CoPs' mediators validating from the CoPs' viewpoints. This led to the need to integrate different viewpoints. The different ontologists had various ways of modelling knowledge: e.g. the concept of *Activity* was needed for modelling *Competency* and *Resource*. Concepts related to *Activity* were thus modelled with various detail grains and various perspectives, requiring more integration work. Moreover, the integration between different concepts developed by different ontologists was often performed through the introduction of relations linking such concepts (e.g. relation between an *Actor* and an *Activity*, etc.). Notice that such kinds of relations were emphasised in the generic models that guided us. But they needed to be refined for more specialised concepts.

Our approach was both bottom-up (relying on a deep analysis of the information sources on the CoPs) and top-down (guided by our generic models).

5 Conclusions

This paper presented an original ontology composed of more than 800 concepts and 80 relations, dedicated to CoPs, and more precisely aiming at enabling the annotation of CoPs' members and the CoPs' resources. The link between CoPs and ontologies was studied in some recent related work. In [9], the authors present a method based on analysis of the relationships between instances of a given ontology in order to identify potential CoPs in an organisation. In [10], the authors develop an ontology aiming at enabling services among a civil servant CoP; [11] studies the design of situated ontologies for knowledge sharing in a CoP. [12] presents a semantic web system for open source software communities and relies on specific ontologies (Code, Bugs, Interactions, Community). In comparison to this related work, the O'CoP ontology is original through:

- the method used to build it cooperatively from the analysis of several real CoPs,
- its objective of enabling to annotate CoPs' resources in addition to modelling the notion of a CoP,
- its 3-layered structure, with a generic layer, a middle layer gathering concepts common to all CoPs and a low layer specific to a given CoP.

O'CoP was for example used by the @pretic CoP, in order to annotate the mails exchanged by the members of the CoPs about their problems in the use of ICT in schools. Our work can also be partially compared to the typology of virtual CoPs (i.e. CoPs interacting through ICT) proposed by [13] or to the typology of CoPs based on their knowledge characteristics [14] but these typologies are not materialised through ontologies.

More generally, the O'CoP ontology can be specialised for a new CoP. The high and middle layers are generic and can thus be reused for any CoP. If the new CoP is similar to one of the Palette CoPs, the low layer corresponding to this CoP can be reused. But if no Palette CoP is relevant, concepts more specific to the new CoP can be added in the low layer, possibly by relying on our method described in section 2.

As future work, after achieving the current validation of the integrated O'CoP ontology by the CoPs' mediators, we will make the ontology available to all the Palette CoPs and develop several KM services based on it: knowledge creation, annotation, retrieval, presentation, evaluation, and evolution services.

Acknowledgments

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