Ontologies, Dialogue and Knowledge Maturing: Towards a Mashup and Design Study

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Abstract
This paper proposes an initial design study to examine and test some of the key concepts and issues within a large-scale European research project that is exploring and aiming to realise learning as a process of knowledge maturing in the workplace. It will outline some of these concepts, based on a contemporary (or Web 2.0 driven) articulation of how ontologies can be acquired, externalised and exploited by a user-community and introduce a new role for learning dialogue - through developing work into 'dialogue games'. An initial scenario, or 'thought experiment', is proposed that is grounded on currently available ontology development (SOBOLEO) and learning dialogue (InterLoc) web-technologies and how these could be integrated, or 'mashed up', to improve the management, understanding and application of labour market information in the context of careers advice. Finally, we also consider the potential role of m-learning techniques and the implications about context that these give rise to.

1. Introduction: Design Based Research and the MATURE Project

According to the Design Based Research (hereafter DBR) Collective, in a seminal issue of *Educational Researcher (2003).*

"The challenge of design-based research is in flexibly developing research trajectories that meet our dual goals of refining locally valuable innovations and developing more globally usable knowledge for the field." [1]

So this approach is particularly relevant to an ongoing EC Framework Programme 7 (FP7) Integrated Project called MATURE (http://mature-ip.eu/en/) that is exploring and aiming to realise learning as a process of knowledge maturing in the workplace. Here we want to develop specific tools such as a Personal Learning and Maturing Environment (PLME) and an Organisational Learning and Maturing Environment (OLME) that are situated and valuable in the contexts that they are being used whilst also developing more generic frameworks - such as a knowledge maturing model and technological approaches to the continuous development of social software and knowledge networks. A lot of our previous research has demonstrated

the application of a DBR approach to develop digital dialogue games for learning and intelligent dialogue systems [2] [3] [4]. These initiatives have demonstrated clear learning benefits (see [5] for a review and [6]) and delivered tools that are popular with users and can be easily adopted within institutional contexts (see www.interloc.org) and [7]. So these projects are useful for MATURE to build on, as they formally modelled effective dialogue processes to then design tools that supported and promoted its practice. And with MATURE an aim is to identify and model – technology mediated - social learning and knowledge maturing processes and behaviours in order to design tools that support and promote these practices.

2. Ontologies, Dialogue and a Design Study

The remainder of this paper will synthesise work in ontology maturing and learning dialogue to propose, or scope out, an initial design study for a system integration, or mashup, that exemplifies important aspects of learning as knowledge maturing and also considers m-learning and the implications this has for notions of context. This will be grounded on existing web-technologies (SOBOLEO and InterLoc) and a particular hypothetical user-scenario based on how practitioners giving careers advice to young people in a particular region of England can more effectively research and use Labour Market Information (hereafter LMI). We will introduce each of these technologies and their rationale before articulating their potential combination to realise knowledge maturing in careers advice settings.

Note that this study is part of a federated set of studies that are examining different aspects of the (large-scale) knowledge maturing enterprise, where our particular emphasis is on: exploring and developing the relationship between notions of social learning and knowledge maturing; testing the technical integration issues related to the creation of suitable mashups; and, exploring the role of collaborative dialogue in the continuous development of knowledge networks. So this complements other ongoing design studies, such as those giving greater emphasis to the role of direct user and community engagement in the specification of system requirements and the design process in general.

3. Ontology Maturing and SOBOLEO

Some important work that reconciles more (traditional) formal approaches to ontology development with more participative (Web 2.0 driven) approaches has been proposed by [8] and demonstrated through work on their SOBOLEO (Social Bookmarking and Lightweight Engineering of Ontologies) tool.

The starting point of their ontology maturing process model were the shortcomings of the usual separation of creation and usage processes, performed by different sets of people [9]. While this might be possible in rather static domains, it is not acceptable for dynamic domains, especially when using ontologies for the

annotation and retrieval of resources, where contents change fast and the ontology requires a permanent update to cover the available contents. In real world setups, this leads to frustrating situations (which is a major problem for acceptance) when users cannot extend the used ontologies by themselves in a work-integrated way, e.g. when they require them for the semantic annotation of web-pages. Instead, they are forced to ask ontology experts for the extension and wait for the update of the underlying ontologies, which – in very dynamic domains – can even last until the ontology element has become obsolete again [10].

This led [8] to rethink ontology engineering as a collaborative and work-integrated activity. In this view, users themselves (within, e.g., communities of practice) can modify the underlying ontology of a semantic application, e.g., add new ontology elements or modify existing ones. This new perspective, motivated by constructivist views of learning (see also [11]), views the quality of an ontology within the context of a semantic application as a balance of three different aspects: appropriateness, social agreement and formality [8].

An ontology needs to be an *appropriate* representation of the domain with respect to the purpose of the ontologies required for a semantic application so that it is actually useful. That means, we need a quick, simple and work-integrated way to adapt and modify the ontologies. The aspect of *social agreement* requires that an ontology is a shared understanding of a given domain among all stakeholders. Therefore, the involved individuals deepen by and by their understanding of the real world and of an (appropriate) vocabulary to describe it. The development of an ontology underlies a process of continuous evolution where different levels of *formality* might co-exist within one ontology. The outcome is an adequate level of formality in the ontology, avoiding both overformalisation and the inability to apply semantic algorithms. This balance comes up in a continuous social learning process tightly coupled with the usage processes of the ontology.

The ontology maturing process model operationalizes this view and structures the ontology development process into four phases. Starting with simple tags, each user shall contribute to the collaborative development of ontologies. Thus, each community member can contribute new ideas (tags) emerging from the usage to the development of ontologies (phase I "*Emergence of Ideas*"). The community picks them up, consolidates, and refines them (phase II "*Consolidation in Communities*") and formalizes with semantic relations towards lightweight ontologies (phase III "*Formalization*") or even adds axioms (maybe with support of knowledge engineers) for improving inferencing processes (phase IV "*Axiomatization*"). In this way the users themselves can directly execute changes if needed. The time and cost-consuming separation of ontology creation and usage is overcome.

The SOBOLEO tool (below) realizes this ontology maturing process model by offering an easy-to-use interface (to allow the usage of semantic technologies also for "ordinary" people) and ontology development integrated into the actual usage processes; i.e. the semantic annotation and retrieval of web resources.

3.1. SOBOLEO

SOBOLEO [12] is a web-based tool that supports people working in a certain domain in the collaborative development of a shared index of relevant web resources (bookmarks) and of a shared ontology that is used to organize the bookmarks. That means, collected bookmarks can be annotated with concepts from the ontology and the ontology can be changed permanently and easily at the same time it is used.

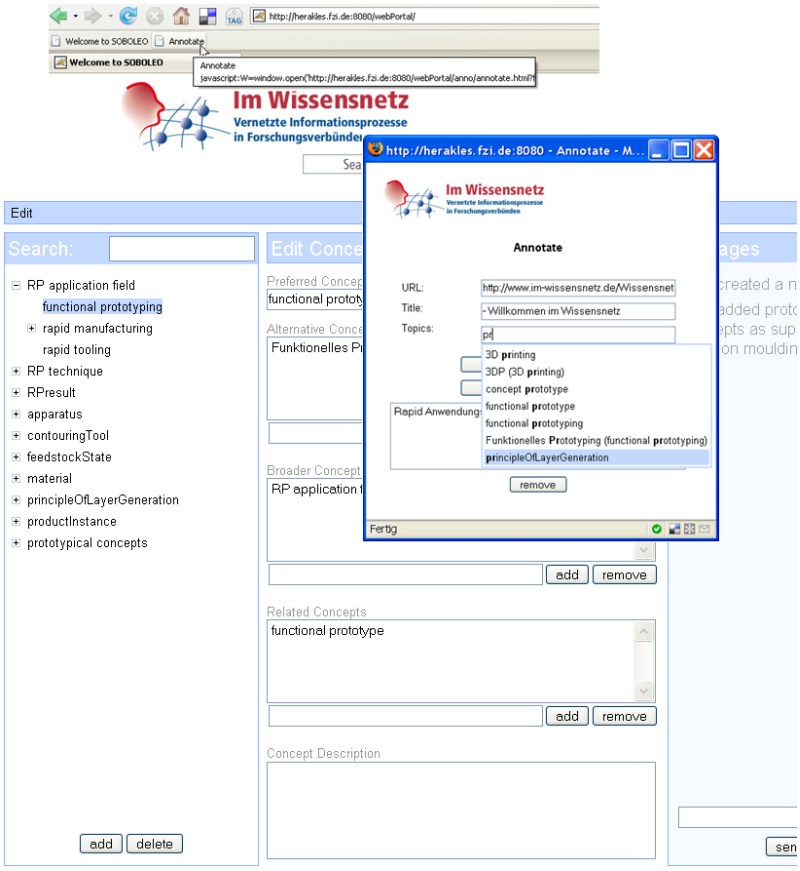

Fig. 1. SOBOLEO – annotation and collaborative ontology editor

SOBOLEO (see Fig. 1) consists of four major parts: (1) a collaborative real time editor for changing the shared ontology, (2) a tool for the annotation of web resources, (3) a semantic search engine for the annotated web resources, and (4) an ontology browser for navigating the ontology and the index of the web resources. Thus, the users can create, extend and maintain ontologies according to the SKOS Core Vocabulary [13] in a simple way together with the collection and sharing of

relevant bookmarks. If they encounter a web resource, they can add it to the bookmark index and annotate it with concepts from the SKOS ontology for better later retrieval. If a needed concept does not exist in the underlying ontology or is not suitable, the users can modify an existing concept or use arbitrary tags, which are automatically added to the ontology.

In this way, new concept ideas are seamlessly gathered when occurring and existing ones are refined or corrected. The users can structure the concepts with hierarchical relations (broader and narrower) or indicate that they are "related". These relations are also considered by the semantic search engine. That means, the users can improve the retrieval of their annotated web resources by adding and refining ontology structures.

So, whilst the role for and value of SOBOLEO is clearly argued above, it seems important and enticing to ask whether the introduction of a specially designed dialogue will improve the way in which its ontologies are developed, refined, shared, used and generally understood. Or similarly, can we support specialised dialogues that promote the phases of knowledge maturing described above? And along similar lines, can we introduce learning dialogues to support collaborative and social learning around ontology development and use? With this in mind we consider work into digital dialogue games that is described below.

4. Learning Dialogues, Dialogue Games and Interloc

Our current dialogue game technology - InterLoc3 [6] embodies the pressing need to reconcile learners developing digital literacies and practices with the well-established requirements for reasoned and purposeful learning dialogues, such as those supporting critical and creative thinking. In brief, InterLoc3 is an attractive, inclusive and pedagogically derived web-technology that is easily deployed and used to address relatively generic learning problems and opportunities.

Essentially, these dialogue games realise engaging and structured rule-based interactions that are performed using pre-defined dialogue features (such as dialogue moves and a model of turn-taking) that are specifically designed to foster thinking and learning in ways that are popular with users [4]. Some of the key features of InterLoc are elaborated below.

The interface in Figure 2 shows how each player participates in the dialogue game to produce a balanced, thoughtful, coherent and yet critical dialogue (about DNA testing in this case)**.** It models natural dialogue through allowing players to either Contribute to the current state of the developing dialogue through selecting "Make Contribution" or Replying to a specific previous contribution by selecting "Reply". Contributing to the dialogue places a response at the bottom of the display and Replying indents the responses below the specific contribution that is replied to - in a threaded way. This visual idiom contains affordances that achieve a balance of 'keeping the dialogue moving forward' whilst allowing reflective asides and specific responses to previous contributions. All contributions or replies are made

using these Move categories (Inform, Question, Challenge, etc.) and scaffolded through using specific Locution Openers ("I think…", "I disagree because…", "Let me elaborate…" etc.) that have to be used to perform the dialogue. Similarly, rules about the legitimate and logical responding openers, based on the specific openers that are replied to, are offered selectively - but these can be overridden to select the full range of options through selecting "More". For example Figure 2 shows a player called Seb[1] deciding to access the full range of moves and openers through selecting "More" instead of using "Because…" - which is the prompted response to the "Please give a reason…" opener.

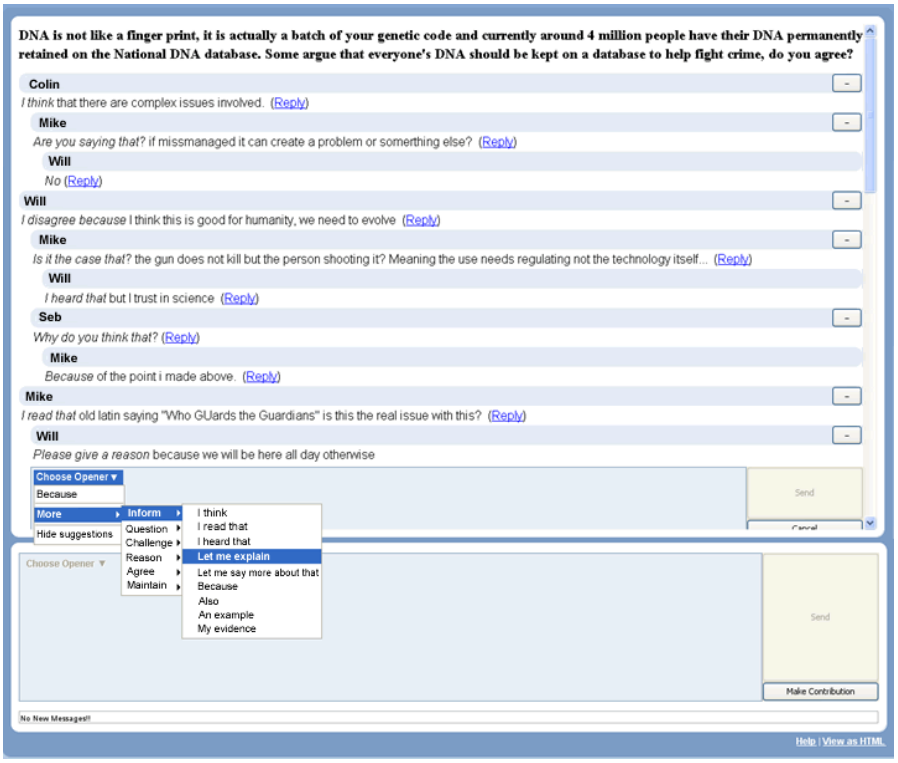

Figure 2. InterLoc3: Supporting balanced, thoughtful, coherent and yet critical dialogue

A model of turn-taking is also incorporated to ensure that the dialogues support: 'listening' to others contributions; fairly balanced patterns of contribution; and, generally, the sort of coherent sequencing that results in reasoned discourses.

An important point about the dialogue game approach is that all the textual contents contained in the Menus (i.e Move categories and specific locution openers) that realise the games are read in from xml files and so can be easily edited and

[1] Note that the actual names have been anonymised but the gender retained.

amended, to provide refined or completely new games. Ongoing work with early adopters is making this process even easier, through the development of a dialogue game-editing tool, which means that it would be possible to develop a knowledge maturing dialogue game (or KM-DG), or number of games, linked to ontology development and use through linking with, or 'mashing up' with a technology such as SOBOLEO.

5. Towards a Mashup: Dialogues for Ontology Creation, Clarification and Negotiation

We now consider the benefits of 'mashing up' the ontology development and learning dialogue tools to investigate learning as knowledge maturing. Also as evaluation results have shown [8], more specifically, it would be useful to have an alternative way – through dialogue - to populate, clarify and refine the ontologies that are produced. Additionally, dimensions such as Appropriateness, Social Agreement and Formality could be negotiated, and therefore also better understood through suitably designed dialogue games. Practically, this could be achieved through replacing or supplementing the Chat component of SOBOLEO with a specially designed dialogue game, or number of games, for Ontology maturing – where we could stimulate users to have a dialogue with and about the developing ontologies to specify, clarify and refine the semantic features or degrees of certainty about their classification. This could be achieved through specifying the pre-defined Moves and Openers of the dialogue game in terms of the semantic relations and classifications that are implicit in SOBOLEO or provided through the dialogue of a user community. In brief – both individual users and the community could have a dialogue with and about the ontology, to construct more understandable and meaningful representations. Allowing the community to engage in collaborative dialogues about the ontologies in this sort of way, should catalyse knowledge maturing and social learning in relation to the domain and the users who are continuously developing their understanding of it. In other words, having a structured dialogue about the development and use of the ontology should actually help to 'bring it to life' and make it more useful.

6. A Proof-of-Concept Scenario based on the use of Labour Market Information (LMI) in Careers Guidance Practice

In this section we consider how such a mashup, of ontology development and dialogue technologies, could be applied within a concrete knowledge maturing context. This is focussed on how Connexions Personal Advisers (P.A.s) located in one region of England use Labour Market Information (LMI) to advise young people. Connexions companies in England provide a range of services to young people aged 13 to 19, including careers guidance. The particular example used here is based on a fictional scenario that was developed by the Institute for Employment Research at the University of Warwick in conjunction with Connexions Kent. Specifically, it is based on how a P.A. might work with a young female interested in becoming a plumber. In this situation the P.A. would need to perform a number of

knowledge maturing processes to research and mediate the LMI in a meaningful way for the young female. Namely, this would involve: 1. Aggregating and scaffolding; 2. Manipulating; 3. Analysing; 4. Storing; 5. Reflecting; 6. Presenting; 7 Representing; 8. Sharing; and, 9. Networking with other people. So below we make an initial attempt to summarise how the proposed mashup might assist with these processes. But to begin with it might be useful to sketch a conceptual overview of how this might work. Essentially, the P.A. is constructing a knowledge representation, or domain model, through continuous on-task activities (such as book marking through SOBOLEO) and through performing a dialogue with and about the developing ontology and its instantiation with LMI. This 'engine' of a (continuously developing) knowledge representation plus various dialogue facilities can then support a range of features associated with the development and application of the knowledge for advising and problem solving. These features could be productively operationalised along the lines below.

Firstly, whilst they are researching suitable LMI, the P.A. could use a SOBOLEO type application to construct an ontology relevant to their situation and context in a continuous and embedded way, that is relevant to their particular domain (i.e. advising a female about becoming a plumber). This could be assisted through using location-based information to automatically direct the P.A.s search for LMI that is relevant to their locality. So in the first instance the P.A. could simply bookmark the resources without saying anything more specific about their nature or relationship to one another (i.e. simply 'collect' LMI resources). Secondly, the P.A. will need to organise their information in a way that is meaningful to them, so they could perform a knowledge maturing dialogue game to create a more semantically rich and organised ontology through introducing categories and relations, such as "is similar to", "is an example of", "an exception is", etc., to produce a personalised and semantically enhanced organisation of the LMI they have collected. They may even want to model 'dialectical' relations, such as contradictions, inconsistencies and uncertainties. And through performing a knowledge maturing dialogue game to externalise these features and aspects they should be able to develop a better understanding, or informally learn, about the domain they are constructing (so these two processes are similar to maturing phase I). Thirdly, they may then want to collaboratively refine the ontology they have acquired and refined through dialogue games with colleagues, to produce a further refined and negotiated ontology, and in the process, again, they are likely to informally learn through these collaborative dialogues. So fourthly, they could then move to knowledge maturing processes that build on the existence of what is, now, more of an organisational or community ontology. This might involve other members of the organisation using the same technology to further develop, inspect and refine the ontology (so these third and fourth processes are similar to maturing phase II). Fifthly, once a relatively mature, negotiated and formal ontology has been produced (which is similar maturing phase III), it could then be compared with those produced for related knowledge domains, such as related parts of the Construction Industry in this case. These could then be shared with other P.A.s in other areas of the country who are also working with individuals expressing similar interests, or may want to learn about successful outcomes from advisory sessions elsewhere. Indeed, locally produced ontologies

could serve as case studies that could enable the proliferation and re-use of similar knowledge maturing processes across the country. Sixthly, matured ontologies could provide visualisations, descriptions or dialogues that are tailored to different audiences, to accommodate different views on the same knowledge maturing processes and structures, such as the viewpoints of the clients of the P.A.s.

So, to summarise the above, through combining a flexible ontology development and learning dialogue technology, a range of knowledge maturing services could be provided that include: 1. knowledge acquisition; 2. personal knowledge refinement; 3. collaborative knowledge refinement and negotiation of meaning; 4. informal learning; 5. collaborative learning; 6. support for advising and problem solving; 7. reflection and meta-cognition about the domain and its application; 8. re-representing domain knowledge for different audiences and purposes. Or summarising all this, arguably, having the potential continuously to develop a personal and community Ontology combined with the means to have a specialised and scaffolded dialogue about it, will potentially make the domain more understandable and the application of the ontology more powerful.

7. Summary and 'going mobile'

The work proposed in this paper is in progress and necessitating the next stage of actually developing the mashup and testing it in a suitable application area, and would clearly benefit from further investigation and mapping of the knowledge maturing phases (e.g. exemplified by SOBOLEO) against practical examples of 'knowledge practices' and how the inclusion of dialogue refines our understanding of these phases. However another key dimension that will potentially be important to such a study is the need to 'go mobile' and the implications this has for context. In the scenario referred to above, this was represented as 'sharing', depending on the precise circumstances of the context in which the P.A. was working. It would typically involve sharing new knowledge and understanding with other practitioners operating in different contexts or possibly 'mobile learner-generated contexts' [14]. And, as various people have pointed out ([4] [14] [15] [16]) contexts are often emergent and not predetermined in events, and understanding and learning from these 'active contexts' will also inevitably benefit from dialogue. So interpersonal activities such as a community interacting (via InterLoc) to refine ontology concepts and relationships (in SOBOLEO) could also be conceived as activities within learner-generated contexts. In considering ubiquitous connectivity through mobile devices, we would draw on distributed information in our actions on the world as well as processes of knowledge building and meaning-making of the world.

So, to summarise, within our proposed design study we have the aim of harmonising key aspects of ontology development, learning dialogue and potentially m-learning to investigate key aspects of learning as knowledge maturing.

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References

1. Design-based research collective (2002). Design-Based Research: An Emerging Paradigm for Educational Inquiry, *Educational Researcher*, Vol 32, No. 1, pp 5-8
2. Ravenscroft, A. & McAlister, S. (2006). Digital Games and Learning in Cyberspace: A Dialogical Approach, *E-Learning* Journal, Vol. 3, No 1, pp 38-51
3. Ravenscroft, A. & Pilkington, R.M. (2000). Investigation by Design: Developing Dialogue Models to Support Reasoning and Conceptual Change, *International Journal of Artificial Intelligence in Education*, Vol. 11, Part 1, pp. 273-298
4. Cook, J. and Oliver, M. (2002). Designing a Toolkit to Support Dialogue in Learning. *Computers and Education*, 38 (1-3), 151–164
5. Ravenscroft, A. (2007). Promoting Thinking and Conceptual Change with Digital Dialogue Games, *Journal of Computer Assisted Learning (JCAL)*, Vol. 23, No 6, pp 453-465
6. Ravenscroft, A. & McAlister, S. (2008). Investigating and promoting educational argumentation: towards new digital practices, *International Journal of Research and Method in Education (IJRME)*. (In Press)
7. Ravenscroft, A., Sagar, M., Baur, E & Oriogun. P (2008). Ambient pedagogies, meaningful learning and social software. Hatzipanagos, S. & Warburton, S. (2008), (Eds.), *Social Software & Developing Community Ontologies*, IGI Global Publishing. (In Press)
8. Braun, S., Schmidt, A., Walter, A., Zacharias, V. (2007). The Ontology Maturing Approach to Collaborative and Work Integrated Ontology Development: Evaluation Results and Future Directions. In: L. Chen, P. Cudré-Mauroux , P. Haase, A. Hotho & E. Ong (eds.): Emergent Semantics and Ontology Evolution 2007. Proceedings of the First International Workshop on Emergent Semantics and Ontology Evolution (ESOE-2007), ISWC 2007, Busan, Korea, November 12, 2007. CEUR Workshop Proceedings vol. 292, 2007, pp. 5-18
9. Braun, S., Schmidt, A., Walter, A., Nagypal, G., Zacharias, V. (2007). Ontology maturing: a collaborative web 2.0 approach to ontology engineering. In: Proceedings of the Workshop on Social and Collaborative Construction of Structured Knowledge at the 16th International World Wide Web Conference (WWW 07), Banff, Canada. (2007)
10. Hepp, M. (2007). Possible ontologies: How reality constraints building relevant ontologies. IEEE Internet Computing 11 (2007) 90–96
11. Allert, H., Markannen, H., Richter, C.(2006). Rethinking the Use of Ontologies in Learning. In Memmel, M., Burgos, D., eds.: Proceedings of the 2nd International Workshop on Learner-Oriented Knowledge Management and KM-Oriented Learning (LOKMOL 06), in conjunction with the First European Conference on Technology-Enhanced Learning (ECTEL 06). (2006) 115–125
12. Zacharias, V., Braun, S. (2007). Soboleo: Social bookmarking and lighweight engineering of ontologies. In: Proceedings of the Workshop on Social and Collaborative Construction of Structured Knowledge at 16th International World Wide Web Conference (WWW2007)
13. Brickley, D., Miles, A.: SKOS Core Vocabulary Specification. W3C working draft, W3C (2005)
14. Cook, J. (2007) 'Smells Like Teen Spirit: Generation CX'. *Ideas in Cyberspace Education (ICE3)*, 21-23 March, Loch Lomond, Scotland. Available at: http://www.education.ed.ac.uk/ice3/papers/cook.html (Accessed 9 April 2008)

15. Cook, J., Bradley, C., Lance, J., Smith, C. and Haynes, R. (2007). Generating Learning Contexts with Mobile Devices. In Norbert Pachler (Ed.), *Mobile Learning: Towards a Research Agenda*, WLE Occasional Papers in Work-Based Learning 1, London. Download from: www.wlecentre.ac.uk/cms/files/occasionalpapers/mobilelearning_pachler2007.pdf
16. Dourish, P. (2004) 'What we talk about when we talk about context.' In *Personal and Ubiquitous Computing 8(1)*, pp. 19-30