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*Collaborative Learning in a Wiki Environment:
Experiences from a Software Engineering Course*

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Abstract

The post-graduate course, Software Requirements for Business Systems, in the Department of Computing of the Open University (OU) is one of the early adopters of OU's Virtual Learning Environment. The course involves teaching systematic elicitation and documentation of requirements of software systems. On a software development project, team members often work remotely from one another and increasingly use wikis to collaboratively develop the requirements specification. In order to emulate requirements engineering practice, the course has been enhanced to include group collaboration using a wiki. In this paper, we describe the wiki-based collaborative activities and the on-going evaluation of the pedagogical effectiveness of a wiki for collaborative learning.

Introduction

The Open University (OU) in the UK has around 200,000 adult distance learners who study part-time. Traditionally, the university has put in place pedagogy primarily based on the independent learner. It has long been recognised that this needs to be supported by a social constructivist pedagogical model (Laurillard, 2002) which includes problem solving in a collaborative environment that requires students to enact knowledge through a process of shared understanding. The OU has always provided face-to-face tutorials, day schools and residential schools but their take-up by students has been declining as other activities compete for students' time. In a wider context, Bruns and Humphreys (2005) also suggest that the pedagogical models need to be changed from the traditional linear learning paradigms to social constructivism.

There are three main characteristics built into social constructivist scenarios: they use complex and realistic problems; they use group collaboration, interaction and cooperation; and learners are responsible and set goals, while teachers provide guidance (from Merriënboer and Pass, 2003, quoted in Schneider *et al.*, 2003). Social software tools such as wikis enable the generation of social constructivist scenarios wherein a group of learners collaboratively construct shared artefacts, create a culture of dialogue, and negotiate meanings.

The OU has embarked on an €7.5m programme to develop an integrated virtual learning environment (VLE) and has adopted the open source VLE, Moodle (www.moodle.org) as its basis. Moodle is now undergoing extensive development to provide the functionality to support social constructivism and course teams are looking for ways to exploit this functionality. In this paper we shall examine how one course team has embraced the new technology, in particular the wiki, and the lessons that have been learned.

A wiki is a collaborative authoring environment – a readable and writeable website in which potentially all the visitors to the site can create new pages or modify existing ones, with optional access control to set limits on authorship. Wikis excel at collaboration and are “*designed to facilitate exchange of information within and between teams*” (Goodnoe, 2006), making them ideal for corporate and educational teamwork. Wikis allow distributed teams to write and edit documents collaboratively through the Internet in a shared online workspace. Educators are realising the potential of wikis in learning and teaching, particularly for collaborative authoring (Bruns & Humphreys, 2005).

Leadbeater (2000) states that “*knowledge sharing and creation is at the heart of innovation in all fields...knowledge cannot be transferred; it can only be enacted, through a process of*

understanding, through which people interpret information and make judgements on the basis of it...Great tides of information wash over us every day. We do not need more information, we need more understanding". Learners build on their knowledge by interacting with each other, their educators and learning materials. This learning process requires social interaction that can foster a shared sense of belonging and purpose. Therefore, at the OU, the academics are working towards integrating activities in courses that develop students' abilities to be creative and to generate knowledge and shared understanding in a collaborative networked environment.

The post-graduate course, Software Requirements for Business Systems, in the Department of Computing of the OU has been one of the early adopters of the VLE. The course involves teaching systematic elicitation, recording, and communication of requirements of software systems. On a software development project, the elicitation of requirements is generally carried out by a team of requirements engineers or system analysts. In software enterprises, requirements engineers often work remotely from one another and wikis are increasingly being used for collaboratively developing requirements specification documents (Farrell, 2006).

The course provides students with the opportunity to engage in small group collaboration in order to emulate Requirement Engineering (RE) practice, thereby providing them with transferable skills for working with community tools in the industry. Further, it is intended that the wiki activities should help facilitate learning and acquisition of skills through the creation of explicit knowledge from tacit understanding, learning through discussion, disagreement and consensus building, effective communication of ideas to others through networked knowledge environments; and articulation, analysis and synthesis of ideas and knowledge-sharing.

In the remainder of this paper we describe how the collaborative activities around a wiki fit within the pedagogy of the course. We discuss the planning, implementation and assessment strategy of wiki activities on the course. We discuss how the five-stage framework for e-groups (Jaques and Salmon, 2007) has guided the design and implementation of the collaborative activities. We examine some of the social, technical and pedagogical issues that have arisen so far. Finally, we describe our on-going evaluations of the wiki-based collaborative activities.

Collaborative Requirements Development in a wiki environment

Eliciting, recording and communicating requirements are key sub-processes during the design and development of software applications, products/services, or business systems. That is, the developers need to know what the different stakeholders want from the system. RE involves determining the stakeholders' requirements and presenting them to the developers in a document known as a requirements specification.

The post-graduate course, Software Requirements for Business Systems, aims to provide students with RE skills including elicitation, validation, and communication of requirements. This involves teaching skills such as: interacting with stakeholders who will have different needs and requirements, resolving conflicts and ambiguities in the requirements, and dealing with the varying perspectives and views of different requirements engineers in a project-team. The removal of conflicts and ambiguity from a set of requirements is generally performed by a small group of requirements engineers who discuss and reformulate the requirements, in consultation with the stakeholders. Our aim of introducing collaborative activities in a wiki environment on the course has been to emulate an experience in which a group of students can discuss a set of requirements, identify conflicts and ambiguities within the requirements, and resolve the conflicts through discussions from perspectives of different stakeholders, and produce an unambiguous requirements specification.

The RE course has two presentations every year: May to October, and November to April. The collaborative activities in a wiki environment (Moodle's wiki) have been implemented in the November 2006 presentation. The assessment on the course involves three tutor-marked assignments (TMAs) and an examination at the end of the presentation. There are around 140 students in every presentation. Each student is allocated a tutor and each tutor-group has a maximum of 18 students. We have divided each tutor group in student-groups of four to six students (big enough to cater for the inevitable drop-out and small enough to be manageable and effective). Collaborative activities, of varying complexity, to be carried out by the student groups are included in each TMA.

Technical challenges

The first challenge to incorporating the wiki into the course was to understand Moodle's implementation of this tool. It became evident to us (the course team) that the existing Moodle wiki would not meet our needs. The main issue was the absence of a locking mechanism to prevent concurrent updates. That is, if two people tried to edit the same wiki page at once, conflicts would occur. The software developers modified Moodle's wiki so that a particular wiki page on which a student (in a particular student-group) is currently working would be locked for usage by other students in that student-group, and only tutors could override the lock.

Another challenge, typical when adopting a new technology, involved the administration of groups. As a VLE, Moodle (and its wiki in particular) is based on a pedagogy which uses a model of teaching and learning that is not directly applicable to the model used at the OU. This means that we had very little experience to work with when setting up our small sub-group wikis since Moodle's wiki is based primarily on course-wide use. Hence, a scheme for individual access rights had to be developed, which took more time than we had planned for.

Assessment strategy

Courses at the OU are developed in response to a set of learning outcomes which are specific, measurable statements about the learning students should attain as the result of studying the course. Typically, learning outcomes are classified as knowledge and understanding, cognitive skills, and practical/professional skills, and our course includes examples in each category. The assessment on the course is then designed around testing the learning outcomes. This involves both continuous assessment (three Tutor Marked Assignments - TMAs) and an end-of-course examination. Our aim has been to develop specific understanding and skills progressively through the course by increasing the levels of knowledge and skills from one TMA to the next.

The three TMAs on the course involve students developing a requirements specification for a system that is included as a case study in the TMAs. The introduction of collaborative working into a course originally designed for independent study required careful integration on our part, in particular in terms of additional work and avoiding 'over-assessment'. Our aim was to provide a collaborative experience that would convince students of the utility of collaborative requirements development, that online collaborative authoring is effective and provides an enhanced learning experience resulting in improved learning. We needed to design a meaningful set of activities that all students would experience while being wary of increasing the work load. This meant revising the assessment strategy.

Our first task was to review the assessment strategy and the learning outcomes to determine where collaborative activities could best be incorporated. It became clear that those parts of the assessment dealing with understanding and practical skills could be divided into two groups: those questions best done independently and those that would benefit from group discussion. In particular, the analysis of requirements to find out conflicts, ambiguities and dependencies between requirements from the perspectives of different stakeholders would be ideal for collaborative activities. In RE practice, it is common for requirements engineers to

come together to discuss and analyse the elicited requirements from the perspective of different stakeholders (Farrell, 2006). Therefore, the wiki activities involve collaborative development of the requirements specification for the case study in the TMAs.

As per the OU's distance-teaching model, our students on this course are supported by tutors, each with a group of 18 students. The tutor is responsible for supporting the students by marking the TMAs, regularly interacting with the students and addressing their queries and concerns throughout the course. Since we decided to introduce wikis on a course that was already running, we wanted to avoid significantly increasing the tutors' workload. Therefore, we designed the wiki activities in a way which, we hoped, would be self-managed by the students and requiring minimal or no intervention by the tutor. We applied the five-stage model proposed by Salmon (2002, 2004) as a guiding framework while we were designing the wiki activities for the TMAs. We also took note of work on the role of e-moderators in asynchronous conferencing (Keirnan *et al.*, 2003) where the four e-moderator roles are related to the Salmon 5-stage model to ensure that the appropriate intellectual, social, organisational and technical roles were adequately covered. In more recent work on non-moderated asynchronous conferencing, Keirnan (*personal communication*) has shown that the same roles must be present but are played by individuals within the group. We also took into account the experiences of a distance-taught course on team working in a distributed environment at the OU based on Tuckman's model of team working (Tuckman & Jenson, 1977).

The Five-stage Model of teaching and learning through online networking

The five-stage model (Figure 1) shows how participants in an e-learning environment can benefit from working, networking and learning online, and what e-moderators need to do at each stage to help them to achieve this success. The model shows how to motivate online participants, to build learning through appropriate on-line activities and by support from the e-moderator. Since we weren't expecting our tutors to perform the role of e-moderators on the wiki activities, we (course team members) decided that we would indirectly support our students via: comprehensive guidance notes on the wiki activities, regular e-mails of encouragement and addressing any queries that the students raise with their tutors or on the course discussion-forum or in their e-mails to the course manager.

Introducing wikis to students

In the first TMA and in the first month of the course leading to the first TMA, we planned activities in a way so as to take students through the *first two steps* of the model in *Figure 1*.

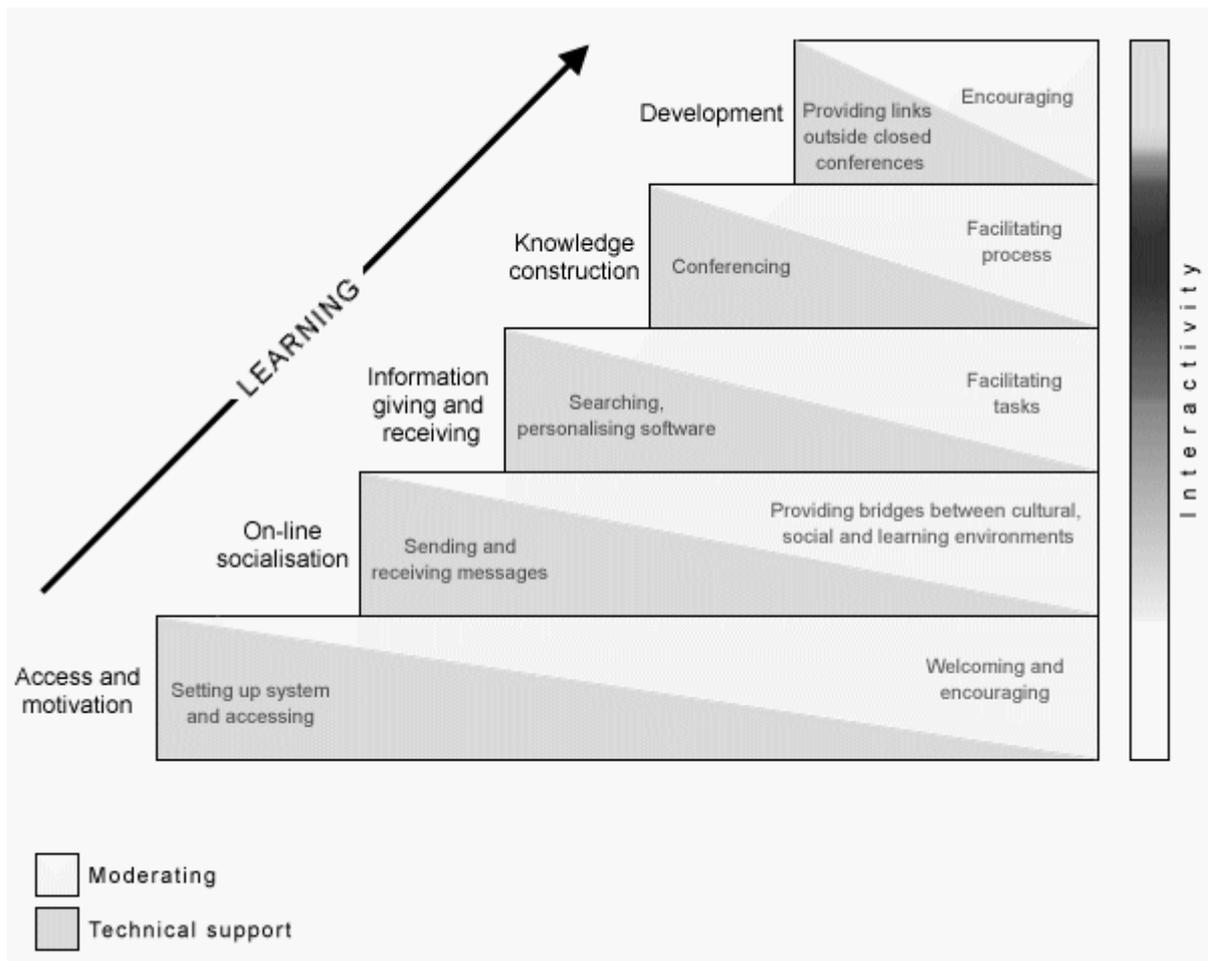


Figure 1 The five-step model (from Jaques and Salmon, 2007, p. 43)

Though the OU is a distance learning organisation, there are two opportunities during each presentation for staff to meet students face-to-face (but both are optional activities and not all students attend): in an introductory tutorial at the start of the course and in a three-day residential revision school just before the exam. During the first presentation of the course at the residential school, informal enquiries with students indicated that they were either unaware of blogs and wikis or had not encountered them in learning environments. We realised that there was a need to design activities and resources that would help in familiarising them with a wiki environment. So we decided that students would have an introductory paper on wikis to read and analyse as part of their first TMA. A literature search was performed on the following criteria: the paper should be an introductory text on wikis; the paper should focus on how wikis are being used in organisations; and the paper should give some idea on how wikis can be applied in software development (to cover both course specific and transferable skills). We short-listed three papers and after an e-mail discussion of each of the papers, we chose the paper by Farrell (2006).

We suggested that the students read Farrell's paper as a part of the first TMA but we also placed many other introductory papers and web links related to wikis on the course website to enable our students to familiarise themselves with wikis as collaborative authoring tools and specifically on the role of wikis in software engineering, RE, and project management applications. It was important for us to convey to the students that the wiki activities fit within the pedagogy of the course, otherwise the wiki would have been perceived as yet another online tool that added to the workload on the course. The students were pointed to these resources on the course website early on in the course and before the first TMA. In addition, students were provided with guidelines for using the Moodle wiki and conducting

the collaborative activities in the wiki, rules of collaboration on the course, wiki-etiquette, role of each student in a student-group, and so on.

Next, as part of the first TMA, the students were asked to participate in their individual groups in an ice-breaker activity. Most of our students generally study on their own and there are no formally constituted meetings (tutorials) as part of the course. Students have the opportunity to 'meet' via a mediated computer conference (forum) for the course but as this is optional, only a small percentage of students use the facility to introduce themselves at the start the course, or for interactions or discussions during the course. Therefore, we realised that it would be essential to have an ice-breaker session before the actual collaboration activity which would enable the students to get to know one another.

The ice-breaker activity has two objectives: students are able to familiarise themselves with the wiki environment and the activity gives them an opportunity to introduce themselves to their fellow group members. Each student is asked to do two tasks in this ice-breaker session: add a small biography to the wiki; and enter a stakeholder type from a list of stakeholders in the case study. The exercise involves very little collaboration in the sense that little negotiation is required. Care was taken to ensure that there would be no advantage or disadvantage in choosing one stakeholder type rather than another. The choice of stakeholder type is actually a preparation for the second TMA where each student is asked to discuss the requirements for the system in the case study from their chosen stakeholder's perspective. Students are advised to complete this ice-breaker activity a week before the TMA cut-off date. The evidence of their individual contributions can be included in their TMAs by copying and pasting the log from the 'History' section of the wiki (the 'History' function in the wiki records all the changes and contributions made to a page in a wiki); however, enhancements to the wiki tool are planned that will allow tutors to see the contribution levels of individual students.

Collaborative Requirements Engineering

The wiki activities in the second and third TMAs aim to provide practical experience of requirements development to emulate real-practice. The activities have been designed around key course concepts so that students can develop shared understanding and situated meanings via collaboration. Following the stage 3 of 'information exchange' in the model of *Figure 1*, the collaboration in these two TMAs involves students individually contributing requirements to the wiki and then discussing them to arrive at an agreed set of consolidated requirements.

The second TMA involves each student in a group adding three requirements to the wiki from the perspective of the stakeholder chosen in the first wiki activity. The aim here is to populate the wiki with a set of requirements from the perspectives of a variety of stakeholders so that the students (in their role as requirements engineers) can practise RE skills such as identifying conflicts in requirements or duplicates, and discussing the requirements to remove any ambiguities. Once all the students have entered their set of requirements, the collaboration involves discussing duplicates, conflicts, ambiguities and thereby achieving an agreed set of unambiguous requirements for the system in the case study. Students can also use the forum for discussion while performing this collaboration.

The collaborative activity in the third TMA involves each group checking the accuracy of the requirements developed in the second TMA and specifying a fit-criterion (a quantified measure) for each requirement. The development of suitable fit-criteria can be difficult if a requirements engineer is working on their own; better quality fit-criteria can be obtained by a group of requirements engineers working collaboratively. Hence, the wiki activity asks the students to agree on a set of fit-criteria for the requirements developed in the second wiki activity.

The marking is based on both the student's own contribution to the activity as well as on the product of the activity. A significant advantage of the wiki is that it records each and every change to the document which means that there is evidence of each student's contribution. In the TMAs, students are asked to report on their individual contribution to the collaborative activity, quoting evidence from the wiki which, of course, can be verified by the tutor. There is a sliding scale of marks given to an individual for the process and the product based on the level of their contribution supported by evidence from the wiki and student's own account.

Reflection during and after collaboration

In order to assess the effectiveness of the wiki activities in collaborative authoring of requirements and to elicit students' perceptions of their learning, we have asked students to reflect on their experiences before and after performing the collaborative activities in the wiki environment. Further, the students' reflections will also enable us to evaluate whether collaboration and on-line interactions have facilitated knowledge creation (stage 4 of *Figure 1*).

Reflection is a strategy that facilitates learning (Moon, 2002). Reflection is the re-examination and re-interpretation of experiences and is central to effective learning and development. Therefore, the students are asked the following question in the third TMA: *"Do you think that your understanding of the RE process has been enhanced by collaboration and do you think that collaborative authoring and discussion contributes to a better RE process (than would otherwise be the case)?"*

To help students get started, we provide a *reflection template* containing some 'trigger' questions or 'probes' to help them think about the various elements of the course as they work through them. The reflection is performed along three dimensions: on experience of using the wiki as a tool; personal views of the course and collaboration in particular; and the use of collaboration in RE. Students are asked to examine these three dimensions in each collaborative activity and to record their experiences. This can be done with any suitable tool (word-processor or even a paper-notebook) but we encourage students to use Moodle's Journal tool.

At the time of writing, the course is about half-way through its first presentation using the wiki. Initial analysis of the feedback from the reflective activity in the second TMA reveals that some students claim that the wiki activities and the reflection have helped their understanding of the course content. However, it is also clear that, in a distance learning environment in which the student expects to be an independent learner, having to collaborate with others is a best an inconvenience and at worst is a serious deterrent to study. If there are any problems with the wiki software, and we had some, this simply increases the level of dissatisfaction and frustration.

Research Challenges

During the planning and implementation of the wiki activities in the course, we have faced a number of pedagogical, social and technical challenges and have encountered a range of research issues. The main pedagogical challenge has been to design appropriate collaborative activities for the wiki environment that help to achieve some of the learning outcomes of the course, facilitate collaborative content creation, and foster discussion and communication. Another challenge has been management of stakeholder interactions: when and how to conduct interactions with a variety of stakeholders associated with the course. For example, students, tutors, course team and the external examiner are directly influenced by or concerned about the pedagogy and assessment of the course and need to be informed if a new e-learning tool or activity is being introduced. Since the VLE is under development at the OU, it has been important to communicate requirements and set priorities for the implementation and maintenance of the wiki in discussions with the VLE team, the programmers and the service delivery team (who support the wiki software). The nature of

communication or dialogue by students in a wiki environment is one of the several research issues that have emerged.

Types of Communication/Dialogue in the Wiki Environment

The type of communication or dialogue students produce can help to identify learning patterns in collaborative work. Hause *et al*, (2003) in a study of communication patterns between high and low performing remote teams, found that success was not based on the amount of communication produced but rather in the quality of communication or the end-product. Morrison and Dennis (2005) in their MetLab project investigated improvement of social grounding and mutual regulation for computer supported collaborative learning (CSCL) environments. They state that “[CSCL] environments promote and enhance the ability of learners to participate in knowledge building communities through synchronous and asynchronous collaborative communication and interaction”.

We are investigating whether the principles of CSCL are supported by a wiki environment. These principles are activity awareness, implicit and explicit communication, synergistically combining knowledge, differentiation of work, and establishment of group identity or sense of membership. We are also analysing the students’ contributions and discussions on the wiki to investigate the extent to which these principles are adhered to by the students and to understand the process of collaboration: what barriers exist, students’ perceptions of the potential audience, and how interacting online influences their reasoning and writing.

It has emerged that collaborating authors can face several tensions. For example, if collaborating authors are accustomed to the visual cues offered by Microsoft Word as they edit documents, the opaque nature of these activities in wiki editing might be unsettling. Encouraging autonomy and ownership to generate accountability and group cohesion are some of the social challenges in collaborative writing. Sometimes co-authors might have strongly opposing views which might result in a flood of repetitive changes on the wiki. Deletion amongst co-authors separated in time and space could be a major source of contention and discomfort. Collaborating authors also tend to set up decision-making and authoring roles: lead authors, editors, facilitators, readers, and so on. There are no rules that define these roles in a wiki and the social norms arise through shared practice and over a period of time. So it will be interesting to explore how these social norms and wiki etiquette arise.

Conclusions and Next steps

The introduction of collaborative activities into the existing RE course has proven to be an interesting exercise not least because group work was being added to a course originally based on the pedagogy of independent learning. We hope that the course in its current form will have contributed to enhanced learning via collaboration: learning through discussion; resolving disagreements; consensus building; communication and collaborations with stakeholders of different roles, perspectives and priorities; articulation of ideas; critical thinking and reflection. We do not have a formal mechanism to track the student’s development in their professional life after this course (stage 5 of the model in *Figure 1*) but we hope that the course will have given students the skills of not only interacting within a wiki environment but also of working in distributed teams in collaborative projects, working with off-shore teams on out-sourced projects which are common in software engineering projects. Further, the practice of reflection on this course, which is uncommon on professional computing courses (Hazzan, 2002), will contribute towards their development as reflective practitioners.

A variety of methods are being used to gather data to assess the following: the benefit of collaborative requirements development to students’ understanding and learning of the course concepts and the RE process; to evaluate the appropriateness of the wiki activities that

we have designed to support collaborative work; to evaluate the usability and functionality of the wiki tool to support collaboration; and to evaluate the effectiveness of wiki in collaborative requirements development. The data sources include: the reporting of the wiki activities in the TMAs of the students; comments or voluntary feedback by students to their tutors and on the discussion forum; students and tutors' comments during retrospective semi-structured interviews that we plan to conduct at the end of the presentation in April 2007; the discussion and related outputs of the collaborative activities in individual sub-wikis of the course; and account of students' reflections in the three TMAs and particularly in the third one. Addressing the research issues outlined above, issues uncovered through our own reflections, the on-going evaluation of the pedagogical effectiveness of incorporating a wiki on this RE course will continue until May 2007. Evidence from different sources will be triangulated and the qualitative inductive analysis of the data will be performed by employing the methodology of interpretative phenomenological analysis. We will be reporting the results of our research in a future publication.

References

- Bruns, A. and Humphreys, S. (2005) Wikis in Teaching and Assessment: The M/Cyclopedia Project. *Proceedings of WikiSym '05*, ACM Press, 25-32.
- Farrell, J. (2006) Wikis, Blogs and other Community Tools in the Enterprise. Available from: <http://www-128.ibm.com/developerworks/library/wa-wikiapps.html> [last accessed 22/02/07].
- Goodnoe, E. (2005) *How to Use Wikis for Business*. InternetWeek. Available from <http://www.informationweek.com/story/showArticle.jhtml?articleID=167600331> [last accessed 21/02/07].
- Hause, M.L., Petre, M. and Woodroffe, M. (2003) Performance in International Computer Science Collaboration Between Distributed Student Teams. *Presented at the 33rd ASEE/IEEE Frontiers in Education Conference*, IEEE.
- Hazzan, O. (2002) The reflective practitioner perspective in software engineering education. *Journal of Systems and Software* **63**, 3, 161-171.
- Jaques, D. and Salmon, G., (2007) *Learning in Groups: A Handbook for face-to-face and online environments*. RoutledgeFalmer, London.
- Keirnan, M., Thomas, P, and Woodroffe, M. (2003) Signposts in the Sand: Key Issues for E-Moderators. *World Conference on E-Learning in Corp., Gov., Health & Higher Ed.*, 1647-1650.
- Keirnan, M. (2007) Findings from the analysis of conference messages for teams on the course 'Team Working in a Distributed Environment'. Private communication.
- Laurillard, D., (2002), *Rethinking University Education: a conversational framework for the effective use of learning technologies*. RoutledgeFalmer, London.
- Leadbeater, C. (2000) *Living on Thin Air*. Penguin, London.
- Mejias, U.A. (2005) Teaching Social Software with Social Software: A Report. *IDEANT*, http://ideant.typepad.com/ideant/2005/12/teaching_social.html [last accessed 02/02/07].
- Moon, J. (2002) PDP Working paper 4: Reflection in Higher Education Learning. Learning and Teaching Support Network Generic Centre <http://www.ltsn.ac.uk/genericcentre/projects/pdp/working-papers/> [last accessed 02/02/07].
- Morrison, D. and Dennis, B. Metlab, (2005) Supporting Social Grounding and Group Task Management in CSCL Environments through Social Translucence. *Presented at TAPIA'05*, ACM, 20-22.
- Salmon, G. (2002) *E-Tivities: The key to active online learning*, RoutledgeFalmer, London.

Salmon, G. (2004) *E-moderating: The key to teaching and learning online*, 2nd edn, RoutledgeFalmer, London.

Schneider, D. K., Synteta, P., Frete, C. and Girardin, S. (2003) Conception and implementation of rich pedagogical scenarios through collaborative portal sites: clear focus and fuzzy edges, *Presented at International Conference on Open and Online Learning*, University of Mauritius.

Tuckman B. E. and Jenson M. A. (1977) Stages of small group development revisited, *Group and Organisational Studies*, **2**, pp 419-27.