Active Learning in Computing: Using Social Media to Support Group Work in Higher Education

Thesis by

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To Kerry

&

My Mam and Dad

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Declaration

All work contained within this thesis represents the original contribution of the author. Conducted as part of the *Active Learning in Computing* project at *Newcastle University*, this study has given rise to a number of publications which are listed below. In particular, the material discussed in *Chapter 3* and *Chapter 4* has been published in [1], [2], [3], and [5]; a small part of *Chapter 5* was informed by the contents of [4]; and the findings discussed in *Chapter 6* first appeared summarised in [2].

[1] T. Charlton, M. Devlin, and S. Drummond, "Using Facebook to improve communication in undergraduate software development teams," *Computer Science Education*, vol. 19, no. 4, pp. 273-292, 2009.

[2] T. Charlton, M. Devlin, L. Marshall, and S. Drummond, "Encouraging interaction and status awareness in undergraduate software engineering projects: The role of social networking services," *IEEE EDUCON 2010 Conference*, pp. 179-184, 2010.

[3] T. Charlton, L. Marshall, and M. Devlin, "Evaluating the extent to which sociability and social presence affects learning performance," *ACM SIGCSE Bulletin*, vol. 40, no. 3, p. 342, 2008.

[4] T. Charlton, L. Marshall, and M. Devlin, "Creating Reusable Learning Objects For First Year Programming," in *10th Annual Conference of the Subject Centre for Information and Computer Sciences*, 2009, p. 80.

[5] A. Gorra, J. Finlay, M. Devlin, J. Lavery, R. Neagle, J. Sheridan-Ross, T. Charlton, R. Boyle, and J. Sheridan, "Learning With Technology: What do Students Want?," in *Proceeding of the 5th International Conference on e-Learning: Universiti Sains Malaysia, Penang, Malaysia, 12-13 July 2010*, 2010, p. 126.

Abstract

Active Learning in Computing was the first *Centre for Excellence in Teaching and Learning* project for Computing Science in England. Facilitating a shift towards far higher levels of active learner engagement in the HE computing curriculum, the project's primary objectives sought to enhance the student learning experience by placing a far greater emphasis on both industry-relevant group work and independent problem solving. As part of this initiative, Newcastle and Durham University partners extended their traditional team-based software engineering programmes to address the emerging commercial adoption of *Global Software Development* (a practice whereby virtual teams of distributed domain experts use ICT-mediated systems to work collaboratively across spatial, temporal and organisational boundaries). Running over the course of an entire academic year, participating undergraduate students were placed into "virtual companies" and encouraged to collaborate both locally and cross-site to create a variety of complex software solutions for real-world industrial clients. Supported by considerable investment in ICT infrastructure, this approach sought to generate active interaction between team members and foster the development of both interpersonal and vocational skills significant to the requirements of employers. However, despite the best efforts of the *Active Learning in Computing* team, students continually reported substantial difficulties interacting and communicating with their peers both locally and cross-site; this in turn led to frequent duplication of work and increased team member frustration and isolation.

Motivated by a desire to resolve these important issues, a new stream of research was established at Newcastle University to explore new, innovative and cost-effective ways to generate and maintain student interaction across all aspects of the group programming activity. Based upon the initial results of this work and an investigation into informal team communication strategies, an Internet-based Web 2.0 social application named *CommonGround* was developed and deployed on the Facebook platform. Conceived of as a means to reduce geographic and temporal barriers to student interaction and community formation, the tool combined project-centric planning facilities with *Facebook's* built-in communication affordances. By doing so, the tool helped to foster the generation of social capital and the inclusion of "peripheral" team members who often presented difficulties forming and maintaining offline relationships with their colleagues. Representing the main contribution of this

study, the results from a successful two-year trial of *CommonGround* are analysed and discussed along with an investigation into the tool's evolution and overall impact on student/team performance.

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Chapter 1

Introduction

1.1 Background and Problem Statement

Established in 2005, *Active Learning in Computing* was the first *Centre for Excellence in Teaching and Learning* project for Computing Science in England. Representing a five-year collaborative effort between a consortium of north-east HE institutions (Durham University, Newcastle University, the University of Leeds, and Leeds Metropolitan University), the initiative sought to enhance the undergraduate educational experience by facilitating a shift towards far higher levels of active learner engagement and autonomy in the computing curriculum. By aligning learning experiences and transferable skill sets with those required by the software engineering industry, the project aimed to address the emerging multi-site working practices of professional software development companies and, in turn, equip students with the technical and transferable skills required to work in this competitive environment. One way the *Active Learning in Computing* initiative aimed to achieve this was by extending Newcastle and Durham University's traditional level 2 software engineering team projects to include a realistic and multidisciplined cross-site group programming activity.

In emulation of industrial trends and practices, teams of students from both universities formed "virtual companies" and collaborated locally and cross-site to develop a wide range of fully-functional software products for genuine corporate clients (examples include a supply chain logistics program, a mobile GPS graphing application, and an educational game created using advanced robotic Lego toolkits). Running over the course of an entire academic year, student teams were required to independently and effectively self-manage all stages of the software development process, from liaising with clients and the encapsulation of design requirements through to task allocation and final product implementation. As well as providing participants with a genuine insight into the professional issues and challenges faced by companies competing in a global market, this approach encouraged active interaction and dialogue between student teams, thus helping participants develop strong, real-world problem solving skills significant to the needs of employers.

In order to succeed on-project, students needed to learn to use their time effectively and communicate with team mates regularly – both locally and cross-site. To support and encourage this collaboration, a wide variety of communication technologies were made available to teams ranging from virtual learning environments and advanced video-conferencing facilities to simple e-mail distribution lists, forums and wikis. Unfortunately, during the early years of the project, it became increasingly obvious that time and resource pressures were making it difficult for students to sustain effective levels of team engagement; beyond face-to-face meetings, the communication channels established by participants to maintain local and cross-site interaction often broke down. Unsurprisingly, such breakdowns led to duplication of work, increased frustration, and reduced team morale and cross-site relations. Moreover, a lack of team awareness and community spirit also occasionally led to the isolation of peripheral team members and to decreases in personal motivation that could potentially affect a student's final grade.

Driven by a desire to address these important issues, a new stream of research was established at Newcastle University in 2006 to study and mitigate the various communication problems experienced by participating students. This thesis describes the results of that work.

1.2 Overview of Study

In the years between 2005 and 2010 that the cross-site project took place, the *Active Learning in Computing* team at Newcastle University gained significant insights into distributed collaboration practices and, in particular, the aspects of group work that caused the most concern to students. Some of those areas, such as assessment, were able to improve year-on-year. Unfortunately, team communication issues presented much more of a challenge. Student feedback, gathered from questionnaires, individual reports and focus group interviews, frequently indicated substantial and long-term resistance to the collaborative technologies provided by each institution (despite considerable investment in dedicated ICT infrastructure and professional video-conferencing facilities). Significantly, in the early stages of the project (and with little regard for the orientation lectures designed to introduce students to the practical benefits of each facility), many teams attempted to use *all* of the communication devices and platforms provided rather than the subset that worked best. As a result, the sheer variety of unfamiliar technologies ultimately undermined student communication strategies and created the very problem that the *Active Learning in Computing* partnership sought to avoid (i.e. a breakdown in team interaction).

When the facilities offered by the partnership consistently failed to meet expectations, they were usually abandoned in favour of more familiar and convenient technologies. Voting with their feet, students began to autonomously incorporate freely available social networking technologies into their local and cross-site team communication strategies. Facebook in particular emerged as one of the primary collaborative tools for both informal and on-task interaction; it was convenient, familiar and already in frequent use. Indeed, as the *Active Learning in Computing* partnership progressed, the availability and usefulness of online social networking services – in addition to student ownership of Internet-enabled personal computing devices – increased considerably. Thus, the work presented in this thesis sought to better understand, leverage and exploit this emerging technology on-project.

1.2.1 Primary Contributions

In this thesis I explore the communication problems experienced by student teams participating in the *Active Learning in Computing* cross-site group programming activity. I document the various technologies autonomously adopted by students to overcome the issues encountered, and investigate how popular social networking technologies were used in both local and cross-site team communication strategies. Following on from this, I go on to discuss how these findings motivated the development of a "proof of concept" tool capable of harnessing and enhancing student engagement with the social networking service Facebook. Taking the form of a web-based application, this tool coupled the inherent communication and social awareness features of the Facebook platform (e.g. profile creation, synchronous and asynchronous chat, status updates, etc.) with project-related status, meeting, scheduling and planning facilities. Representing the main contribution of this study, I describe the design, development and implementation of the tool and analyse how its introduction was able to affect the outcome of the group project. In particular, I focus on how well the tool was able to generate and sustain team collaboration and enable the creation of *social capital* (i.e. the benefits gained through social connections that enable groups to effectively pursue shared objectives). I then go on to describe the impact of the tool on team performance and individual student grades, before finally making recommendations for future educational practitioners and researchers working in this area.

1.2.2 Motivation

To meet the broader objectives of the *Active Learning in Computing* initiative, partner institutions were given the remit to evaluate new pedagogic approaches and collaborative technologies capable of enhancing student engagement with the HE computing curriculum. It was this aspect of the partnership, coupled with student feedback lamenting the communication breakdowns experienced on-project, that initially motivated this study. The direction of the work that followed, however, was mainly influenced by the growing body of research emerging in the literature that demonstrated the instrumental role of social interaction and feelings of connection in the development of computer-mediated group performance. The rise and ubiquity of social networking services in the daily routines of students also greatly motivated the focus of this investigation, leading naturally to the development of a social tool capable of reducing the geographic and temporal barriers to team interaction. By filling the "communication void" that often arose between team student/team face-to-face encounters [6], this tool was designed to help users become increasingly aware of each others' skills, personalities, work rhythms and needs – both online and off – within a pre-existing, persistent, convenient infrastructure (with potential technology and educational implications extending beyond the scope of the academic remit of the *Active Learning in Computing* activity). Perhaps more importantly, this increase in social interaction would foster the inclusion of "peripheral" team members who often presented difficulties forming and maintaining offline relationships with their colleagues – a primary motivational factor of the work discussed.

1.3 Structure of Thesis

This thesis consists of nine chapters. Following this introductory discussion, *Chapter 2* provides a brief overview of background research and related work that will serve to place the remainder of the study in context. Where applicable, any similarities to my own work will be noted.

In *Chapter 3* I go on to discuss the *Active Learning in Computing* partnership in detail and provide a complete description of the aims and objectives of the collaboration. Following coverage of the intended learning outcomes of the cross-site group programming activity, I then explore the various software development tasks undertaken by student teams over the five year duration of the initiative. Touching on team formation and assessment techniques, I give an overview of facility provision at Newcastle and Durham University partner sites and, to explore the alternate channels through which students were able to communicate, also introduce and briefly describe the findings of a study into undergraduate technology ownership and Internet usage. The results of this investigation serve to ground the research that follows, providing a starting point from which I will explore the wider issues of local and cross-site team communication strategies.

In *Chapter 4* I provide an overview of the collaborative technologies selected by students for use in the cross-site group programming activity, and then discuss the resultant communication issues encountered. Data captured from content analyses and post-project surveys will show that the facilities provided by the *Active Learning in Computing* partnership ultimately failed to meet team communication needs and, consequently, forced students to seek alternative technologies. Of the technologies selected, the autonomous adoption of the social networking site Facebook will be discussed, including how teams adopted and integrated its social affordances into their team communication strategies.

In *Chapter 5* I report on the proposal and implementation of a Web 2.0 application named *CommonGround*. Designed to harness and support student use of Facebook on-project, an overview of the salient design requirements of the application will be given, followed by a detailed discussion of how those considerations informed the implementation of a "proof of concept" trial. A tour of the tool's feature set is also provided followed by a brief discussion of how the application performed in practice.

To determine the viability and "sociability" of *CommonGround*, and thus determine its effectiveness at generating student/team social capital, *Chapter 6* will go on to summarise and assess an initial experimental trial of the application conducted during the 2008/09 academic year. In addition, I will investigate the effect that network "connectedness", social presence and group awareness (i.e. knowledge of the current activities of one's team mates) had on the success of the student collaboration. A complete discussion of student feedback will also be given.

Expanding on the preliminary work introduced in *Chapter 5* (and motivated by student feedback from initial trials), *Chapter 7* introduces a more robust, flexible and refined version of the *CommonGround* application. Redesigned to better achieve the goals of this study, the second release represented an important step in the tool's evolution from proof-of-concept to fully-featured Web 2.0 social "app". An overview of the revised tool will first be presented, followed by a detailed discussion of the design rationale which directed its evolution. A summary of the updated design requirements raised in the previous chapter will also be given, followed by a complete overview of the application's redesigned feature set. Finally, I include another brief discussion of how the new application performed in practice.

Following the same format as *Chapter 6*, *Chapter 8* will go on to summarise and assess a second trial of the *CommonGround* application conducted during the 2009/10 academic year. Intended to replicate and corroborate earlier findings, I again focus on the impact that the application had on the creation of social capital and the success of student/team communication efforts.

To conclude this thesis, *Chapter 9* summarises the outcomes of the work presented and makes recommendations for future studies in this area. Finally, a complete list of references to the sources cited in this work is included followed by an *Appendix* featuring a glossary of nomenclature and a selection of original research materials created for and used during this study.

Chapter 2

Background & Related Work

2.1 The Global Knowledge Economy

The rapid growth of Information and Communication Technologies (ICT) over the last decade has had a profound impact on the world economy; as posited by Guruz & Nancy [7], the ICT revolution has “transformed the industrial society into the knowledge society” with far reaching commercial and educational implications. Both developed and developing countries have entered a new global economic era based on technological innovation and the creation, distribution and exploitation of ideas and knowledge [8]. As the catalyst behind this change, recently published figures show that global Internet adoption exceeded 2.4 billion at the end of 2011, representing over 35% of the world’s population (having grown from approximately 8% in 2001) [9]. In the developed world this population penetration reached almost 74% in 2011 and, in the UK, surpassed 86%. As the developing world races to catch up and the global “digital divide” continues to shrink, a new worldwide knowledge economy and labour market is emerging. To compete for work within key sectors of this global community, countries such as China, India and Russia are now moving to expand their secondary and tertiary education systems to create highly-skilled “knowledge workers” comparable to those traditionally produced by the west [8].

Consequently, large increases to the global workforce – referred to as the “great doubling” by Freeman [10] – has demonstrably outstripped the demand for high-skilled workers and exerted downward pressure on employment opportunities (and earnings) throughout the world. Disadvantaged further by a recessive economic climate, UK graduates in particular are finding it more and more difficult to find work commensurate with their expectations and levels of education. As recent research conducted in collaboration with the *Association of Graduate Recruiters* and the *Council for Industry & Higher Education* indicates, considerably more UK university students are now applying for considerably fewer graduate vacancies [11]. Again, although most high-skilled employment opportunities in the UK require a level 8 qualification [12], it cannot be understated that employees matching this criteria are becoming increasingly available globally [8].

As economic and technological changes alter traditional business operations and recruitment patterns around the world, it is in today's computing and ICT sectors that those changes are having the most disruptive effect [7, 8]. As suggested by Ferguson et al., "What is happening in computer science and information systems is analogous to what happened to manufacturing in the 1970's and 80's only at a much faster rate" [13]. The "off-shoring" of knowledge-based work, for instance, is becoming increasingly commonplace; in a practice known as *Global Software Development* (GSD), many large software engineering companies now design, develop, test and maintain their latest product ranges using teams of globally dispersed domain experts (capable of employing computer-mediated communication (CMC) technologies to work collaboratively across geographic and temporal boundaries) [14, 15]. With traditional requirements for employer/employee co-location relaxed, organisations are therefore able to extract the most value from their human resources and, in turn, respond more effectively to changes in industry, threats from competition, and increases to IT system complexity [16, 17, 18]. Consequently, as Last describes in [16], multinational corporations such as IBM, Oracle, Microsoft, Sun and Lotus all now depend on distributed virtual software development teams to operate.

To compete successfully in this environment, UK graduates must possess a range of "global competencies" and be highly adaptable and responsive to change [11]. Leading UK recruiters have echoed this sentiment and identified four critical graduate skills for the modern knowledge worker: "an ability to work collaboratively with teams of people from a range of backgrounds and countries", "excellent communication skills", "drive and resilience", and "an ability to embrace different perspectives" [11]. However, in a stark warning to government and higher education, employers have also voiced serious concerns regarding the lack of such competencies in the UK graduate labour market [e.g. 11, 19, 20]. More alarmingly, industry leaders have advised that if employers are unable to find suitable staff in the UK, they can, and will, recruit from elsewhere [11]. It is therefore the responsibility of educators to respond to both the evolving role of ICT in the world and the skill demands of an increasingly globalised software engineering industry. To that end, the *Active Learning in Computing* initiative was conceived to promote change in HE computing curricula and provide the best environments and opportunities for students to flourish.

Established in 2005, this five-year collaborative effort between four north-east universities sought to better align undergraduate teaching and learning outcomes with the global and technical competencies demanded by the software engineering industry. As part of this work, Newcastle and Durham University partner sites embedded a complex, multifaceted and multidisciplined cross-site group programming project into the curriculum in emulation of industrial trends and GSD practices. By encouraging independent learning and active dialogue between local and geographically distributed team members, it was the partnership's intention that students would develop greater learner autonomy and cultural agility in addition to skills significant to the needs and requirements of employers (e.g. communication, project planning and team-working skills). Before I discuss the *Active Learning in Computing* project in detail (which I will do in the following chapter), I first provide an overview of the established theory and associated background literature that serves to place this study in context. Although I draw references to supporting research wherever relevant, please note that other related works will also be referred to and summarised in the individual chapters that follow.

2.2 Theoretical Motivations

2.2.1 Constructivism

Constructivism is a prominent and widely supported learning theory which argues that human beings construct understanding and meaning as a function of experience rather than as a function of what someone else says is true [21]. Based predominantly upon the work of Piaget [22], this popular epistemology asserts that prior "real-world" knowledge and reflection play a significant role in an active learning process that facilitates critical thinking and intellectual development. Extending this theory to place a larger emphasis on social interaction, the seminal constructivist work of Vygotsky asserts that peer interaction and group collaboration are also fundamental requirements in the building of individual knowledge [23]. The author goes on to suggest that students are capable of performing at far higher intellectual levels when working in collaborative situations than when working alone. As stated respectively by Woolfolk and Wang, "learning is active mental work, not passive reception of teaching" [24], with academic learning "enhanced when knowledge is shaped by the activities and perspectives of the group" [25]. Naturally, traditional didactic approaches to teaching and learning are seen as antithetical to the constructivist philosophy. For example, in an article on new methodologies for enhancing student learning, Guskin suggests that "the primary learning environment for undergraduate students, the fairly passive lecture-discussion format where faculty talk and students listen, is contrary to almost every principle of optimal settings for student learning" [26].

Extending constructivism to take into account the increasing impact of ICT, researchers now argue that the focus of modern education should be on learning with and for others, be it via peer tutoring or project-based learning programmes, in flexible, dynamic and adaptive ways [e.g. 21, 27]. Generally referred to as "communal" or "social" constructivism, these derivative theories again see learning and problem-solving as collaborative activities (cooperative in nature and most productive when done as a team) but also place an additional emphasis on technology use and social interaction. Although a number of variables such as group size, group composition, task and learning styles can all potentially influence the effectiveness of collaborative learning, all of these factors are in one way or another related to one single key element: *social interaction* [28].

Intelligence is no longer the privilege of the individual, and students who create understanding do so both for themselves and their larger co-located and Internet-based learning communities [27]. In such contexts, students move from passive observers to "active learners" who are capable of constructing meaning by integrating and reconciling new information with past knowledge and experience [29]. In fact, socially-oriented problem-based learning is viewed as one of the critical dialogical processes by which modern ICT-supported "communities of practice" acquire domain-specific and professional lifelong learning skills.

2.2.2 Communities of Practice

As the basis for a new social theory of learning, the concept of *Communities of Practice* was developed by Lave & Wenger to describe how groups of practitioners working in a common domain share information, learn from one another, and develop their skills both personally and professionally [30]. As more recently defined by Wenger [31]:

> *"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."*

In the context of this study, communities of practice can be used to view socio-cultural activities as central to the learning process, with the social activities that surround learning considered to be "legitimate peripheral participation" and "an integral and inseparable aspect of social practice" [30]. Today, with the advent of new ICT and social technologies, organisations and distance educators alike are taking advantage of this new pedagogical theory to improve employee and student performance [31]. By creating "online communities" or "virtual teams" of mutually motivated peers (referred to as "weak ties"[1] by Granovetter [32]), participants are able to develop the interpersonal

[1] Conversely, "strong ties" refer to the bonds between, and resources available from, one's network of close family and friends.

structures required to support and learn with, and from, each other. Indeed, we are all social beings and our communities represent an important part of how we *actively learn* and engage with the world, as I will now discuss.

2.2.3 Active Learning

It is alongside Lave & Wenger's "communities of practice" and the principle tenets of communal and social constructivism that the term *active learning* is best described. Characterised as a student-centred learning paradigm in which the individual is able to influence the content and pace of their own education, active learners are encouraged to engage in a cooperative or collaborative activity that "forces them to reflect upon ideas" and attain "knowledge by participating or contributing" [33]. As the definition continues, "the instructor provides students with opportunities to learn independently and from one another and coaches them in the skills they need to do so effectively". Properly implemented, this approach can lead to "increased motivation to learn, greater retention of knowledge, deeper understanding, and more positive attitudes towards the subject being taught". Successful communities of knowledge-builders therefore foster social interdependence where learning outcomes and values are known and directly affected by the actions of others. In a fairly new line of educational research which focuses on the social and cultural contexts of learning, computer-supported collaborative learning (CSCL) theorists agree that "it is not so much the individual student who learns and thinks as it is the collaborative group" [34].

To establish community and the "mutual knowledge, mutual beliefs, and mutual assumptions" that are essential for successful communication [35], team members must find and accumulate *common ground* (i.e. the joint basis of mutual awareness, interest and agreement required for short-term contribution and negotiation of shared understanding [34]). In doing so, individuals can build an "affective structure" based upon the processes of affiliation (i.e. a propensity for getting in touch with one's team), impression formation (i.e. the individuating impressions of one's co-members), and group awareness (i.e. up-to-date awareness of one's co-member roles and activities) [28]. The fledgling social and working relationships created can then be developed and explored further; a process seen as vitally important at the outset of a multidisciplinary collaboration where participants tend to have little basis for shared understanding [36].

In Newcastle and Durham University's understanding of active learning (the implementation of which I will discuss in detail in Chapter 3), students posses a greater control over the subject matter they are taught, the teaching and learning resources they use, and the learning methods they employ [37]. Through the use of new learning environments and the application of loosely scaffolded and challenging problem-based pedagogical approaches, students take control of their own educational experiences and collaboratively construct and share knowledge, explore ideas and concepts, develop workable solutions, and take time to reflect upon their learning. Respectively, these actions map directly to the middle-tier *application* and *analysis* levels and the higher-tier *evaluation* and *creation* levels of Bloom's taxonomy [38]. Furthermore, by focussing on autonomous, realistic, experiential learning (or "learning by doing"), "higher-order thinking skills" and "deep understanding" [39] are emphasized with outcomes and transferable skills relevant to the workplace and natural complexities of the real-world. In turn, students are able to independently learn new skills with a sufficient enough grasp of concepts and principles to "bring them to bear on new problems and situations" [40]. Thus, adoption of an active learning strategy in higher education represents a necessary shift towards a more learner-oriented educational philosophy in which students are the "chief-agents" [19] in the learning process.

2.2.4 Digital Natives

Newcastle and Durham University's approach to active learning is predicated upon the assumption that modern students possess a natural inclination towards information and communication technologies (ICT) and are completely comfortable with their use. As described by Prensky, this so called "digital native" generation – referred to occasionally as the Net Generation or the Y Generation – are fluent in the language of computers and are held to be active, experiential learners proficient in finding information and interacting with others via technology [41]. The literature now features a wide range of research which concurs with this contention, demonstrating that students are inherently inclined towards use of technology and the Internet within both their private and professional lives [e.g. 42, 43, 44]. Moreover, in a recent study by Sparrow et al., users of ICT are becoming "symbiotic" with their computer tools, "growing into interconnected systems that remember less by knowing information than by knowing where the information can be found" [45]. In HE contexts, digital natives are adept at processing information rapidly, "are fascinated by new technologies", prefer "experiential activities", and thus "gravitate toward group activity". Combined with a low tolerance for lectures, today's students therefore rely heavily on technology to access information and carry out social and professional interactions [46]; they are aware of the obvious benefits of ICT and are "clamouring" for new technologies to be integrated into their education [45]. Consequently, researchers now stress that university leaders should view ICT as a means for re-engineering a curriculum based on new collaborative and constructivist pedagogies [48].

2.3 Active Learning Experiences

Employers have long emphasised the importance of connecting academic learning with vocational skill development [49, 50]. To succeed in an increasingly competitive and globalised labour market, graduates must be seen to be highly adaptable and responsive to change. This holds particularly true in computing-related disciplines where regular technological, organisational and social change – in addition to the complexities of developing modern ICT systems – has created the need for professional graduates capable of working remotely with people from a variety of different backgrounds and disciplines [15]. In the 2002 UK government-appointed SET report (which suggests improvements throughout the education system), Roberts therefore advises that educators improve the relevance of science and engineering courses and move towards a more contextualised learning approach that involves "group-based learning as well as individual skills development" [20]. Similarly, a burgeoning literature also describes a variety of active learning studies which advocate opportunities for undergraduate and postgraduate computing students to work with a diverse range of colleagues [e.g. 51, 52, 53]. As well as helping to reinforce theoretical concepts, these studies also place a strong emphasis on group work and collaborative problem solving, the educational benefits of which have been well documented (for example, Rovai's study into educational communities shows a distinct relationship between a student's sense of community and their perceived degree of cognitive learning and course satisfaction [54]).

In the last decade, new forms of communication have emerged with the development of Web 2.0 technologies that have affected all parts of private and business life. The term Web 2.0, coined by O'Riley [55], refers to a new generation of Internet-based, community-centred services and applications that encourage openness and interaction between participants (e.g. blogs, wikis, social networking sites, RSS feeds, podcasts). Considerable research exists in the literature today that exhorts the potential of these systems – and the Internet as a whole – to enhance HE distance learning, democratise access to educational resources, and "accelerate university students' learning and knowledge-building" [42]. For example, a vast number of case studies exist that demonstrate the ability of e-learning materials and virtual learning environments to deliver individualised content and assessment at a time, place and pace that suits the learner exist [e.g. 56, 57, 58]. As summarised by Franklin & Harmelen [59], the University of Leeds offers blogs and wikis to staff, the University of Warwick and the University of Brighton offer personal blogs to staff and students ("in the spirit of shared academic interest and social community"), and the University of Edinburgh offers blogs, RSS feeds and Internet bookmarking technologies to all institutional members. In the context of global software development, a number of interesting research projects can also be found in the literature that specifically tailor collaborative technologies to the needs of undergraduate team programming assignments [e.g. 60, 61, 62, 63, 64]. As summarised by Nevgi et al., these Internet-based environments and computer-mediated collaborative technologies are important forums for joint problem solving, knowledge building and sharing of ideas, especially where students with weak team-working skills are concerned [65].

As advocates of active learning in HE, ICT naturally represents an intrinsic part of Newcastle and Durham University's computing programmes. In addition to technical and professional skills, both institutions seek to provide students with a "holistic view of technology and learning" similar to that suggested by Sharpe et al. (i.e. an approach that is not focussed on content delivery alone but combines learner self-direction with traditional instruction) [66]. However, due to the co-operative nature of software development, success is largely dependent upon "the quality and effectiveness of the communication channels established within the development team" [67], with a good proportion of problems associated with virtual teams being social rather than technical [64].

2.4 Social Learning Perspectives

As I have already discussed, a variety of online platforms and collaborative environments currently exist that seek to facilitate student interaction and access to both human and material resources. However, as Bielaczycs [68] and Cho et al. [69] argue, such systems often fail to provide the collaborative depth and social affordances needed to significantly influence the acquisition, building and exchange of knowledge. Learning and group interaction are inherently social processes, but the developers of Internet-based collaboration tools invariably overlook this psychological dimension (assuming it will occur simply because the environment makes it possible) [70]. As reasoned by Kreijns et al., it is not enough to simply add a forum to an online system with the label "café" or "lobby" and expect collaborative learning to occur; one must focus instead on the actors in the group and their specific collaborative needs [28]. Consequently, a growing body of research is now emerging in the literature that seeks to demonstrate the instrumental role that social interaction and feelings of connection play in increasing computer-mediated group performance and student motivation [e.g. 71, 72, 73].

As I will discuss later, an established area of that work now concerns how learning can be enhanced via computer-mediated social networking environments – online communities such as Facebook, LinkedIn and Twitter and Yammer – through which registered users connect with friends and colleagues in order to explore similar interests and activities. By placing an emphasis on social sharing and user-generated content [74], these sites have gained a great deal of popularity in recent years and, by simplifying the dynamics of building and strengthening relationships, have arguably transformed the social behaviour and collaborative potential of individuals and virtual teams alike. Consequently, researchers now regard online social interaction a critical and integral part of daily student life [75].

2.4.1 Social Media

Fuelled in no small part by considerable media attention and low entry costs, socially-oriented Web 2.0 technologies – collectively referred to as *social media* – have experienced unprecedented growth in popularity and membership in recent years [76]. As a result of this proliferation, the latent sociability of the Internet has been exposed and transformed how users think of and use the technology. Once considered a content resource and research tool, people are now accustomed to thinking of the online world as an interactive *social space* [77]. Of course, social interaction and community organisation on the web are nothing new, but the scale at which people are adopting and actively using the technology is [78]. Consequently, mainstream social media now represents one of the most important communication channels for individuals, organisations and researchers alike.

Since the release of *SixDegrees.com* in 1997, more popular (and far more successful) services have appeared that allow users to represent themselves and their social networks online. These sites are all based on the common principle of connecting and building virtual communities, but also offer myriad variations around that shared theme. Facebook, for instance, connects people from similar education, employment, and personal backgrounds, MySpace connects people with similar social pursuits, and LinkedIn connects people with similar business and commercial interests. Over time, however, as users and developers have extended and evolved these services, many of the subtle variations between offerings have faded somewhat. Consequently, most services now feature a very similar set of self-presentation and synchronous/asynchronous communication tools (designed to allow members to create public profiles, publish short “status updates”, post photos and videos, and share content with their network). Following the social trend, other mainstream online services such as YouTube and Flickr have also started offering integrated social networking facilities to encourage conversation and enhance their core functionalities.

Also gaining in popularity and membership are microblogging services such as Twitter which allow users to compose and openly publish short text-based messages (up to 140 characters) regarding one’s current activities, experiences and thoughts. Of interest to this study in terms of student-status dissemination and group-awareness, users of Twitter generally “follow” other individuals or groups in order to subscribe to their updates (called “tweets”). As I will touch on again in Chapter 4, these specific forms of networking technology achieve a wide variety of social objectives, from keeping friends, families, and co-workers up-to-date with one's activities to sharing information with interested observers and seeking knowledge and expertise in public tweets. Following the trend towards convergence described previously, these too are technical affordances which other social networking services have been quick to imitate; it could even be argued that the basic "status update" feature is one of the primary attractions of most social networking services.

As is typical of most emerging CMC technologies, the "social web" is a rapidly evolving field and new products and services appear frequently. Naturally, a great many of the offerings simply attempt to reproduce the successes of those that have gone before but with an additional focus on a specific domain (e.g. photography, personal relationships, employment, business collaboration, etc). Unfortunately, most of these fail to gain significant traction with users and often fade into relative obscurity (even reasonably successful services such as *Bebo*, *Friends Reunited*, *Google Wave* and *Jaiku* were unable to maintain a critical mass of users and have since fallen by the wayside or closed altogether). Despite considerable investment and market exposure, *Google* has frequently attempted to create social networking services for a number of years and has arguably failed every time; the company's latest offering, *Google+*, seeks to reverse that. However, as both bookmark sharing services such as *Delicious* and location-based services such as *Foursquare* have proven, there *is* room for different types of social services that "socialise" unexplored areas of life, but, so far, none have achieved the universal popularity of Facebook.

2.4.2 Social Networks

Gunawardena suggests that constructivist learning can only take place when students are able to share a sense of community and a common goal [72]. Similarly, Haythornthwaite contends that knowledge is not created in an individual vacuum but in the myriad interactions that occur via one's network of connections [79], with "the social process of developing shared understanding through interaction" being the natural way for people to learn [80]. The learner's *social network* – the collection of friends, peers and educators with whom a student relates and interacts, whether online or not – is therefore considered central to the theories of social and communal constructivism and key to the efficacy of collaborative learning. However, in the context of this study, it is the CMC-mediated online social network that is of most interest.

In [81], Boyd and Ellison define online social networks as:

> *Web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other*

users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system.

Sharing expertise and creating knowledge in a group (especially in distributed online contexts) is a continuous, reflective process in which members must be strategically aware – at all times – of both their own and their colleagues' roles, tasks and responsibilities [65]. A group's social network can thus be considered the primary basis upon which team cohesion, trust, common understanding and an orientation towards cooperation are achieved [28]. Indeed, the importance of online social networking in educational contexts is evidenced by many academic institutions that have reported significant benefits of integrating social media into student/group activities; namely the facilitation of trust, consensus and a sense of community that positively effects both individual and team performance [e.g. 58, 79, 82]. Student use of social media is also associated with increased involvement in campus-wide groups and a greater sense of belonging to the university community [83]; in such contexts, social networking acts as an important tool for the informal cultural learning of *being* a student, with online interactions allowing roles to be learned, values understood, and identities shaped [84]. These findings have been mirrored in industry where a variety of social technologies have been used successfully to encourage integration, collaboration, co-ordination, community building and information sharing among employees (especially where "digitally native" student graduates are concerned) [85, 86, 87]. And as these works suggests, the informal connections created in such environments return strong payoffs in terms of social support and access to expertise and organisational knowledge.

Importantly, many productive "on-task" discussions in team-working environments occur during impromptu, informal "water cooler" encounters and casual conversations [70]. Such serendipitous, non-task related interactions often involve an abundant exchange of information which can contribute to common understanding, impression formation, a sense of community and positive feelings of trust and empathy [28, 88]. As research in both academic and professional contexts demonstrates, the networks of weak ties afforded by these simple interactions can allow individuals to maintain and strengthen fledgling relationships with colleagues [79, 81, 85]. Similarly, social networking sites such as Facebook can help crystallise relationships that might otherwise remain temporary or ephemeral [86]. Perhaps more importantly, social media also encourages inclusion and participation from people with low self-esteem who often present difficulties forming and maintaining offline relationships with their colleagues [81, 89].

From a software engineering perspective, communication and cooperation are an integral and important part of the team development process [88, 90]. To achieve a successful outcome to any large scale task, individual programmers and contributors must be aware of how their actions affect the team dynamic [10]. Naturally, given the specific domain of this work, very few prominent studies focus on the constructivist uses of ICT and social networking technologies to support both co-located and distributed collaborative software development. However, a number of interesting studies have attempted to enrich collaborative online systems with a variety of social affordances in order to increase active interaction and sharing across various levels of education and employment [e.g. 91, 92, 93, 94, 95]. These studies suggest that the features of social media and shared online spaces correlate well with modern social constructivist thinking and thus represent an attractive means to foster student interaction and community building on-project. It is ironic, then, that many educators continue to regard social networking services as a distraction to learning, especially as social media now represents an area of broad interest to employers seeking to work closely with universities to shape a new generation of "global graduates" [11].

2.5 Social Measures

Social networks have been shown to play an instrumental role in developing interpersonal relationships between both local and distributed students. A large body of literature has accumulated on the dynamics of these networks, including a number of instruments purporting to measure the social factors that contribute to their formation and use. In this section I very briefly explore some of the key concepts and measures that will serve to inform my research going forward. Although many of these works relate directly to distance learning, I contend that they also apply equally well to the context of the *Active Learning in Computing* initiative.

2.5.1 Social Capital

The term *social capital* broadly refers to the perceived levels of information, knowledge, resources and opportunities available to a person or group via their network of friends, family, colleagues and acquaintances [96]. It is embedded in the informal and professional social structures of both students [21] and workers alike [97], with large and diverse networks of contacts considered to have more social capital than smaller, less diverse networks [98]. Of the two types of social capital described by Putnam [99], it is an individual's "bridging social capital" that this study is most interested in (i.e. the information and perspectives provided by one's "weak ties"). However, "bonding social capital" (i.e. the resources acquired from close relationships with friends and family) is also important in the generation of group support, trust and responsibility, and thus can't be ignored.

For co-located and distributed communities of practice, research shows that members must form reciprocal and mutually beneficial connections if they are to succeed in their endeavours [100]. To facilitate these efforts, a number of CMC technologies have been created to encourage and support team interaction (as touched upon in 2.2). However, as described in 2.4, most platforms fail to provide the collaborative depth and "sociability" needed to significantly influence the acquisition, building and exchange of knowledge in these contexts [68, 69]. Conversely, research indicates that Facebook (and social networking services like it) are *far* better equipped to allow members to accrue social capital cheaply and easily [e.g. 77, 81, 86, 98]. Ellison et al. also found that Facebook's various communication affordances are able to maintain and strengthen *offline* relationships, especially where users will low self-esteem are concerned [86]. Similarly, Kobayashi states that increased participation with Facebook typically helps to build trust and social capital between both online and offline groups [101]. I will revisit and explore ways to harness and enhance Facebook's collaborative potential (and its capacity to generate social capital on-project) in later chapters.

2.5.2 Sociability & Social Spaces

Sociability is concerned with how members of an online community interact with one another via CMC technologies [102]. Moreover, the term refers to the extent to which a technology-mediated environment is able to give rise to a "sound social space" [103] capable of generating social capital and fostering effective, trusting and cohesive working relationships. In the context of this study, I use Kreijn's [104] definition of a social space:

> *"…the network of social relationships amongst the group members embedded in group structures of norms and values, rules and roles, beliefs and ideals."*

As Kreijns continues, a social space is considered to be "sound" if it is "characterized by affective working relationships, strong group cohesiveness, trust, respect, belonging, satisfaction and a strong sense of community". For individuals to recognise collaboration as a valuable experience and wilfully contribute "tentative ideas" to their communities (and be willing to give and receive constructive critique), they need to trust and feel close to one another [105]. A sound social space therefore determines, reinforces and sustains a positive social climate with resultant increases in social interaction, cooperation, support, commitment to group goals, and low-risk open critical dialogue [105]. The concept of a sound social space therefore provides an important basis for describing and analysing the success of an online community in a collaborative context, from simply counting the number of messages exchanged between participants to measuring more complex (and interdependent) levels of interactivity, trustworthiness, reciprocacy, social presence and group awareness (the latter two of which I will now describe).

2.5.3 Social Presence

Although conceptualised over the years in many different ways by both researchers and practitioners alike [106], Short et al. originally defined social presence as the "degree of salience" of actors in an interaction [107]. Since then, this popular concept has been used to describe the perceived physical "presence" (i.e. feelings of "being there") of interlocutors in a variety of online CMC contexts, from real-time video-conferences to asynchronous distance learning encounters. More recently, however, social presence has been extended to provide an indication of how online group participants relate to one another and how willing they are to engage and connect with others [106, 108]. It is the latter of these definitions that this thesis addresses: the ability for team mates to project their identities [109], disclose personal information, and connect with their larger online networks both synchronously and asynchronously (an important determinant to participation and social interaction [104]). Going forward, I therefore adopt Jochems & Kreijn's definition of social presence [104]:

> *"The perceived degree of illusion that the other in the communication appears to a 'real' physical person in either an immediate (i.e. real-time or synchronous) or delayed (i.e. time-deferred or asynchronous) communication episode."*

The more a CMC medium is able communicate verbal and non-verbal cues (and thus convey a range of socio-emotional information), the more social presence that technology is said to possess [104]. A CMC medium high in social presence allows its users to discernibly perceive those with whom a communication episode can be initiated, and is therefore considered more appropriate for creating communities of learners [54], conducting interpersonal tasks [110], and building mutual trust and social influence [111]. Social presence is said to be key to promoting collaborative task-oriented learning and knowledge building, and is a strong predictor of overall student satisfaction [109]. As suggested by Rourke et al., social presence also instigates, sustains and supports critical thinking and makes group interactions appealing, engaging and intrinsically more rewarding [112]. Approaching the topic from the perspective of social learning theory, Tu further reasons that social presence is required to enhance and foster the collaborative process: "if social presence is low, the foundation of social learning, social interaction, does not occur" [113]. I will introduce more specific measures pertaining to social presence later in this thesis (Chapter 6).

2.5.4 Group Awareness

Group awareness refers to the ability for an online community of practice to keep track of the actions and beliefs of its members. Although taken for granted in face-to-face work, "up-to-the-minute knowledge" of group activities – what everyone has done so far, what they are doing now, and what they will do next – is necessary for effective online interaction [114] (research indicates that group awareness directly influences overall levels of interaction and course satisfaction in collaborative educational contexts [115]). However, distributed teams often only work together for short periods of time and thus struggle to accumulate the critical "awareness information" required to build shared understanding around a common goal (establishing a climate of group awareness needs time, interaction and experience of working together [116]). Thus, as reasoned by Carroll et al., people must reduce the uncertainty surrounding their task – and one another – by using CMC-mediated tools to coordinate work [117]. General group awareness affordances (or group/work awareness widgets [118]), which facilitate processes of social/work relationships and impression formation, are therefore considered of prime importance to modern communities of practice and a necessary part of any collaborative software tool [119].

Carroll et al. also distinguishes three forms of group awareness that are inherently linked with the sociability and social presence constructs described earlier: *social awareness*, *action awareness* and *activity awareness* [117]. With social awareness, a person is conscious of the basic online presence of others in their group (i.e. by using simple representative pictures or videos). With action awareness, a person is able to establish and maintain basic knowledge about the current actions occurring in their group (i.e. who is doing what). And with activity awareness, a person is able to keep track of important information pertaining to their group's aims, objectives, performance and progress towards completion of a shared goal. Beyond these three forms, Greenberg also identifies another key type of group awareness needed for effective collaboration: *group-structural awareness* [120]. This important form of awareness encompasses knowledge about people's roles, statuses, responsibilities and positions on issues [120].

Of relevance to this study, research into group awareness in software development contexts has also found that a lack of ad-hoc communication and team awareness between developers can decrease coordination and collaboration between remote sites [121]. However, contrary to what one may think given the simplicity of the medium, the study also goes on to illustrate that developers can achieve satisfactory levels of group awareness by simply monitoring the text-based chat contributions and file uploads of colleagues. Simple group awareness affordances – if implemented correctly – can therefore represent a low-cost means to encourage sociability in online collaborative contexts. Accordingly, the group awareness characteristic of social interaction is now a very active area of study in its own right, with many researchers advocating the necessity for measuring and encouraging group awareness across all aspects of online collaboration. I will again introduce more specific measures pertaining to sociability and group awareness later in this thesis (Chapter 6).

2.6 Considerations

As an advocate of active learning in higher education, the work that I present in this thesis is based upon the communal and social constructivist principles described so far. However, whilst embracing the benefits of these pedagogical approaches, I am also required to recognise and consider the wider implications of their use. For example, practitioners frequently voice concerns that collaborative learning techniques require considerable additional resource [122] and costly flexible learning environments [123] (not to mention sophisticated, time-consuming approaches to assessment [124, 125], which I will touch upon further in the next chapter). Fortunately, the work discussed in this thesis made considerable advances in resource provision and cost-reduction by employing student-owned equipment and free social networking technologies. Although the availability and accessibility of computing equipment should not be assumed [126], the falling cost of personal technology and high-speed Internet access has steadily negated many of the resource-provision arguments present in the literature [42]. However, to mitigate any remaining device ownership concerns and thus maintain parity between students, it should be noted that the work presented in this thesis was supported by a "standard" set of public computing resources at each partner institution.

Researchers have also warned in recent years that many of the assertions put forward with regards to digital natives are done so with little empirical evidence [e.g. 127]. Although one must always be careful of acting on generalisations, my experiences to date – and the work presented in this thesis – support the evidential assumption that modern students are highly adept at using CMC technologies (especially in computing-related disciplines). Thus, I agree with Selwyn [42] that researchers need to take a broader view of technology adoption in education and consider how students embrace and use ICT systems in the real-world (as opposed to what educational theorists believe students potentially *could* – or *should* – be doing with that technology).

However, it is important to consider that students who are successful in face-to-face situations may not necessarily be so in virtual environments [65], and may naturally resist replacement of traditional student-to-student contact with Internet-based alternatives [128] (especially if the environments concerned are ordinarily used for recreational purposes [75]). As Jonassen notes, the sole use of computer-mediated communications for collaboration may amplify existing insecurities and prevent individuals from participating openly and fully [129]. Virtual teams may also have difficulties interacting due to reduced social cues [65], lack of immediacy [129], and increased "information overload" [130], privacy concerns [131, 132] and misunderstandings. As I agree wholeheartedly with Jones & Lau that "pedagogy rather than technology should lead the learning experience" [133], it is therefore important to note that my efforts to encourage team collaboration via social media were designed to *extend* and *enhance* traditional face-to-face encounters rather than replace them. Indeed, although opinions are mixed on the academic implications of using social media in education, research nevertheless indicates that they are best implemented as a *supplement* to face-to-face contact [17, 134].

2.7 Summary

Worldwide adoption of information and communication technologies has transformed the industrial society of yesterday into the knowledge-driven economy that we live in today. In the global communities and labour markets that have arisen from that transformation, UK graduates are faced with a variety of challenges posed by an ever-increasing over-supply of highly skilled, low cost workers from developing economies (in addition to a recessive economic climate and shortage of jobs closer to home). This is particularly true in ICT-based sectors where the internationalisation of business now requires graduates that can embrace the technological and cultural demands of 21st century commerce. Multi-cultural and cross-domain team-working skills and an ability to manage complex interpersonal relationships are the most basic of the "global competencies" students must possess if they are to operate successfully in their chosen fields. It is therefore the responsibility of educators to respond to the growing global demand for "knowledge workers" and thus prepare students for the realities of working in this highly competitive environment.

In Chapter 3 I will go on to introduce the *Active Learning in Computing* initiative, a multi-institutional collaborative effort established to encourage and support active learning techniques in higher education. By extending traditional stage two undergraduate group-working projects to include a collaborative cross-site perspective, this initiative sought to enhance the student educational experience by aligning teaching and learning outcomes with the transferable skills sought by today's software engineering industries. Touching on facility provision and student technology ownership, I will continue to build on the work and key concepts reviewed in this chapter before moving on to explore the application of technology and social media in student/team communication strategies. Following this, I will go on to investigate the effects of augmenting undergraduate group project with emerging social networking technologies and simple scaffolding techniques that encourage group awareness, communication, and the building of social capital.

Chapter 3

Active Learning in Computing

3.1 Introduction

Active Learning in Computing (ALiC) was the first *Centre for Excellence in Teaching and Learning* (CETL) project for Computing Science in England [135]. Beginning in 2005, this five year initiative was a collaborative effort between a consortium of North East HE institutions: Durham University, Newcastle University, the University of Leeds, and Leeds Metropolitan University (providing a broad representation of the student population and the variety of software engineering curricula available in the UK). Lead by Durham University and financed by HEFCE [136], the project's primary objectives sought to enhance student engagement with the computing science curriculum by placing a far greater emphasis on both industry-relevant group work and independent problem solving. In particular, the CETL-ALiC project attempted to address the emerging commercial adoption of global software development (GSD), a practice whereby distributed "virtual teams" [137] collaborated across spatial, temporal and organisational boundaries to design and develop a variety of software solutions [138]. Importantly, the GSD approach to software engineering had been shown to offer a number of business benefits including improvements in efficiency, time-to-market, access to specialised labour, and reduced development costs [17, 18].

As Last describes in [17], multinational corporations such as IBM, Oracle, Microsoft, Sun and Lotus all now depend on distributed virtual software development teams to function competitively. To emulate this growing trend and thus equip students with the skills necessary to work in this environment, Newcastle and Durham partners extended their "traditional" undergraduate software engineering modules to include a year-long, inter-institutional group programming exercise (before the CETL-ALiC partnership, software engineering was taught in a manner consistent with other HE institutions, with lectures, practical lab sessions and individually focussed assessment dominating the curriculum). Forming the basis of this study, local and cross-site teams of students were invited to act as "virtual companies" and work together to develop a wide range of software products for national corporate clients. A detailed discussion of this work, including the various collaborative projects undertaken by students, will now follow in section 3.2. Section 3.3 will then provide an insight into facility provision at Newcastle and Durham University partner sites, followed in 3.4 by an investigation into student technology ownership and Internet usage during the 2008/09 and 2009/10 academic years.

3.2 Software Engineering Team Project

The software engineering team projects at both Newcastle and Durham universities were compulsory second year modules designed to provide participating students with a practical and authentic experience of large-scale software development tasks. Spread over the course of an entire academic year, geographically distributed learners from a diverse range of backgrounds, disciplines and abilities were brought together to work on complex and substantial assignments created in cooperation with local industrial partners. Collaborating in small teams across sites (geographically separated by 18 miles), students had to take responsibility for their own learning and time management, thus facilitating a shift towards far higher levels of active learner engagement (where knowledge could be obtained by creating, sharing, communicating and problem-solving rather than by passive listening) [135]. From a vocational point of view, this approach served to introduce a strong real-world perspective to the project, providing students with a valuable insight into the challenges faced by companies competing in a global market. In addition, the project afforded Newcastle and Durham universities the broader opportunity to evaluate new pedagogic approaches and collaborative technologies that could be used to foster local and cross-site team interaction (with potential implications extending far beyond the scope of this study and the academic remit of the CETL-ALiC partnership).

Naturally, the complexity and authenticity of group assignments, in addition to the choice of industrial partners, ultimately determined the realism of the project and thus dictated how students responded to its educational aims, as I will now discuss.

3.2.1 Learning Outcomes & Project Mandates

As previously touched upon, the wider objectives of the CETL-ALiC initiative sought to address the growing trend and increasing commercial adoption of GSD, a practice whereby software products were collaboratively designed and developed by teams of multi-disciplined and geographically distributed domain-experts. In particular, this work sought to extend the traditional HE computing curriculum to include a realistic simulation of GSD, thus providing students with experiences significant to the requirements of employers. Indeed, industry leaders frequently voiced concerns that students were leaving higher education deficient in vital soft skills [49] and often emphasised the need for graduates to possess more vocationally relevant knowledge and business acumen (contrary to the widely accepted view that university education produces graduates capable of performing in an "intelligent way outside the confines of what has been taught in formal courses" [50]). In response, the CETL-ALiC cross-site software development activity was designed specifically to extend traditional didactic teaching and assessment approaches to both focus on and encourage the development of critical soft/transferable skills.

In particular, via the application of problem-based learning [139], the cross-site project endeavoured to provide students with critical experience of multidisciplinary team-work, strategic thinking, leadership, independent problem solving, adaptability, professional communication, conflict resolution, requirements engineering, product design, testing and project management. Mapping directly to the intended aims and learning outcomes of the group programming activity as a whole, the project thus sought to provide participating students with:

- practical experience in the design and implementation of a large scale software system
- first-hand experience of professional software design and development methodologies
- awareness of complex professional issues such as project management, quality assurance, team structure and task allocation/delegation
- an appreciation of the need to fulfil an appropriate role within a team and to work responsibly and considerately with others
- practical experience in independent problem solving and the use of one's own initiative
- the ability to correctly apply particular skills to the job at hand
- the ability to objectively evaluate personal learning objectives and monitor progress
- practical experience of document preparation and technical report writing
- critical self-evaluation and peer evaluation skills
- an ability to present findings and results.

To achieve these learning outcomes, diverse teams of students from Newcastle and Durham universities worked locally and cross-site to solve complex yet authentic "real-world" problems, the success of which depended on efficient project management and carefully considered team communication strategies. Each specific project assignment (or mandate) was designed so that all students, regardless of institutional affiliation or degree course, needed to work together professionally in order to achieve the module's objectives.

Mandates were open-ended and initially based on the requirements of fictitious “clients”. Later, to add more realism to the project and introduce a degree of relevance to the professional lives and aspirations of students, the client role was undertaken by a number of genuine industrial partners and top graduate recruiters (examples include *IBM*, *Accenture*, and *Proctor & Gamble*). Mandates differed from year to year and ranged from a supply chain logistics program to a mobile geocaching application capable of collecting positional information from GPS and Wi-Fi access points. A brief summary of all CETL-ALiC project mandates set during these five years can be found in Table 3.1 below.

Academic Year	**Project Mandate Overview**
2005 – 2006	Student teams were invited to collaboratively develop a mobile “digital assistant” for a fictitious holiday company based in the North East of England. The client, seeking to make their holiday offers more attractive to customers, required a PDA- or mobile phone-based application that was capable of providing users with relevant and interesting information on specific holiday destinations. This initial project was designed primarily to assess the feasibility and benefits of the CETL-ALiC cross-site collaboration.
2006 – 2007	For the second year of the project, teams were asked to develop a software solution for running enthusiasts which had the ability to record routes and monitor performance over distance and time. Designed to operate on mobile devices with GPS functionality, students had to develop a desktop application with a back-end database (to manage training schedules, route plans and statistics) and a front-end GUI with advanced mapping/graphing capabilities.
2007 – 2008	Working with Proctor & Gamble as an external “advisor”, teams were asked to design and develop a supply chain logistics program that could plan and track product deliveries, maximise efficiency, and keep stock inventories at an optimal level. Order fulfilment, delivery, reporting and stock level warning systems were also requested.

2008 – 2009	Working as direct contractors for IBM, teams were invited to collaboratively create a virtual geocaching game for use on mobile devices[2]. Using GPS and/or Wi-Fi access points, the game was required to direct users – via the shortest route possible – to specific real-world destinations. Upon arrival at those locations users would receive a virtual prize for their efforts (the form of which was left open for students to explore). Back-end systems to support user profiles and the creation/hosting of new caches were also expected.
2009 – 2010 (a)	Local Newcastle teams were tasked by IBM to create a virtual campus application to help new students navigate their way between university buildings and useful shared resources (e.g. computing clusters and vending machines). The software solution was expected to interface with departmental student timetables (available online) and work on modern mobile devices equipped with GPS technologies.
2009 – 2010 (b)	Working in collaboration with product development staff at Lego Denmark, a team of Newcastle students was invited to work internationally with a team from Aarhus Engineering College to develop an "educational game" using Lego Mindstorms[3]. Given the expertise of students, it was also expected that new Lego prototype components/sensors would be developed and programmed during the project.

Table 3.1: Overview of CETL-ALiC Project Mandates (2005-2010)

Based upon the experiences, research and contributions of this author, the remainder of this thesis will concentrate primarily on the four academic years between September 2006 and July 2010 with a focus placed on the Newcastle University perspective.

[2] Geocaching is a popular outdoor activity in which participants use GPS systems to "treasure-hunt" hidden items (caches) placed in specific locations by other players.
[3] Lego Mindstorms is an advanced form of robotic Lego. In addition to standard Lego "bricks", a programmable unit can be used to monitor and control a range of sensors and motors (from touch, sound and light detectors to Wi-Fi transmitters, cameras and multi-speed servo motors).

3.2.2 Module Structure & Team Formation

In the five years that the CETL-ALiC software engineering group project took place, 557 level 2 Newcastle University students have participated (in addition to over 200 students at partner institutions). All were enrolled on a number of computing programmes including single honours Computing Science, Software Engineering, Information Systems, and Natural Sciences, with the software engineering module being common to all. During the first four years of the exercise, teams of students from Newcastle University were paired with similar teams from Durham University to create a number of "companies". On average, 12 companies were formed each year containing 10 to 16 students each (6-10 from Newcastle University and 4-6 from Durham University). To ensure a fair distribution of programming skills throughout, and to give each company an equal chance of delivering a satisfactory end product, group membership was largely based on performance and achievement in relevant software engineering classes during level 1. Furthermore, as each participating degree course presented students with specific skill sets, representatives from each discipline were evenly spread across teams (representing a true emulation of GSD practices).

Each company then had one full academic year (approximately 33 weeks; 24 contact, 9 non-contact) to complete the shared assignment allocated to them – a complex and multifaceted project which required each participant to independently collaborate and communicate with local and cross-site team mates. To encourage an even distribution of large-scale tasks between teams, two distinct and complementary system parts were defined in all project mandates (e.g. a mobile application and a desktop application, or a database and a front-end GUI). In order to provide continuous/formative assessment and feedback [140], a number of shared deadlines spanning both semesters were specified for both major individual and team deliverables (see Table 3.2 overleaf for an example; subject to minor differences between sites). Beyond these basic milestones, however, each company was expected to define their own organisational structures and software design methodologies and then self-manage all stages of the development process (from liaising with the client and encapsulating design requirements through to the implementation, integration and testing of their final software systems). To ensure each team worked towards that goal, and to spot any problems early on, formally supervised meetings were organised locally every week during term time. Staff members, PhD students or third year undergraduates monitored meetings and, in all instances, observed and assessed a team's effectiveness rather than guided the students.

As I will touch upon again in Chapter 8, the partnership between Newcastle and Durham universities concluded prematurely at the end of 2008/09. As a result, the final year of the project at Newcastle was conducted mainly with local teams (and a smaller cohort of students participating in a focussed international cross-site experiment with Aarhus Engineering College in Denmark). Despite a slight change in format and scope, however, the successful outcomes and good practices developed during the first four years of the project served to directly inform Newcastle University's approach to team formation and assessment in the final year (which, incidentally, it has continued to do ever since).

Deliverable	**Submission Deadline**	**Scope**
Skills/Strengths Assessment	Semester 1/Week 2	Individual
Team Structure	Semester 1/Week 3	Team
Project Preparation Essay	Semester 1/Week 4	Individual
Team Contract	Semester 1/Week 5	Team
Draft/Interim Specification	Semester 1/Week 8	Team
Interim Team Report	Semester 1/Week 9	Team
Peer Percentages 1	Semester 1/Week 9	Individual
Final Specification	Semester 1/Week 11	Team
Interim Design Document	Semester 2/Week 3	Team
Demonstrate Interim System	Semester 2/Week 5	Team
Final Design Document	Semester 2/Week 7	Team
Submit Final System	Semester 2/Week 10	Team
Demonstrate Final System	Semester 2/Week 10	Team
Final Team Report & Log	Semester 2/Week 11	Team
Peer Percentages 2	Semester 2/Week 11	Individual
Individual Report & Log Book	Semester 2/Week 12	Individual

Table 3.2: Example Individual and Team Deliverables (Newcastle University 2009/10)

As hypothesized by Strijbos et al. [141], functional roles stimulate group coordination and cohesion. However, although the CETL-ALiC partnership intentionally distributed a range of specialisations across teams, the actual choice of individual roles were ultimately chosen democratically by the students themselves. To help, each participating institution encouraged students to consider their various skills prior to choosing a role (which they did in their first formal team meeting). At Newcastle University, for instance, each participating student was required to complete a critical self-assessment of their perceived primary and secondary strengths (based on the Belbin team role self-perception inventory [142]). This simple questionnaire – and an assignment requiring a short discussion of its outcome – helped students connect their knowledge and skills to the various stages of the software engineering process, thus allowing them to choose the most suitable role available. However, as the project evolved and unforeseen problems developed, students naturally found that their roles changed or expanded.

As discussed by Devlin et al. [143], the large majority of Newcastle University students adopted a role that matched their primary skills and strengths. Interestingly, although few students initially sought power or status within their teams, many chose a managerial or leadership role, motivated, according to their final project reports, by a desire to gain experience and improve confidence. This autonomous approach to role selection also encouraged students to consider the types of employment they would like to pursue upon graduation (as Devlin states in [143], graduates typically undervalued soft skills and often ignored employment opportunities based upon them). Accordingly, by the midpoint of the project, most students recognised that their respective roles – whether chosen or allocated by a team leader – represented a valuable opportunity to strengthen any weaknesses identified in their skill assessments.

In terms of team organisation, students generally adopted a hierarchical structure – or a variant thereof – in which a team leader made decisions and delegated tasks to specific team members (some of which had also adopted sub-leadership roles, e.g. chief programmer, documentation lead, head tester, etc.). However, given the nature of the project and its participants, teams generally evolved a more egalitarian approach over time, democratically making important decisions during formal and informal team encounters. As one would expect, many organisational structures also changed dynamically depending on project demands, with participants taking on roles fluidly in response to the tasks at hand and the problems experienced.

In formally monitored team meetings, where participants were expected to report on and openly discuss one another's work, the team leader usually acted as chair with the team's secretary handling administrative tasks (i.e. room booking, agenda preparation, minute taking, etc). Regular cross-site company communications, although mandatory, were left open for students to organise and were not formally observed. In practice, however, this form of collaboration was often channelled through a single "liaison" at each site whose primary role was to collect and disseminate information between teams. Although understandable given the perceived difficulties in communicating with a remote, unknown team (as I will discuss in the next chapter), this approach effectively shielded the majority of participants from an important aspect of the collaboration.

During the first five weeks of each project year at Newcastle University, traditional lectures were also used to revisit professional software development methodologies and project planning techniques taught previously at level 1. These weekly, hour-long lectures were designed to place students' project work in context and highlight important, relevant concepts that would apply to their work going forward. Although no formal lectures or laboratory sessions were organised beyond this (apart from timetabled student meetings which coincided across partner sites), time was set aside for a number of guest lectures by industry leaders and relevant employers. In all, a participating student at Newcastle University was expected to commit to 200 hours of study to receive 20 credits (72 hours of lectures/meetings and 128 hours of self-directed study).

3.2.3 Assessment

Before 2005 and the focussed efforts of the CETL-ALiC project, Newcastle University's software engineering module had naturally evolved – as a result of changes in industry and GSD trends – to have a strong team-based focus. Similarly, most UK university computing departments provided students with a similar, basic experience of team-based software development. However, the opportunity to adopt cross-site collaboration was rarely taken [144], despite research that indicated its significant educational benefits [39, 145, 146]. Such undertakings were often seen as being overly difficult to put into practice; prohibitive issues such as curriculum opportunity and cohort size were of particular concern. Perhaps more of a problem was the complicated issue of assessment, in which the effectiveness of a student's team-contributions were often deemed too complex to convert into an accurate and fair grade [144]. Due to the significance and contentious nature of this issue, alternate streams of CETL-ALiC research were established to explore and investigate more reliable and academically rigorous assessment techniques [147, 148, 149]. Informed by the results of this work, it was decided that there would be no exam for the software engineering project at Newcastle University, with achievement based primarily on a combination of formatively assessed individual and team deliverables.

A student's marks were largely determined using a product of individual assignments (35%) and team deliverables (65%). As described in Table 3.2 previously, these included continuous reflective reports, team-based software engineering documentation (e.g. design specifications, project plans, testing evidence, end-user literature, etc.) and, of course, the final software solution. Group presentations and live demonstrations were also allocated marks. To mitigate the risk of unequal contribution within a team, students were required – at the mid and endpoints of the project – to democratically allocate their local colleagues a "peer percentage" (a value that represented each student's contribution to the team effort). Contribution matrices were also submitted with each team deliverable to allocate specific credit.

Thus, a student's final grade was a product of individual marks and team marks weighted using "peer percentages" and "contribution matrices" (as discussed in detail by Devlin et al. [147]). Marks were adjusted one last time to take into account feedback from monitor observations recorded during weekly formal team meetings (ultimately expressed as a fraction of total team effort). This final step helped to ensure that intangible achievements – in addition to individual and team deliverables – were taken into account (e.g. professional demeanour, willingness to participate, leadership effectiveness, etc.). Although collaboration represented a minimal part of the total marks available (marks depended on how well students evaluated and analysed their team working experiences, not on how good or bad their actual communications were), participants were made very much aware that peer-percentage, contribution matrix and monitor-observation weightings would all adjust any final grade awarded to them, effectively penalising poor team interaction and lack of professional decorum.

3.3 Technology Provision

Supporting and encouraging collaboration between students – both locally and cross-site – involved the wide-scale use of a variety of CMC technologies, ranging from custom-built, fully-equipped video-conferencing facilities to simple e-mail distribution lists, forums, file repositories and shared wikis [150]. In addition to video-conferencing for cross-site communication, e-mail was also recommended in the early stages of the project for disseminating important information between company members; as suggested by Fussell [151], it represented a simple yet effective means to keep team members aware of each other's work. Other collaborative technologies provided were *Skype*, *Subversion* (an open-source version control system allowing students to share their code) and *NESS* (Newcastle E-learning Support System, a web-based coursework submission and Virtual Learning Environment (VLE) developed by Newcastle University). The supporting technologies selected were largely influenced by real-word industrial software engineering practices where CMC technologies acted as the primary and most cost-effective means of communication for geographically and temporally distributed virtual teams [17].

Durham University's impressive "Techno Café" was created to provide student teams with a sophisticated, flexible working environment supported by the latest video-conferencing and communication technologies. Private "pods", which offered teams a comfortable space in which to collaborate locally and communicate cross-site, featured a range of interactive white boards, plasma displays, in-built tablet PCs, and Wi-Fi access points (Figure 3.1 and 3.2 overleaf). Following this lead, Newcastle University's video-conferencing suites – although smaller – featured the same basic technologies in addition to a number of adjacent "social" rooms for more relaxed, impromptu and informal meetings (Figure 3.3). Where applicable, *Access Grid* software [152] was used to facilitate video conferencing between sites, coupling webcam functionality with file and desktop sharing.

Figure 3.1: Durham University's Video Conferencing "Techno Café"

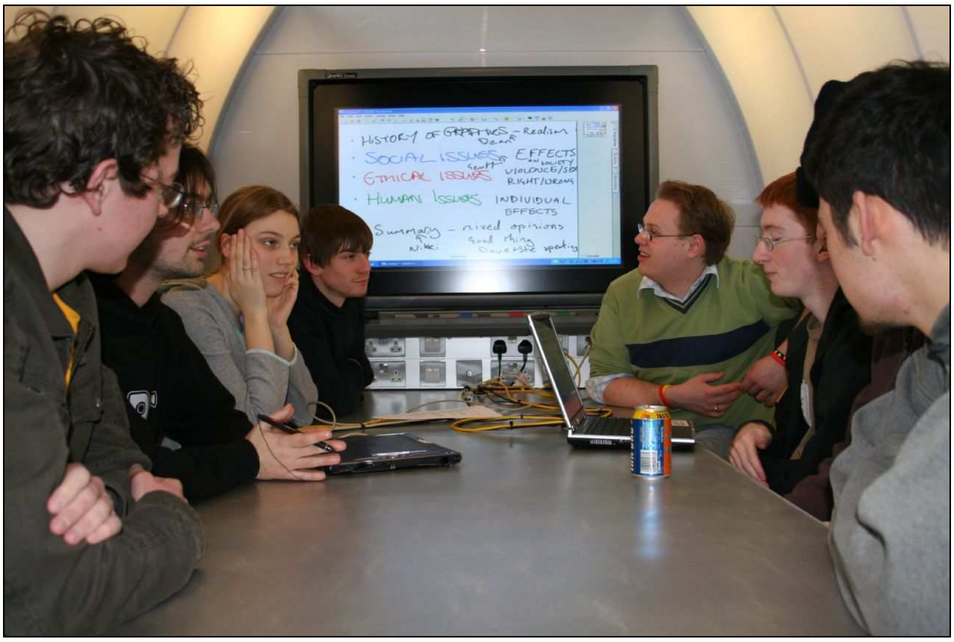

Figure 3.2: Durham University's "Techno Café" Pods

Figure 3.3: Newcastle University's Video Conferencing Suite

In all, a significant amount of resources were invested in technology provision for the CETL-ALiC project, both in terms of initial capital outlay and dedicated service personnel (most in-house technologies – especially video conferencing facilities – were time-consuming to set up and required frequent maintenance and support). Unfortunately, as I will discuss in the next chapter, a lot of this expenditure did not always offer the return on investment that the partnership had envisaged.

3.4 Technology Ownership Survey

Fostering and maintaining student communications was the most challenging aspect of the CETL-ALiC cross-site project. Despite considerable investment in technology and infrastructure, participating students continued to report significant problems with facility provision, availability and reliability. These problems were exacerbated during the course of the project as facilities aged and quickly became redundant. At the same time, however, personal computing technology and mobile devices with fast, reliable Internet access were becoming increasingly affordable. Consequently, during the latter years of the CETL-ALiC initiative, it became very much apparent that students possessed a far higher standard of CMC technology than Newcastle and Durham universities were able to provide.

In my own attempts to promote student interaction in group programming contexts, I recognised the opportunity that the growth of personal, Internet-enabled computing devices represented. By utilising student-owned desktop computers, laptops, tablets, netbooks and mobile phones on-project, partner institutions could move away from a traditional “provider-centric role” towards a more personal model of education where private technologies support and drive the collaboration and learning process [66, 153]. However, before I could pursue this avenue of research further, I had to ascertain the extent of personal ICT device ownership in Newcastle University’s student population, as I will now discuss.

3.4.1 Data Collection

A basic paper-and-pencil self-report survey of all new entrants to computing-related programmes in 2008/09 and 2009/10 was conducted (a sample questionnaire is provided in Appendix B). Later extended to assess social networking trends, this simple questionnaire sought to determine the functionality and uses of mobile devices *regularly* carried by students (in addition to whether students would be willing to access online learning resources and collaborative environments using them). Performed during the first week of each academic year, printed questionnaires were distributed in level 1 lectures to ensure a high response rate (undergraduate students were often inundated by electronic surveys and response rates were traditionally very low).

3.4.2 Results & Discussion

Surveys were conducted as part of this study between 2008/09 and 2009/10 with results summarised below. A very good coverage of each year's intake was obtained with 125 respondents in 2008/09 and 108 respondents in 2009/10. All participants surveyed were enrolled on full-time, single honours Computing Science and Information Systems programmes at Newcastle University, represented by 87.5% male and 12.5% female undergraduate students across both years with a mean average age of 19.63 (standard deviation 1.81).

	2008/09 (n=125)	*2009/10 (n=108)*
Do you personally own any of the following computing technologies?		
A laptop/tablet computer	114	102
A desktop computer	79	58
A games console	88	72
Internet access	114	108
If you regularly carry one or more mobile devices with you, what features do they have?		
Telephone/SMS	123	108
Internet browser	49	84
Application platform or PDA	85	78
Music or Video player	113	72

Table 3.3: Student Technology Ownership (2008/09-2009/10)

In both survey years described in Table 3.3 above, all participating students reported that they personally owned and used either a laptop/tablet computer (approximately 91% and 94% respectively) or desktop computer (approximately 63% and 53% respectively), with the rate of Internet access increasing from 91% in year 1 to 100% in year 2. Although this is perhaps unsurprising given the nature of the respondents' chosen degree programmes, it also suggests parity and equality of technology-access between students (thus largely negating any provision concerns expressed in Chapter 2). These findings also support the work of Selwyn [42] whose research indicates that the proportion of HE students compromised by their reliance on shared public Internet access facilities is steadily diminishing.

Also of relevance to this study, the ownership of mobile telephones increased from approximately 98% in year 1 to 100% in year 2, with mobile Internet access rising from 39% to 78%. With respect to mobile technologies, I did not seek to make any distinction between the various types of device owned and carried by students (of course, the results strongly suggest that the reported functionality is integrated into mobile telephones). Instead, I focussed on the various features and CMC capabilities of their chosen devices (described in Table 3.4 below) which showed a steady increase in Internet browsing and associated technology use (coinciding, no doubt, with the marked growth of "smart" phones). Over 59% of 2009/10 respondents possessed and actively used a mobile device capable of browsing the Internet, an increase of more than 20% over year 1. Interestingly, this seems to have occurred at the expense of traditional voice calls and text messages with both exhibiting a small decrease (approximately 12% and 6% respectively).

In year 2, mobile access to e-mail and online social networking services (e.g. Facebook and Twitter) increased by approximately 20% and 16% respectively, with 37% of respondents reporting that they use mobile applications (or "apps"). As an aside, a large number of respondents also used their mobile devices for listening to music, watching videos and, perhaps more predictably, playing games.

	2008/09 (n=125)	*2009/10 (n=108)*
Do you regularly use a mobile device to do any of the following?		
Make or receive voice calls	119	90
Listen to music	83	83
Access the Internet	49	64
Watch videos	35	45
Play games	68	72
Send or receive e-mail	30	48
Blog and/or forum posts	13	23
Update Twitter or Facebook	28	42
Send/Receive instant messages	42	31
Download learning content	N/A	12
Send or receive text messages	118	96
Use apps	N/A	41

Table 3.4: Student Mobile Technology Usage (2008/09-2009/10)

Supporting the widely held assumption that the Internet is a prominent part of many young-peoples' lives [42], students surveyed in this study spent a considerable part of their learning and leisure time online. As can be seen in Table 3.5 below, over 47% of respondents at the start of the 2009/10 academic year reported that they used the Internet more than 4 hours every day, with a further 41% reporting daily Internet usage of between 2 and 4 hours. Representing a small growth on the year before, these figures indicate that students invested an increasingly large part of their day in online activities (although no differentiation is made here between recreational and academic use).

As part of my work to foster team interaction and community building on-project, this level of online activity thus represented an important potential opportunity to provide students with additional tools to assist and encourage communication and group awareness. In support of those efforts (and in response to an additional question asked during the 2009/10 survey), the number of students who reported that they would be willing to access online project-related social tools was approximately 70%, with a further 18% undecided but open to its consideration.

	2008/09 (n=125)	*2009/10 (n=108)*
How many hours would you say you spend on the Internet every day?		
Less than 1 hour	1	0
1-2 hours	20	13
2-4 hours	41	44
More than 4 hours	63	51

Table 3.5: Student Internet Usage Statistics (2008/09-2009/10)

Replicated across CETL-ALiC partner sites in a joint comparative study [5], the findings presented in this chapter show that the majority of undergraduate students arriving at university are equipped with personal mobile devices capable of accessing the Internet both on-campus and off (a trend which appears to be growing year-on-year). From laptop computers to smart phones, these powerful computing and communication devices are owned and carried by students on a daily basis, thus providing an important alternative channel through which learners can access faculty resources and connect with friends and colleagues. It therefore made increasing financial and practical sense for the CETL-ALiC partnership to explore ways to cater for and integrate those personal CMC devices into the group project initiative, as I will go on to discuss in the next chapter.

3.5 Concluding Remarks

This chapter introduced the CETL-ALiC initiative, a five-year inter-institutional research project established in 2005 to facilitate a shift towards far higher levels of active learner engagement in the HE computing curriculum. As a major part of this work, Newcastle and Durham University partners extended their traditional team-based software engineering programmes to address the emerging commercial adoption of GSD. Running over the course of an entire academic year, participating undergraduate students were placed into virtual companies and encouraged to collaborate both locally and cross-site to create a variety of complex software solutions for real-world industrial clients. By focussing on team work, this approach sought to generate active interaction between team members and foster the development of both interpersonal and vocational skills significant to the requirements of employers.

As part of the CETL-ALiC group programming initiative, students were given access to a wide variety of modern CMC technologies to encourage and support team collaboration, from purpose-built video-conferencing suites to virtual learning environments, file repositories, forums and wikis. However, as the project progressed, it became increasingly obvious that students possessed a far higher standard of CMC technology than Newcastle or Durham universities were able to provide. To gauge the availability and functionality of these student-owned devices in computing-related disciplines, this chapter described an investigation into undergraduate CMC technology ownership and Internet usage. An important outcome of this study highlighted the fact that the majority of students arriving at university are equipped with powerful personal computing devices capable of accessing online resources and communication services. I therefore contend that, by integrating those personal CMC devices into educational activities, practitioners can move towards a more effective and personal model of education where students use their own devices to support and drive their learning.

3.6 Summary

This chapter presented a detailed description of the pedagogic motivations, aims and objectives of the CETL-ALiC group programming activity. A discussion of the various collaborative projects undertaken by students over the five-year duration of the initiative was provided, followed by a brief insight into facility provision at Newcastle and Durham University partner sites. Finally, I presented and discussed the results from an investigation into student technology ownership and Internet usage during the 2008/09 and 2009/10 academic years.

The next chapter will go on to expand upon this initial study and discuss the CMC technologies adopted by participating students. Following on from this, I will investigate the growing use of social media in student communication strategies and examine their potential as a platform for formal team collaboration and group-awareness.

Chapter 4

Team Communication Strategies

4.1 Introduction

As part of the CETL-ALiC group programming project described in the previous chapter, students were given access to a wide variety of cutting-edge CMC technologies for both local and cross-site team interaction. In addition to providing a real-world experience of distributed software development (and the professional communication tools used therein), this approach also represented an important opportunity for Newcastle and Durham universities to explore and evaluate technologies for enhancing student/group collaboration. Unfortunately, despite considerable investment in hardware and supporting infrastructure, students continued to report significant problems communicating both locally and, to a much larger extent, cross-site. In particular, students found it difficult to determine, even after face-to-face and video-conference discussions, what their local and cross-site team partners were working on at any one time. Coupled with the delays experienced in e-mail communications (as I will discuss in detail later), this lack of interaction frequently led to duplication of work and increased frustration and isolation for many students. To help better understand these issues and, in turn, find ways to mitigate them, this chapter will investigate the technologies tried, adopted and rejected by students participating in the project.

Firstly, in section 4.2, I present and discuss the findings from an investigation into team CMC technology use. Then, in 4.3, I provide an overview of the general communication issues experienced by students collaborating on-project, including a brief summary of the techniques adopted by teams to overcome those problems. In 4.4 I go on to describe the emergence of the social networking site Facebook during the five-year lifetime of the CETL-ALiC initiative, followed in 4.5 by a detailed analysis of the increasing impact of that service on team communication strategies. Motivated by these findings, I finally propose in 4.6 the development of a social networking tool capable of harnessing the collaborative potential of Facebook to foster greater team awareness and community building across all aspects of the group programming activity.

4.2 Technology Adoption

As I described in detail in the previous chapter, supporting and encouraging collaboration between both local and cross-site group project participants involved the wide-scale use of a variety of modern CMC technologies, ranging from advanced video conferencing suites to simple e-mail distribution lists, forums and file repositories [150]. In addition to these facilities, teams were also provided with access to communication and information exchange technologies such as Skype, Subversion and NESS (a web-based virtual learning environment allowing students to submit project deliverables and receive marks and staff feedback). This choice of supporting technologies was influenced both by common industrial software engineering practices and the CETL-ALiC partnership's desire to encourage student/team interaction across all aspects of the group programming activity. However, students were also encouraged to investigate and use other communication and collaborative technologies as they saw fit, including instant messaging tools, mobile phones and SMS text facilities.

In order to succeed on-project, students were required to utilise their time effectively and learn to adopt and exploit the local and cross-site communication technologies that worked best for them. To help students consider and critically review the various CMC tools available, introductory orientation lectures were given in the first few weeks of each academic year. Paradoxically, the sheer variety of unfamiliar technologies presented arguably undermined team communication strategies and contributed to a breakdown in student interaction (as I will discuss in detail in the following section). Additionally, the considerable costs involved in obtaining and supporting a constantly evolving range of CMC devices significantly restricted the partnership's ability to stay up-to-date with industrial trends and modern practices. To refine technology offerings and better focus on the equipment and groupware systems *actually* used by students collaborating on-project, the CETL-ALiC team at Newcastle University therefore conducted a four year analysis of the CMC devices and services most frequently adopted by student teams. Contributing to the underpinning motivation of this thesis, the results of that study will now be summarised.

4.2.1 Comparative Analysis of Student Reports

The CETL-ALiC team's understanding of the CMC technologies chosen and actively used by teams during the first *three* years of the cross-site project (2005/06-2007/08) is based mainly on information gathered from individual student and team reports. The data for this particular study was gathered by fellow members of the Newcastle CETL-ALiC team and presented in detail in a joint journal publication with this author [1]. Therefore only a brief overview of the study's findings will be discussed here to help illustrate the communication strategies adopted by student teams during the formative years of the project. A further, more detailed investigation into technology use (as conducted by this author during the 2008/09 academic year) will be discussed afterwards.

4.2.1.1 Overview of Methodology

For individual and team end-of-project reports, students were required to reflect on their performance and learning experiences during the project and then discuss – from a personal and group perspective – how well their local and cross-site team communication strategies had worked. Although there was no formal coding of reports, the communications section of each submission was reviewed for instances of positive and negative experiences with various communication technologies. Importantly, the assignment outlines and instructions for both forms of report remained the same throughout the duration of the study allowing comparisons to be drawn across all three years.

4.2.1.2 Findings and Discussion

Firstly, given significant investment in technology and infrastructure (and, of course, a desire to emulate modern industrial practices) CETL-ALiC partners were especially keen to encourage students to collaborate cross-site using video-conferencing facilities. This technology was recognised as a rich form of virtual interaction and a good solution to compensate for the lack of physical face-to-face meetings [154]. "VC suites" were therefore mandated for weekly company communications during the first two years of the project (2005/06-2006/07), resulting in an initial high rate of adoption. Unfortunately, most teams only fleetingly used those technologies and very quickly abandoned them. To explain that rejection, most student/team reports cited poor hardware reliability and Internet connectivity issues; however, post-project interviews conducted by this author also found a lack of self-confidence to be a significant contributing factor (I will return to this in 4.3). Later, in the 2007/08 academic year, the partnership opted not to mandate any form of communications technology and thus saw a significant drop-off in the use of the video-conferencing facilities. Similarly, the NESS e-learning system fell into a secondary supporting role early in the project once its mandatory use was removed (again in the 2007/08 year).

To fill the communication void created by the rejection of these facilities, teams experimented with a variety of other technologies such as Skype and Instant Messaging (both for local/cross-site interaction and the dissemination of documents and code). Notably, a number of teams also adopted mobile telephone calls and SMS text messaging for company-wide communications, albeit only in "emergency" situations when information or status updates were promptly required. As before, however, although a few teams found some traction with those technologies, most inevitably abandoned them early in the project. In their place, e-mail was often reported as the dominant technology of choice for most student teams; it was quick, convenient, already in frequent use, and the asynchronous nature of communications required very little cognitive effort. However, as I will return to later, that ease of use came at a price: reading and responding to e-mail messages was too easy to defer and considerable delays often occurred before a message was read and/or replied to. In some circumstances messages were even ignored altogether – usually during times of increased academic pressure or holiday absence – which did little to aid team communication.

4.2.2 Level 2 Technology Usage Survey

The results of the three-year comparative study described above did not paint a complete picture of student technology use on-project. Post-project focus group interviews conducted at the end of the 2007/08 year (which I will discuss in 4.3) indicated that many of the technologies adopted by participants were omitted from their reports. When queried on this, students replied that they did not perceive certain CMC media to be acceptable forms of professional communication and therefore intentionally left such technologies out of formal documents. In particular, social networking sites such as Facebook were often used by students working on-project but were rarely reported due to their perceived use as a predominantly recreational tool (despite awareness of large corporate networks already present and active on those services). However, students did state that they would have formally reported Facebook use more if they had known "it was okay to do so". To explore the on-project uses of social media and provide a more robust and comprehensive analysis of team communication strategies, I therefore decided to conduct a more focussed survey of student technology adoption. As I will show next, the results obtained produced a far more detailed picture.

4.2.3 Data Collection

Conducted after the first semester of work in the 2008/09 academic year, a simple paper-and-pencil questionnaire was developed to ascertain the various CMC technologies adopted by student teams working both locally and cross-site. In addition to team structure formation and communication techniques, the survey also sought to determine student adoption of social networking services (however, in this section, only the questions pertaining to technology use are considered). A five-page questionnaire (see Appendix B) was printed and distributed to Newcastle University students during formal team meetings. An identical web-based questionnaire was also created for cross-site use with Durham University students.

4.2.4 Results & Discussion[4]

All 12 companies formed in 2008/09 academic year participated in the survey with responses received from 63 Newcastle students and 28 Durham students. This response rate provided coverage of 56% and 41% of project participants respectively. All respondents were enrolled on full time degree programmes and comprised 86.8% male and 13.2% female students across both years (mean average age of 20.46; standard deviation 2.01). Survey participants were provided with a list of commonly used collaborative technologies and were prompted to select those which they used "regularly" to interact with both their local and cross-site team mates (see Table 4.1 below and Figure 4.1 overleaf).

Which forms of CMC do you *regularly* use to interact with team mates?				
	Newcastle Uni. (n=63)		*Durham Uni. (n=28)*	
	Locally	*Cross-site*	*Locally*	*Cross-site*
Mobile Phone	44	18	17	14
Skype	13	41	13	18
E-mail	59	52	22	20
SMS Text Messages	53	14	17	9
Instant Message	39	19	13	10
Facebook	39	27	18	8
NESS	17	2	1	0
Company Wiki	29	24	7	5
Forum	10	11	4	2
Other	2	2	2	2

Table 4.1: Student CMC Technology Use (2008/09)

Supporting the results of the CETL-ALiC project's previous comparative analysis of student reports, e-mail once again played a dominant role in the communication strategies of student teams,

[4] To account for small discrepancies between the results presented here and those described in [1], it should be noted that additional late responses to the survey were received following the latter's publication date. For completeness, all responses have been included here.

represented by a combined mean average of 89% local student adoption and 79.1% cross-site adoption. Continuing another trend, mobile phone and SMS text usage received approximate combined means of 67% local/35% cross-site use and 77% local/25% cross-site use respectively. Unfortunately, no survey respondents reported adoption of the video-conferencing suites at either institution, although Skype was often used in their place for both local and cross-site communication (with a combined mean of approximately 29% local use and 64% cross-site use). Wiki adoption was high at Newcastle as its use was mandated, partially for assessment purposes but also to provide students with a central record of their decisions. Furthermore, wiki technology replaced NESS file storage, hence the e-learning platform's marked decline.

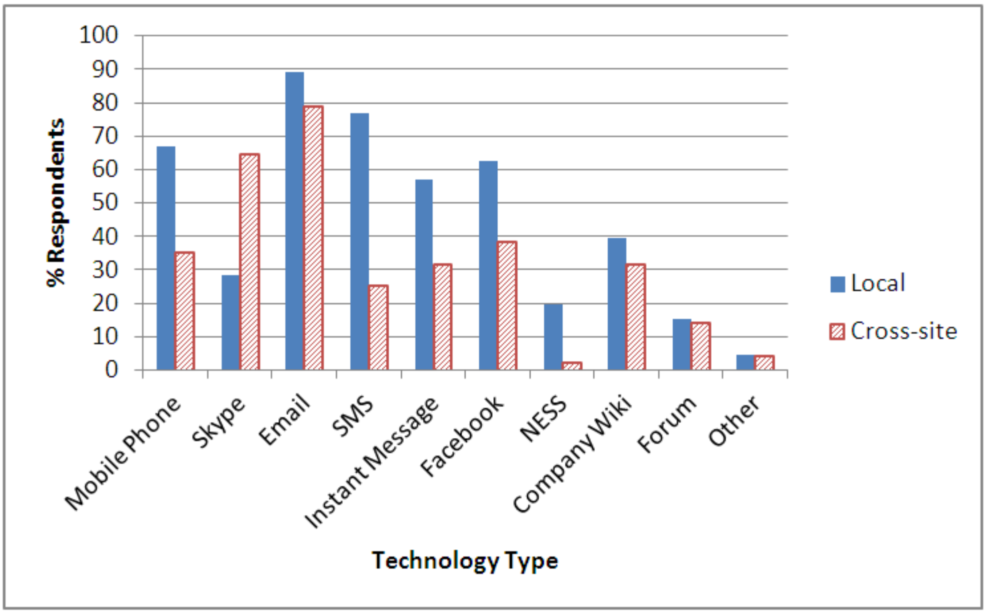

Figure 4.1: Student Technology Use Survey Results (2008/09)

One notable difference between earlier findings and this investigation is the significant number of students who used Facebook regularly for both local and cross-site project-related communication. At Newcastle University, 61.9% of respondents reported that they made use of the social networking service for local team collaboration, with a further 42.9% adopting the technology cross-site. At Durham University, 64.3% of students reported local use and 28.6% cross-site. These figures represent a far higher level of social media adoption than was ordinarily reported in student reports (very little mention of Facebook appeared in interim team reports submitted at the same time). In actuality, I suspect the true amount of regular social-media use to be higher again, but students often stated that they did not regard off-task social interaction with team mates to be a valid form of “professional” communication (as I will discuss in 4.4, interviews conducted post-project suggested that all respondents used Facebook at one time or other to interact with team mates locally and/or cross-site).

Which technology is your primary method of communication?				
	Newcastle Uni. (n=63)		*Durham Uni. (n=28)*	
	Locally	*Cross-site*	*Locally*	*Cross-site*
E-mail	41	44	9	16
Skype	1	16	6	6
Telephone/Text	12	0	4	0
Facebook	4	1	2	0
Face-to-Face	3	0	4	0
Other	2	2	5	6
Which would you say allows you to collaborate best?				
E-mail	35	25	6	3
Skype	0	16	3	7
Telephone/Text	6	1	1	0
Facebook	5	7	4	1
Instant Message	11	5	1	2
Other	6	6	4	5
None/NA	0	3	9	10

Table 4.2: Primary/Preferred CMC Technology (2008/09)

This survey also sought to determine each students’ *primary* communication choices for both local and cross-site collaboration. In the majority of cases, as described in Table 4.2 above, e-mail was reported as the primary choice for team/company interaction; a combined mean local and cross-site preference of 54.9% and 65.9% respectively was discovered. Telephone calls and text messages took second place in terms of local communication preference (17.6%) with Skype representing the second cross-site tool of choice (24.2%). When students were asked which tool allowed them – in their opinion – to collaborate best with team mates, again the majority chose e-mail with an average local and cross-site mean of approximately 45.1% and 30.8% respectively. Of particular interest, the emergence of Facebook as a primary and preferred communication technology suggested a notable shift in student/team technology adoption. Although comparatively low when considered alongside the dominance of e-mail and Skype, I do again believe that these numbers were in reality a lot higher, especially towards the latter half of the activity (as I will show in Chapter 6).

4.3 Communication Issues

As touched upon earlier in this thesis, participating students at Newcastle University were required to compile mid- and end-of-year reflective reports on the communication strategies adopted on project – both individually and as a team – and demonstrate an appreciation of how their actions, roles and attitudes affected the software development process as a whole. With particular relevance to this study, students were also expected to discuss the communication problems encountered on-project, both locally and cross-site, and then provide an account of the tools and techniques adopted to overcome those difficulties. It is from those sources, alongside simple team observations, that I mainly derive my understanding of the problems faced by student teams during the first three years of the cross-site project (2005/06-2007/08). However, a number of valuable post-project interviews were also conducted with students to gather additional feedback on the CETL-ALiC project as a whole. I will now briefly describe the format and approach of those interviews before going on to provide an aggregated summary of student feedback.

4.3.1 Post Project Interviews

Unstructured group interviews were conducted at Newcastle University in week 12 of the 2007/08 (and later 2008/09) academic years. The primary goal of each hour-long session was to gather qualitative feedback from students on a broad spectrum of CETL-ALiC project-related topics, from team formation and communication issues to facility provision and mandate quality. Although open to all participants, at least two students were required to attend from each team to ensure that the experiences of every company were represented (n = 59, 2007/08). Chaired by this author, questions were kept intentionally open-ended to encourage two-way communication and allow students to express their opinions freely on whichever topics mattered most. However, a broad framework of questions asked:

- How well did students enjoy the project and how could it be improved next time?
- How interesting and challenging did students find the project mandate?
- How effective and realistic was communication with the client?
- What lessons did students learn that could help them in their future careers?

- How well did students get on with their local and cross-site team mates?
- What was the working atmosphere like? Did everybody pull their weight?
- Did students feel a vital part of their team/community?
- Where students always able to tell what their team mates were working on at all times?
- If students needed to contact a team mate immediately, could they?
- Which roles/team structures were adopted on-project and how well did they work?
- How fair was the division of work between sites?
- Which forms of communication technology were adopted for local and cross-site interaction?
- What communication problems were experienced and why?
- Which faculty-provided technologies were\were not used and why?

As instructor contact with student teams was kept intentionally low during the project, these final-stage feedback sessions represented a valuable opportunity to surface problems and expose latent issues that affected the quality and learning outcomes of the project. With the pressure of deadlines removed, students were able to reflect and focus on the practical successes and failures of the project as whole without being distracted by routine, trivial difficulties and short-lived interpersonal conflicts (of which there were many). The feedback gathered, although at times anecdotal, therefore served to confirm my understanding of the communication issues experienced. In turn, the lessons learned directly informed successive year's project mandates, technology provisions, team sizes, pedagogic approaches, and assessment techniques.

As mentioned, additional post-project group sessions were also conducted in week 12 of the 2008/09 and 2009/10 academic years. However, as the focus of these interviews relate directly to later studies, I will address their observations separately in Chapters 6 and 8.

4.3.2 Overview of Student Feedback

Students collaborating on project frequently reported substantial problems interacting with team mates both locally and cross-site, attributable in no small part to the sheer variety of technologies provided by the CETL-ALiC partnership. Due to students' initial unfamiliarity with collaborative technologies (despite orientation lectures designed to introduce students to the practical benefits of each facility), many teams attempted to use *all* of the technologies available to them rather than the subset that worked best. Coupled with the cognitive effort required to interact via modern CMC devices [151], the end result was often a breakdown in team communications that invariably led to duplication of work, increased frustration, and reduced team morale and cross-site relations. Far more troublingly, a lack of team awareness and community spirit also occasionally led to the isolation of peripheral team members and to decreases in personal motivation that could potentially affect a student's final grade.

Local communication issues stemmed primarily from poor attendance at meetings, a lack of confidence during discussions, and the ever-present perceived threat of "free-loading" – issues which brought to the fore any latent dissonance in the group and fuelled the very breakdowns in communication that students complained of (whether or not those concerns were valid in the first place). Furthermore, students frequently reported that communications simply ground to a halt between weekly team meetings; for some students, formal meetings represented the *only* time that two-way interaction could be achieved. Unfortunately, company-wide communications were far more problematic with students often finding it difficult to view their cross-site counterparts as part of a larger, single team (I frequently observed that student demeanour and language were notably formal and restricted during video conferences). Again, a lack of cross-site communication between formal meetings often resulted in the same deterioration in relations (especially in the second semester), although those occurrences were greatly exacerbated by the very nature of the company division – both geographic and institutional – as the following student comment illustrates:

> *"With our cross-site counterparts obviously not being on the same site as us we are required to use different forms of communication to contact them and it has not been going as well as we had hoped. From an outsider's view keeping up communications and maintaining good relations is simple as it only requires a video conference or a few emails or meetings each week. In reality this was hard to maintain..."*

The communication strategies adopted by teams generally went some way to work around the problems encountered, as did their efforts to persist with the technologies provided. In video-conferencing sessions, teams often elected a single "liaison officer" at each site to collect and disseminate information between teams. Unfortunately, this effectively shielded most participants from an important aspect of the collaboration and thus widened the perceived divide between institutions. As students rarely interacted in person with their cross-site counterparts, an "us and them" mentality grew distinctly apparent – sentiments which were echoed in final reports and post-project interviews (of course, there is always a tendency for teams to denigrate the out-group [155]). In other teams, video-conferencing meetings were often dominated by one or two individuals, leaving other students reluctant to speak. The outcome of this was that some participants failed to see the value of video conference sessions and thus stopped attending [150].

Feedback also showed that co-located students often found it particularly difficult to determine, even after face-to-face discussions, what their team mates were working on at any one time. This was even more evident cross-site where few students were able to keep track of the activities of their geographically remote team mates. Inevitably, this lack of communication led to the duplication of work and increased frustration mentioned earlier; in particularly acute cases, it also often resulted in serious motivational and interpersonal issues. As a result, participants were not greatly motivated to help one another across sites and thus found it difficult to respond to company communications in a timely fashion (see [156] for a more detailed discussion). Paradoxically, e-mail was often reported as the primary cause of delays and frustration on-project, despite representing the CMC tool of choice for many students. A lack of reciprocacy was one lament often reported by participants; many students frequently heard nothing back from important cross-site communications or received feedback too late to be of any use (as an aside, this is also a common problem in industry where distributed working practices have been shown to slow down work, at least perceptually [157]). Reports from team monitors also suggested that students were reluctant – at least in the early stages of the project – to exchange personal contact information (e.g. mobile telephone numbers, instant-messenger IDs, etc.) until they had become better acquainted. Naturally, this did little to foster team interaction, group awareness and community building between teams.

To better highlight the issues discussed thus far I now include excerpts from student feedback reports discussing the communication problems encountered on-project, emphasising the difficulties experienced both locally and cross-site:

> *"We could not meet ad hoc to discuss progress. This meant we had no way of monitoring or checking the progress at the other site between formal weekly meetings, except via email – and these messages did not contain enough detail about what had been done."*

> *"The bigger the team, the more people that we needed to keep in the loop, which was a problem because each student had their own working patterns. Some did not read their email every day and some decisions needed a quick response from key members in the team. This meant that decisions were often delayed."*

"Brief comments in the repositories for code and documents were not detailed enough and we were often unsure who was working on which module or document at any one time. This often led to the repetition of work."

"It was often easy to misinterpret the intent and tone of an email or IM message and this led to conflict in the group. Some of us felt that being asked constantly about progress meant that our colleagues did not trust that we were working on our assigned tasks."

Returning briefly to the level 2 technology usage survey discussed in 4.2.2, I also sought to determine the exact types of problems encountered by students collaborating on-project during the 2008/09 academic year. In response to the question "*Where do you feel communications are breaking down between team mates?*", again the majority of respondents blamed e-mail – or rather the non-checking of e-mail. For example, free-text responses to the aforementioned question included:

"Poor rate of response from email, makes us feel like [the cross-site team] are not bothering."

"Email, when people don't check it often enough."

"It takes people a while to reply to emails."

"Lateness in responding to emails."

Further results from the 2008/09 survey helped to provide a snapshot of student participation and perceptions towards local and cross-site interaction at the midway point of the project. However, as that data complements a later investigation presented in Chapter 6, I will defer discussion of these general findings until then.

4.3.3 The Ties That Bind

As students became increasingly familiar with freely available online communication technologies, they started to incorporate them into the CETL-ALiC project to fulfil their group communication needs (and to mitigate the shortcomings of the technologies provided). Facebook is perhaps the best example of this. During the first three years of the project its use was reported by a significant proportion of participants, but usually only during meetings, presentations and post-project interviews; rarely was it mentioned as part of an individual or team's formal communication strategy. In the 2007/08 academic year, only two companies noted its use as a formal collaboration tool with four others reporting that they had used it on an informal basis to "maintain the momentum of the project", "build team morale" and "organise social events". Interestingly, the companies that did formally report use of Facebook stated that they had used the chat and message facilities as a back up for when there were delays in response to e-mail (their primary method of communication). Even if someone did not answer their mobile phone or read their e-mail, companies felt certain that team members would eventually log on to Facebook and would feel compelled to respond – almost as if resistance to Facebook was futile. And unlike all of the other CMC technologies mentioned in team reports, Facebook received no negative comments.

4.4 Facebook

Learning does not occur in a vacuum. It is a social, reflective process in which students continually share expertise, create knowledge and strategically monitor the assigned actions of others [65]. The social interaction that occurs in this context encourages trust, empathy and the strengthening of weak ties [88], especially where the social process of software engineering is concerned [90]. The connectivity and community building affordances of social networking services therefore represented an extremely attractive means to improve student communication, group awareness and the generation of social capital across all aspects of the group programming activity. As a focus of this research going forward, the phenomenal popularity of Facebook in particular – in addition to its integral place in the daily lives of students – made it an obvious choice.

4.4.1 A Brief History

Launched in February 2004, Facebook is a social networking service that encourages its registered members to freely establish and maintain online connections with friends, family, acquaintances, business and customers around the world. Initially restricted to academic communities, in 2005 the developers made Facebook available to the wider public without limitation, a move which stimulated unprecedented viral growth. At the end of 2011 the site reported it had surpassed 845 million *active* members (users who have logged on to Facebook within the last 30 days), approximately 50% of whom are reported to access the service at least once during any one 24 hour period [158]. In the UK alone, Facebook account penetration stood at almost 49% of the population (nearly one in every two people) [159], with growth showing little sign of abating.

Based on the concept of a US-style “year book”, members joining Facebook are compelled to create a self-descriptive profile to represent themselves and their interests [81], accompanied by an identifying – and often flattering – headshot photograph (see Figure 4.2 overleaf). Users are then invited to articulate their social graph by connecting to other people’s profiles; in doing so they build networks of affiliations based around common relationships, interests or shared circumstances (e.g. home town, educational institution, place of work, political views, recreational interests, etc.). Mutual “friends” (i.e. connections that have been approved by *both* parties) are then able to view one another’s profile information and use the various Facebook collaboration features to interact. These collaboration features stand at the forefront of the Facebook platform’s development strategy and are represented by a constantly expanding array of synchronous and asynchronous communication facilities (providing all common forms of “digital expression” [160]). These facilities include public and private text, video, photo, music and link sharing tools.

The practice of co-constructing social networks of connections on Facebook, informally referred to as “friending”, represents an integral piece of an individual’s self-presentation on the service [77]. Importantly, to facilitate this process, members tend to present their identifying information openly and truthfully (e.g. the use of real names rather than pseudonyms or aliases) seemingly undeterred by privacy issues (as I will discuss in more detail later). As reasoned by Grossman [161], “identity is not a performance or a toy on Facebook; it is a fixed and orderly fact.”

Creating a genuine and representative Facebook profile greatly lowers the transaction costs associated with social searching; that is, finding and connecting to one’s known acquaintances [85]. Notably, this act of mirroring one’s offline relationships online is peculiar to the Facebook community and largely contradicts the longstanding assumption that CMC relationships move predominantly in an online to offline direction [6]. To support this finding, recent surveys [162, 163] also found evidence that the primary use of Facebook was for learning more about one’s longtime acquaintances rather than actively seeking out new connections, with the vast majority of user interactivity (approximately 90%) occurring between close friends and colleagues.

Active and well-connected Facebook members tend to use the service primarily to “track the actions, beliefs and interests of the larger groups to which they belong” [162]. In a recent study, researchers also showed that young people tend to “friend” newly met offline acquaintances whom they would like to learn more about [164]. Facebook’s ability to aggregate and summarise the actions of others – mainly friends – within the system therefore represents an area of particular interest to users [165, 166]. At the forefront of this interest lies the service’s *News Feed* feature, a simple yet powerful facility that allows members to keep track of their friends’ actions via a real-time chronicle of Facebook activity (e.g. public conversations, media uploads, shared links, upcoming events, etc).

Figure 4.2: Illustration of a Typical Facebook Profile Page

More significantly, the ability to broadcast and share "status" information – brief text-based messages describing one's opinions, thoughts and current activities – via the *News Feed* is also highly regarded by users, demonstrated not only by its dominant use on Facebook but also by the unprecedented success of microblogging services such as Twitter [167]. As described in the broader sense by Lampe et al. [162], status updates provide the means by which users interact with one another and track the actions, beliefs, and interests of those in their network.

4.4.2 The Facebook Platform

Facebook offers unparalleled access to the personal information and activities of one's friends and colleagues, in addition to supporting numerous synchronous and asynchronous communication facilities. To exploit these features and further enhance the user experience, Facebook opened its platform – via the Facebook Application Framework [168] – to software developers in 2007. As I will discuss in detail in the next chapter, this allowed third-party web-based applications (or "apps") to be deeply and seamlessly integrated into the site, taking advantage of the social connections of its members. To the end-user, applications and third-party web services are presented as a native part of the site, embedded within its layout and inheriting many of the visual styles that Facebook members are accustomed to. Of course, many of the applications available on the service are social in nature and tend to rely largely on existing contacts rather than the accrual of new "friends". As such they serve to strengthen social ties rather than increase the overall size of one's social network [163].

As an aside, developers can also use an extension of the application framework (named *Connect*, released in 2008) to expand and socially-enable their own third-party web pages and services, thus leveraging the inherent power of their user's Facebook identities. Impressively, since the release of both frameworks, Facebook now boasts more than 500 million users of 7 million third-party applications worldwide [158].

4.4.3 Level 1 Facebook Survey

For many students, Facebook is an integral part of their daily routine; beyond micro-managing their social life it offers an inherent capacity for generating social capital [86]. Students can interact with one another formally and informally [70], build trust [132], and extend their communication potential beyond the geographic confines of their institutions. As shown by Selwyn [84], the service can also act as an important site for the informal, cultural learning of being a student, with online interactions allowing roles to be learnt, values understood, and identities shaped. And as the service pervades the private and business world more and more, Facebook represents a communication channel that is hard to ignore. Thus, to ascertain the extent of Facebook adoption in Newcastle University's level 1 student population (and in turn allow me time to prepare for their participation in the CETL-ALiC project at level 2), I conducted a basic paper-and-pencil self-report survey of all new entrants to computing-related programmes. A brief account of the most relevant results from that investigation will be presented here.

Conducted as part of the technology ownership survey discussed in detail in Chapter 3, printed questionnaires were distributed in introductory lectures during the first weeks of the 2008/09 and

2009/10 academic years. Excellent coverage of each year's intake was obtained with 125 respondents in 2008/09 and 108 respondents in 2009/10. All participants surveyed were enrolled on full time, single honours Computing Science and Information Systems programmes at Newcastle University, represented by 87.5% male and 12.5% female undergraduate students across both years (with a mean average age of 19.63, standard deviation 1.81).

	2008/09 (n=125)	*2009/10 (n=108)*
Do you have an account with [Facebook]?		
Yes	121	108
If yes, how often do you access your Facebook account?		
Several times a day	65	59
Once or twice most days	39	41
Once or twice a week	12	8
Once or twice a month	5	0

Table 4.3: Student Facebook Account Ownership Statistics (2008/09-2009/10)

By the 2009/10 academic year, Newcastle University student Facebook account ownership had risen to 100% from approximately 97% the previous year (following ownership of 91% in the 2007/08 year). As shown in Table 4.3, these findings reflect the growing trend of student Facebook adoption across the CETL-ALiC partnership [5] and in wider academic contexts [169]. Results also exposed significant daily use of the service: approximately 86% of registered students logged in "several times a day" or "once or twice most days" during the 2008/09 year, increasing to 93% the year after. However, as one would expect, the estimated amount of time students reported that they spent on the site during each visit varied widely and offered few insights; however, the 10-30 minute time span found the most favour with a combined mean average of 40.1% across both years.

When prompted to describe the primary reasons why they used Facebook (see Table 4.4 overleaf), a 96.5% combined mean average of respondents across both years reported it was "to keep in contact with current friends and family". Similarly, 54.1% reported that they made use of Facebook "to find and reconnect with old friends and family with whom [they had] lost touch", with a further 53.7% stating it was "to organise and participate in events or groups". Only 18.3% of respondents claimed that they used the service "to find and make new friends", confirming the assertion that relationships on the service tend to move in an offline to online direction. In response to additional questions which sought to gauge the degree of familiarity between student participants and their social graphs, respondents stated that "few" or "none" of their relationships existed online only (an approximate average of 30% and 51% respectively) or that their "friends" were largely unknown to them (an approximate average of 42% and 52% respectively).

	2008/09 (n=121)	*2009/10 (n=108)*
What are the primary reasons that you use Facebook?		
To keep in contact with current friends and family	114	107
To find and reconnect with old friends and family with whom you've lost touch	69	55
To find and make new friends	24	18
To organise and participate in events or groups	62	61
To use applications (including games and quizzes)	28	51
Other	7	6
Which features of Facebook do you engage with most?		
Posting status updates or viewing/commenting on others	109	96
Browsing my friends' profiles	7	56
Viewing and commenting on my friends' photos and videos	87	59
Using apps/playing games	46	75
Organising or participating in events	46	52
Chatting with friends	96	90
Creating or participating in online groups or discussion boards	11	11

Table 4.4: Student Facebook Usage Statistics (2008/09-2009/10)

Use of "apps" to perform tasks or play games increased from 23.1% to more than 47% between 2008/09 and 2009/10 indicating an increasing willingness to use this aspect of the service (free-text responses in 2008/09 indicated that students found Facebook applications to be "a waste of time" and "used to generate spam"; no such responses were received in 2009/10). Incidentally, this growth coincided with the increase in social gaming platforms on the service [170]. In terms of the Facebook features most regularly used by students, a fairly wide spread of technology adoption was observed across both years of the study. As detailed in Table 4.4 and illustrated in Figure 4.3, “posting status updates or viewing/commenting on others” came out top with a combined mean average across both years of 89.5%, followed closely by “chatting with friends” with a little more than 82%. Viewing and commenting on photos and videos achieved a combined mean average across both years of approximately 63.8% with profile exploration reported by 56.8% of respondents and participating in events reported by 42.8%. Continuing the trend identified earlier, application use and game playing again grew from 38% to nearly 70% between the 2008/09 and 2009/10 academic years.

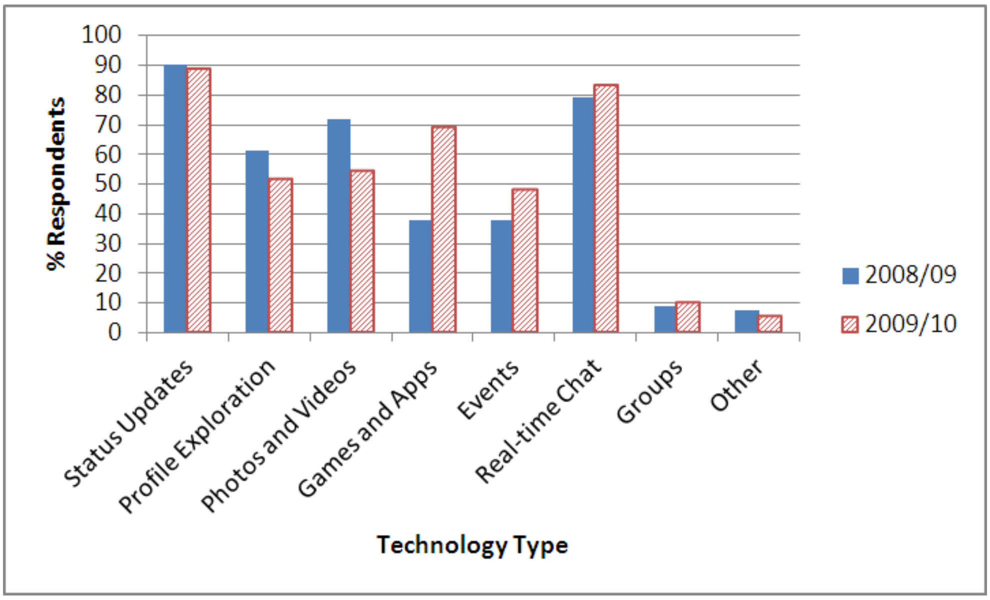

Figure 4.3: Overview of Student Facebook Usage (2008/09-2009/10)

Notably, when prompted to consider if Facebook helped strengthen offline relationships, over 65% of 2008/09 respondents believed it did, with a further 18% unsure. In 2009/10 these figures increased to approximately 81% and 16% respectively, indicating an increase in the perceived positive impact of the service on real-world social connections.

4.4.4 Trust, Privacy & Self Disclosure

As I have already shown, Facebook is a dominant locus in daily student life both on and off campus, and as complementary research indicates, students will often invest considerable effort in building relationships around shared interests and knowledge communities on the service [171]. However, without a sense of trust and belonging between virtual participants, understanding, empathy and consensus are not likely to occur [88, 172]. Fortunately, Facebook's online mirroring of offline relationships and real-world social boundaries often dictates a user's self-presentation and behavioural norms on the service (members tend to create genuine and representative profiles and publish reliable and accurate user-generated content). As described by Grossman [161], there is very little room for idealisation or misrepresentation on Facebook, and as a result users operate under the assumption that the social clues that they receive about fellow participants are truthful [132]. In turn, this unique aspect of the service encourages community members to track one another's actions and beliefs [162] and ultimately build trust and empathy within their social groups.

Motivated by these findings, the technology ownership survey conducted during the 2008/09 and 2009/10 academic years also sought to determine student attitudes towards self-presentation and information disclosure on Facebook. Importantly, I did not intend to investigate privacy issues in detail (Facebook privacy has been the subject of many works [e.g. 131, 132, 172]); I simply wished to gain a general understanding of the degree to which students represented themselves accurately on the service (and, in turn, the extent to which project participants could trust the personal information and published content of their colleagues).

	2008/09 (n=121)	*2009/10 (n=108)*
Are you concerned about protecting your privacy on SNS services?		
Yes	82	84
No	17	20
Don't Care	22	4

Table 4.5: Student SNS Privacy Concerns (2008/09-2009/10)

As shown in Table 4.5, approximately 67.8% of 2008/09 and 77.8% of 2009/10 respondents stated that they were concerned about protecting their privacy on social networking services, with those who did not – or at least did not care – falling from 32.2% to 22.2% between years. Acquisti & Gross [131] found in 2006 that students often only paid lip service to privacy concerns and, in practice, took a far more relaxed approach to information publication (often unaware of the consequences and true reach of their online activities). Since the time of that work, however, Facebook members have grown increasingly aware of the issues surrounding online security. As stated by the findings of Boyd & Hargittai [169], students are now far more active in the management of their privacy settings to an extent dictated by individual technical know-how and confidence.

	2008/09 (n=121)	*2009/10 (n=108)*
Is your Facebook profile an accurate representation of you?		
Yes	92	93
Is your Facebook profile picture an accurate representation of you?		
Yes	102	104
If you have intentionally omitted, restricted, obscured or exaggerated information in your profile, why?		
To protect my privacy	90	101
To make myself look better to friends	17	7
To pretend to be someone else for fun	14	5
To hide potentially embarrassing information	21	11

Table 4.6: Student Self Presentation on Facebook (2008/09-2009/10)

In response to questions regarding student self-presentation online (as shown in Table 4.6 above), approximately 76% of 2008/09 participants felt that their Facebook profiles represented a true reflection of their personality, growing to over 86.1% the following year. Similarly, 84.3% of 2008/09 participants felt that their Facebook profile pictures resembled a genuine personal likeness, growing to 96.3% in 2009/10. Where a student's profile did not reflect their true self, the primary reason given was one of privacy protection (74.4% in year one growing to 93.5% in year two) and, to a lesser extent, to hide embarrassing information. Beyond protecting sensitive personal information, however, the number of respondents claiming that they had intentionally falsified or exaggerated their profile information fell between survey years; as suggested by Lampe et al. [162], an accurate representation lowers the costs associated with social searching and allows participants to accrue more social ties (Facebook users often attempt to "show off" to their peers by creating vast networks of friends, believing their perceived popularity to be directly linked to the depth and extent of their online social connections [173]). Moreover, due to Facebook's basic opt-in philosophy and the reciprocal nature of its connections, users who do not adhere to the behavioural norms of the service will quickly find themselves isolated from the group; misrepresentations are therefore usually playful or ironic as opposed to intentional deceitful [85].

Of course, although social networking services are open to abuse – a fact often reported by popular media – it is nevertheless extremely important to recognise their significant popularity and potential as a platform for community building and professional on-task collaboration.

4.5 On-Project Facebook Adoption

Returning to the results of my level 2 technology usage survey, I also sought to determine the degree of autonomous Facebook adoption by students participating in the CETL-ALiC group programming project (see Table 4.7 overleaf). The motivation for this investigation was to determine the particular communication tools most used by students collaborating via the service, and in turn the facilities that they found worked best for both local and cross-site team communication. Of the 91 respondents who completed the questionnaire (distributed after the first semester of work in the 2008/09 academic year), approximately 75% of respondents stated that they used Facebook to communicate with members of their local team (represented by 50 respondents at Newcastle University and 18 at Durham University). Significantly, only a little over 32% of respondents stated that they used Facebook cross-site (22 at Newcastle and 7 at Durham), once again confirming that Facebook is used predominantly for building and maintaining online connections with one's offline social groups. Of those respondents, the most popular Facebook functionality used on-project was chat: 89.7% stated they had used this facility to interact with their local team mates with a further 60.2% stating they had used this facility cross-site. The next most popular facilities were direct messages (75% locally, 26.5% cross-site), wall-to-wall posts (55.9% locally, 20.6% cross-site), and discussion pages (47% locally, 38.2% cross-site).

Interestingly, the most popular facilities used by students on Facebook are the same as, or at least comparable to, the technologies provided by Newcastle and Durham universities for use on-project, differing only by being located in one combined, readily accessible location. Of course, a long standing body of research establishes the importance of context and familiarity when people are confronted with new technologies. Kling [174] and Orlikowski [87], for example, show that learning a new technology requires considerable time and mental effort. Unless individuals can *quickly* understand and appreciate its benefits, they can and probably will resist it. These findings provide an explanation for the failure of the CETL-ALiC initiative's attempts to stimulate collaboration by introducing students to a variety of new communication methods early in the project – too many technologies presented too fast.

Which Facebook features have you used to interact with team mates?				
	Newcastle Uni. (n=50)		*Durham Uni. (n=18)*	
	Locally	*Cross-site*	*Locally*	*Cross-site*
Chat	44	27	17	14
Wall-to-wall posts	30	12	8	2
Status comments	15	3	4	0
Group pages	22	20	10	6
Photo/Video comments	5	1	0	0
Applications	6	4	0	0
Direct messages	39	21	12	6
Other	2	1	1	0

Table 4.7: On-Project Student Facebook Technology Adoption (2008/09)

	"Yes" (n=68)
Would you say Facebook encourages you and your team to be more open with each other?	50
Have you ever sought to learn more about your team mates via their Facebook profile?	47
Would you say Facebook helps you to build trust with your team mates?	43
Would you be comfortable using Facebook to interact with your team mates?	57

Table 4.8: Student Attitudes Towards On-Project Facebook Use (2008/09)

Returning to the results of the technology usage survey, students' attitudes to Facebook were very positive in terms of team-building and team communication. As can be seen in Table 4.8 above, when project participants were asked if they thought Facebook encourages openness, a combined total of 73.5% of respondents across *both* institutions said yes. In terms of developing relationships, 69.1% reported that they had sought to learn more about their company team mates via their Facebook profile. These results are encouraging, especially considering the lack of on-project face-to-face interaction which, in normal team working situations, often helps to strengthen working relationships. Thus, if Facebook can help increase student familiarity and establish an increased level of trust (63.2% of respondents said they thought Facebook helped to do this), then the stronger relationships created as a result would make communication easier. Leading into the following section, 83.8% of respondents also said they would be comfortable interacting with team mates via Facebook.

4.6 Finding a Common Ground

As discussed in the previous chapter, the CETL-ALiC team became increasingly aware during the early stages of the partnership that time and resource pressures were making it difficult for students to maintain adequate levels of communication during the project (adequate, in this sense, referring to the minimum degree of communication required to ensure a successful outcome to the activity). In particular, once structured face-to-face and video-based team meetings dispersed, participants noticeably struggled to preserve the levels of enthusiasm and collaborative momentum needed to work effectively. To address this issue, project teams were provided with a variety of advanced CMC technologies to support and enhance their distributed efforts; however, whilst those technologies did play a role in supporting interaction, experiences also demonstrated that teams ultimately abandoned them in favour of more convenient, proven technologies. Facebook, as I have already shown in this chapter, is perhaps the best example of this.

4.6.1 Embracing Facebook

As posited by Fussel et al. [151], for a distributed group to accomplish a shared task effectively, its members must maintain frequent communication in order to coordinate their efforts, negotiate their goals, disseminate task related information, and successfully make decisions. Facebook provides a uniquely effective means to do just that; it is demonstrably capable of reducing the barriers to interaction and community formation by offering users unparalleled access to the personal information and activities of their friends and colleagues. More specifically, the numerous synchronous and asynchronous communication facilities offered have been shown to strengthen existing social ties by encouraging users to interact with and explore the personal profiles, statuses and work rhythms of their connections [163]. Thus, by creating virtual networks based upon personal relationships and academic, business and geographic affiliations, the connections formed on Facebook can significantly enhance a user's "place-based community" [175] and return strong payoffs in terms of support and access to expertise and knowledge (e.g. social capital).

Consequently, in a collaborative educational context, Facebook represents an extremely attractive means to foster student interaction and community building on-project. Motivated by this reasoning, I endeavoured to find ways to embed the networking service's communication and "social awareness" affordances – profile creation, synchronous and asynchronous chat, status updates, etc. – into the CETL-ALiC cross-site software engineering project. Forming the main contribution of this thesis, that work ultimately resulted in the proposed development of a "social application" capable of coupling the aforementioned collaborative features of Facebook with project-centric team scheduling and planning facilities. Affording project participants the capacity to explore the "common ground" that exists between them, the application would create a "sound social space" [104] capable of facilitating social presence, chance encounters and social contact that often facilitates valuable "on-task" discussion (productive interactions in a team working environment often occur during chance encounters [70]). Consequently, this effort would extend into the virtual domain the CETL-ALiC mandate to create flexible and "sociable" public spaces in which students can interact.

The pedagogic motivation behind this work was to foster greater group-oriented interaction by filling the communication void that often arose between face-to-face meetings [6]. By reducing the geographic and temporal barriers to interaction and community formation (especially where 'peripheral', passive team members were concerned), participants would become increasingly aware of each others' skills, personalities, work rhythms and needs – both online and off – within a pre-existing, persistent, convenient infrastructure. Although other social media were considered during this study (and, in the case of Twitter [167], FriendFeed [176], and Presently/Socialspring [177], actively trialled), none were able to compare with the ubiquity, openness, facility provision and extensibility of the Facebook platform, hence my focus on the service. To reiterate a key point made earlier, I was especially keen to avoid overloading students with new, potentially unfamiliar technologies. Clearly, the simplicity, ease of use and instantly recognisable communication affordances of the Facebook service represented the obvious choice of platform going forward.

4.6.2 Considerations

During the concept development phase of this study, my proposed social application was introduced to students in formal team meetings held early in the first semester of 2008/09. Feedback on my research intentions, gathered from a representative sample of student team interviews, highlighted a number of significant considerations. Firstly, participants stated that it was important that my study did not interfere with or monitor their recreational uses of the service (a finding mirrored by similar research into academic social media use [e.g. 178]). Secondly, participants insisted that any application created by me should in no way attempt to interact with or advertise its use to their social graphs (reflecting my earlier discussion, Facebook users posses strong privacy expectations concerning their online exchanges. Indeed, studies have shown that online community members are particularly averse to online observation [165] and feel quite negatively about having their actions and messages studied in research [179, 180]). Thirdly, the common issue of "forced friending" was again raised, with clear anxieties regarding any requirement to add team mates – especially cross-site colleagues – as "friends" in order to participate in this study. It was therefore important that my application did not depend on the platform's standard "friending" processes in order to create a project-centric network on the service. Finally, as an extension of the first concern, participants did not want my application to generate an abundance of project-related information (as Fussel comments, with an increase in information volume comes potential overload [151]). A means to aggregate project-specific information asynchronously was therefore required.

	"Yes" (n=91)
Would you consider installing and using [our proposed application] on Facebook?	76
Would you prefer to keep [your application status] separate from your main Facebook profile status?	72

Table 4.9: Student Attitudes Towards On-Project Facebook Use Cont. (2008/09)

Aside from these concerns, however, the technology usage survey discussed in 4.2.2 found that students were quite willing to use my proposed Facebook application for both local and cross-site team collaboration. Importantly, for those participants who were averse to Facebook use, the reasons given again mirrored the privacy discussion above (i.e. apprehension about being monitored or needing to use the service for formal "work" purposes). Furthermore, as shown in Table 4.9 above, 79.1% of respondents requested that any application-based status information be kept separate from their main Facebook profile status (with a further 16.5% stating that they did not really care).

As touched upon in Chapter 2, I also faced some opposition from colleagues who were uncomfortable with my approach to personal technology use on-project. One argument against the CETL-ALiC initiative as a whole was the need to maintain parity between students by offering a "standard" set of computing equipment in a laboratory setting, thus avoiding any individual requirement to invest in expensive computing technology (a fear also expressed in the literature by Breen et al. [126]). Of course I shared this concern, but as the level 1 technology ownership survey shows, it is in fact commonplace for computing students to possess comparable, internet connected CMC devices (furthermore, students could always access and use university facilities if required). With regards to initial criticisms regarding Facebook's longevity (most social networking services tend to experience fast initial growth followed by inevitable decline – often as users move to competing services), I believe it is safe to say that the platform has stood the test of time. I also sought to conduct my research as generically as possible so that the pedagogic outcomes and practical lessons learned could be applied equally well to any social networking platform, past, present, or future.

4.7 Concluding Remarks

Encouraging interaction and communication in student teams presented a significant challenge to the CETL-ALiC partnership. As discussed in this chapter, students often struggled to create and sustain an effective degree of contact outside of formal face-to-face and video-facilitated meetings (invariably resulting in duplication of work, increased frustration, and reduced team morale and cross-site relations). As this study has revealed, local communication problems usually stemmed from poor attendance at meetings, a lack of confidence during discussions, and the ever-present fear of "free-loading". Cross-site, the geographic and institutional divisions only added to these problems, with students frequently unable to tell at any one time what their counterparts were working on. Left unchecked, this lack of interaction and community spirit ultimately lead to decreases in motivation and contribution that could potentially affect a student's final grade.

To explain the cause of these issues, the analysis of reflective reports and interview feedback presented in this chapter indicated that students were often reluctant to adopt and embrace unfamiliar CMC technologies on-project (mandating faculty-provided platforms and devices helped somewhat, but such intervention was costly and frequently undermined natural team collaboration). When frustrated by unreliability issues or an "overload" of CMC tools, teams invariably adopted the technologies most familiar to them. Results from this chapter's technology survey indicate that e-mail in particular played a dominant role in both local and cross-site student communication strategies (coupled with mobile phone calls and text messages for fast, "emergency" team contact). However, although some positive results were reported, the tools adopted were simply unable to provide the collaborative depth and social affordances needed to significantly influence group awareness and the building of social capital on-project. As a result, students were not greatly motivated to help one another and found it difficult to respond to requests for information and assistance in a timely fashion.

One notable exception to this general trend was the high levels of interaction with popular and freely available social networking services. As the work presented in this chapter observes, Facebook in particular emerged as a popular choice for communication with team mates (albeit mostly in local circumstances). The findings described also show that students rated the service's ability to facilitate interaction and community building on-project very positively, with universal account ownership and heavy daily usage indicated. Indeed, for many students, Facebook is an integral part of their daily routines both on and off campus. Beyond helping to micro-manage social activities, the simplified dynamics of relationship building on the service also enables students to strengthen fledgling relationships with colleagues, disseminate information, and interact with one another formally and informally. In turn, the service is able to facilitate trust, group cohesion, common understanding, and an orientation towards cooperation. And unlike many other CMC technologies available, Facebook users present their identities openly and truthfully with little exaggeration or misrepresentation – a critical requirement for effective online team building.

Facebook therefore represented an attractive means to foster team collaboration across all aspects of the CETL-ALiC group activity. Motivated by this finding, I proposed the development of a social application capable of extending and augmenting the Facebook service with project-centric communication and planning facilities. Conceived of as a means to encourage group-awareness, interaction and community formation (and in turn the generation of social capital), the proposed application would also foster greater inclusion of "peripheral" team members who present difficulties forming and maintaining offline relationships with their colleagues. Importantly, survey data confirmed student willingness to use such a tool so long as it did not interfere with their normal, recreational uses of the service, as I will discuss in the following chapter.

4.8 Summary

In this chapter I presented and discussed the findings from an investigation into CMC technology use and the general communication issues experienced by students participating in the CETL-ALiC group programming activity. Leading on from this, I explored the techniques and tools adopted by students to overcome those problems, including the emergence and growing use of the social networking site Facebook. A detailed analysis of the service's use on-project, and its impact on team communication strategies, was provided. Motivated by these findings, I finally proposed the development of a social networking tool capable of harnessing the collaborative potential of Facebook to foster greater team awareness and community building across all aspects of the group programming activity.

In the next chapter I will go on to discuss the realisation of the proposed application and the additional functional requirements requested by students. Then, in Chapter 6, I will summarise and assess an initial experimental trial of the tool conducted during the 2008/09 academic year.

Chapter 5

Toward a CommonGround

5.1 Introduction

As part of the CETL ALiC initiative, undergraduate computing students at Newcastle and Durham universities participated in a year long, inter-institutional group programming exercise in emulation of modern industrial practices. Teams of second year students acted as “virtual companies” and collaborated cross-site to develop robust software solutions for real-world corporate clients. So far, this thesis has investigated the adoption of social networking technologies by students participating in this project and touched on the potential role that “sociability” and “group awareness” (knowledge of the current activities of one’s team mates) can have on the outcome of that interaction. The previous chapter closed by proposing the creation of a tool capable of harnessing student engagement with the social networking service Facebook; a tool that would strengthen team ties, encourage more effective group interaction, and ultimately generate higher levels of social capital. Naturally, the next logical step in my study was to design and build such a tool.

In this chapter I discuss the implementation of a “socially-enabled” cross-site collaboration tool named *CommonGround*, designed to couple the communication and social awareness features inherent on the Facebook platform with basic project-related meeting, scheduling and project planning facilities. Firstly, in 5.2, I provide an overview of the salient design requirements of the tool as raised in the previous chapter, and then in 5.3 discuss in detail how these considerations informed the implementation of a “proof of concept” trial of the tool. A tour of the tool’s feature set is provided in 5.4, followed in 5.5 by a brief discussion of how the tool performed in practice.

5.2 Requirements

As discussed in the previous chapter, I conducted an initial survey into team communication strategies to gauge student attitudes towards the use of social networking technologies for local and cross-site collaboration. Informed by the findings of this investigation, I proposed the creation of a social tool that, when embedded on the Facebook platform, would harness and extend the built-in collaborative affordances of the service. The proposed tool would then offer an accessible, convenient channel through which team members could meet and interact online.

However, the students questioned in this survey expressed initial reservations concerning my proposal to embed formal academic tasks into what they perceived – quite naturally – to be a predominantly private and recreational social networking service. In fact, students were hesitant to embrace any project-related activity that would interfere with their social identities and behavioural norms on Facebook. Understandably, they wanted to maintain a distinct separation between their professional and personal interests. As indicated by the work of Postmes, Spears & Lea [155], a student's existing social processes, boundaries and divisions are largely accentuated – not reduced – by the casual context in which they use Facebook; any attempt on my part to interfere with this would likely result in the rejection of my proposed tool. In addition, students expressed a great deal of anxiety regarding the "forced friending" of team mates on the service, especially where cross-site colleagues were concerned. Again, these misgivings were perfectly understandable given the informal expectations of Facebook.

In actuality, however, most students recognised and appreciated the salient advantages of using social networking services to foster team collaboration (paradoxically, despite their stated reservations, many were *already* using Facebook for on-task interaction with local team members and welcomed the opportunity to extend this potential cross-site). Thus, provided that I addressed their concerns and respected the line between personal and professional uses of Facebook, students confirmed that they were willing to participate in my study (of course, in an academic context, the line between formal and informal social connections is very fine). An updated proposal was therefore developed specifying a tool to complement and enhance student collaborative potential without directly impacting upon their routine, day-to-day use of the service (primarily by avoiding intrusive profile integration techniques). To maintain the separation between social identities I suggested a self-contained tool that had to be manually launched to be used; activation of the tool would thus indicate "buy-in" and signify a shift in user expectation (and a willingness to engage with team mates professionally, whether on-task or not).

Encouraged by my updated proposal, students next expressed a number of functional requirements for the tool. Coupled with the concerns raised above, I now summarise these below:

- There must be no requirement to add team mates as "friends" on the Facebook service in order to participate in the study

- The tool should not interfere with a participant's routine use of Facebook (or in any way diminish the "fun" aspect of the service)
- Interaction with the tool must be initiated by the participant (i.e. no unsolicited prompts)
- The tool should in no way change the profile information or the primary Facebook status of participants
- The tool must not publicise its adoption or use to a participant's social network
- The tool must respect the privacy of participants; beyond basic profile data, the tool must not solicit/disseminate detailed personal information to other participants
- The tool must include custom collaboration affordances; use of the built-in Facebook communication channels should not be presumed
- The tool must be easy to locate and install; where possible, sign-in details should be stored to permit friction-free access and streamline repeat visits
- The tool must be stable and reliable throughout the duration of the study
- The tool should feature a simple and fast user interface; key team-status and schedule information should be available via a single, comprehensive view

In the remainder of this chapter I will discuss the design and implementation of a proof-of-concept tool created to realise and accommodate the functional requirements proposed above.

5.3 Proof of Concept: CommonGround

Endeavouring to embed Facebook's inherent collaboration and "status awareness" features into the CETL-ALiC cross-site group programming activity, a proof-of-concept Web 2.0 application called *CommonGround* was built to run on the Facebook platform (see Figure 5.1 overleaf. All profile names, e-mail addresses and images used throughout this thesis have been altered to maintain the anonymity of participants; where possible, stock photography representative of the original profile portraits has been used). As third-party Facebook applications exist outside of the site's primary user experience (as optional extensions to the site's standard interface and functionality), this allowed me to realise an important requirement requested by students; namely the creation of a cross-site team-collaboration tool that, when embedded on Facebook's application platform, would in no way interfere with their private day-to-day use of the service. In addition, by taking the form of a Facebook application, a conscious effort would be required to start the tool, thus signalling a change to the context in which the student wanted to use the service.

Figure 5.1: CommonGround on the Facebook Platform

One of the biggest criticisms levelled at Facebook applications by students (during my initial investigation) was that they tended to be unstable and “full of bugs”, slow to load and respond, and prone to lengthy and rather inexplicable “down-times”. Therefore, any inherent difficulties accessing *CommonGround* would immediately put users off – such was their attitude towards third-party Facebook applications. I therefore made considerable efforts to ensure any application created as part of this study was of a professional standard and free from such problems. These concerns largely guided my design and development choices, as the remainder of this chapter will attest.

I will now introduce and discuss the Internet technologies and back-end server support systems required to realise *CommonGround's* design requirements. I first outline and justify my chosen programming languages and target platforms before describing in detail the design and implementation of a broad range of collaborative affordances and supporting server-based systems. I also touch upon the methodologies and approaches used to embed and interface my third-party web application with Facebook's developer platform.

5.3.1 Adobe Flex & Flash Builder

Adobe Flex is a freely available open source framework for designing and developing cross-platform Rich Internet Applications (RIAs) for deployment via the web. Based in part upon the same technology as Adobe Flash, Flex-built applications are rendered by the ubiquitous Flash Player client runtime; a "virtual machine" plug-in available for all major Internet browsers. Additionally, applications limited by the sandbox nature of the Internet browser can also run directly on operating system desktops via Adobe AIR (an installed version of the plug-in), thus receiving elevated privileges to computer resources and the local file system.

Developing Flex applications requires the Flex Software Development Kit (SDK), downloadable from Adobe.com [181]. In addition to providing a comprehensive and mature library of classes and extendable user-interface components (e.g. buttons, text boxes, menus, etc.), the SDK includes robust in-built support for connecting to and interacting with "back-end" data services. Completing the framework is the Flex compiler and debugger along with sample applications, templates, themes and redistributable client runtimes. To complement the open-source SDK, Adobe also offers a premium Eclipse-based Integrated Development Environment (IDE) for Flex called Flash Builder, intended to aid UI design and development [182].

Applications implemented in Flex typically use a combination of two entirely independent programming languages: MXML (an extended form of XML primarily used to mark-up UI components and their appearance), and ActionScript (a fully object oriented, standards-based language for scripting client logic). Both elements are combined during compilation to produce one, small, self-contained Shockwave Flash (SWF) file capable of being seamlessly embedded within an HTML web page and quickly served upon request (or, in the case of AIR applications, downloaded to the desktop). To run, SWF files require the Flash Player client runtime environment for execution; a browser "plug-in" that must be downloaded and installed prior to viewing Shockwave Flash content. Although a potential stumbling block in terms of user acceptance, it was estimated at the outset of this study that "more than 99%" of computer users *already* had the Flash Player installed [183]. Consequently, its availability and installation overheads did not pose a significant concern.

The Flex framework thus represented an attractive platform upon which to design and implement my *CommonGround* RIA. In trials of the SDK, the platform's capacity to realise highly interactive web applications far faster than Java, Silverlight or AJAX alternatives became apparent. Moreover, the platform's enhanced graphics, impressive client-side performance, rich user-experience, and Flash plug-in player availability significantly bolstered its appeal (users which did not have the Flash Player installed were prompted to do so when *CommonGround* was loaded). Running within the Flash environment also ensured my RIA would maintain consistent visuals and behaviours across all supported platforms and browsers.

Considering the authors' pre-existing familiarity with Flash, coupled with the time constraints presented by the project (in particular my desire to deploy the application in time for the 2008/09 academic year), I justifiably decided to employ Flex. The envisaged end product would thus be a web-based RIA – or "app" – capable of running within and interacting with the Facebook website (of which more later). Although Flex applications could be created independently of Flash Builder, it did represent a significantly faster and more robust means to achieve my goals – I thus made use of the IDE to construct *CommonGround* (a free developer's licence for strict use within this academic project was kindly provided by Adobe).

5.3.2 Supporting Server Implementation

To the consumer, third party apps designed for the Facebook platform are presented as a native part of the site, seamlessly integrated and embedded within its layout and reflective of the visual styles its users are accustomed to. This ability to transparently leverage the familiar Facebook UI was actually one of the primary reasons that I chose to target the service – the built-in communication affordances were already fully understood by students. However, as touched upon previously, Facebook apps are hosted on third-party servers and not by Facebook itself; Facebook simply provides an entry point to the application and a means to access and interact with a user's social data. Thus, to support the *CommonGround* RIA, a local server implementation was required to both host the application and to store application-specific user and group data.

I therefore deployed Apache Tomcat (a standalone "pure Java" HTTP web server developed and freely distributed by the Apache Software Foundation [184]) on a non-dedicated desktop computer connected to the Newcastle University campus network. Although other server technologies were considered (and in some cases trialled), Tomcat proved to be the most suitable for the limited scale and load expectations of this study. Tomcat was arguably neither the most robust nor scalable server solution available, but it was easy to deploy, configure, and extend; perhaps more importantly it also provided the Java servlet technology required to support my chosen collaboration and remoting service, BlazeDS (described in more detail in the following section).

Alongside Tomcat I installed the open-source relational database JavaDB (also known as Apache Derby), again distributed by the Apache Software Foundation [185], to host user and group data in addition to a comprehensive array of log files (recall that the application and its data were not stored on the Facebook platform but on my own local server implementation). Naturally, the server-side logic providing the connection between *CommonGround* and the database was also written in Java.

In practice, students were required to consent to my storage and logging of user data before participation in this study, in addition to allowing the application to expose their most basic profile information to team-mates (agreement to the terms and conditions of an EULA was a prerequisite to the activation of their *CommonGround* account). Of course, it was and is my duty to protect the privacy and integrity of all user data as best I can and therefore considerable care was taken to safeguard the server from unauthorised access (including secure setup of services and installation of industrial-strength software firewalls). Furthermore, by hosting the application locally, the *CommonGround* server implementation was also afforded the added protection of Newcastle University's considerable – if at times overly restrictive – network defences and monitoring systems. The university's direct connection to the UK Joint Academic Network (JANET) also ensured I was able to support *CommonGround* with excellent bandwidth and download speeds. As a result, no security issues were encountered or concerns reported during the lifetime of the study.

5.3.3 BlazeDS

To enable me to realise the real-time collaborative features of *CommonGround* – namely distributed text-chat and presence detection (i.e. the process of monitoring and detecting user connection states) – I needed to implement a back-end server component to support the "pushing" of data from one client to the next without the need to constantly poll the server. Unfortunately, this functionality requirement came in addition to the development of the *CommonGround* RIA itself and the application's server-based user/group management and logging systems. Given the time constraints already imposed upon this project, I justifiably sought a "plug-and-play" solution to support these real-time messaging demands. After a lengthy period of investigation I chose BlazeDS.

BlazeDS is an open-source server-based web messaging technology from Adobe designed for use primarily with Flex-built RIAs. Created in pure Java and downloadable from Adobe.com [186], the web application is intended to run on the Java Enterprise Edition (J2EE) platform (however, as touched upon previously, I chose to use the Apache Tomcat server instead). In its most basic form, BlazeDS acts as a *connect* between Flex applications and their back-end server's underlying logic, permitting the asynchronous passing of messages – chat text, for example – between multiple clients in real-time. More specifically, client-side applications utilise BlazeDS's messaging service via its Application Programming Interface (API), publishing messages to a persistent streaming channel on the server via the HTTP protocol (using the open-source and serialised binary Action Message Format). Any other applications subscribed (listening) to the server will then automatically receive those messages. In addition, if any functional calls need to be made direct to the server to invoke specific Java methods (e.g. login authentication), the BlazeDS's remoting service can be used.

Consequently, by deploying BlazeDS on my local server (see Figure 5.2 below), I provided the underlying infrastructure to support *CommonGround's* range of multiuser collaborative features. Real-time chat messages could be published to the server and immediately consumed by all other subscribed clients (server-side logic ensured messages were only passed to the relevant parties – i.e. the members of one's group). Furthermore, following changes to shared data or presence status, "command" messages were generated by the server instructing client applications to automatically refresh their individual data views (e.g. status updates, schedule updates, etc.). This ensured real-time syndication of activity updates to all shared data providers and, again, mitigated any unnecessary traffic from repeat and often redundant polls of the server.

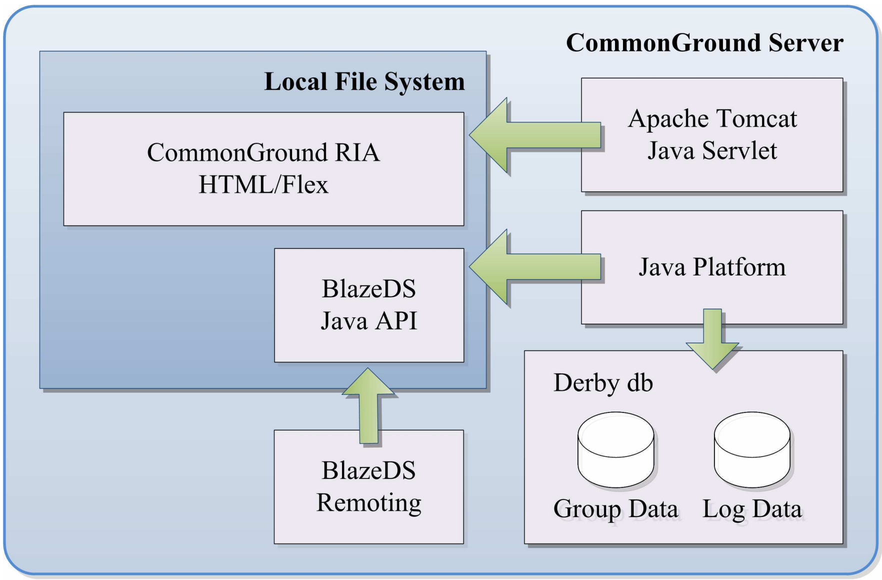

Figure 5.2: CommonGround Server Infrastructure

The server implementation also recorded all user-interactivity information transparently in the JavaDB database, building a comprehensive – and considerably large – data log (the majority of which will help inform the next chapter's analysis).

5.3.4 FBML & the Facebook API

From the myriad social networking sites available online, the motivation for this study's focus upon Facebook was described in detail in the previous chapter: it is an integral part of student life; convenient, familiar and already in frequent use. At the risk of labouring a point reiterated once in this chapter already, it is perhaps more the ability to deeply integrate third-party applications into the Facebook experience that first attracted me – it provided an unequalled opportunity to embed research tools into a student's daily routine in a largely transparent and non-invasive way. However, that transparency can only be attained when those tools "look and feel" part of the Facebook platform, appearing and functioning seamlessly as students interact normally with the site.

Figure 5.3: Facebook Canvas Page and Facebook API Architecture

However, as discussed earlier, third-party Facebook applications are not hosted on the Facebook platform itself. Facebook simply provides a window – or more precisely an *iFrame* – onto remote applications hosted elsewhere, making them accessible at specific web addresses called *canvas pages*. Users then simply visit a canvas page to load an application; Facebook automatically requests the application's content from its hosted location (known as its *callback URL*) and serves that content within the iFrame window (see Figure 5.3 on the previous page). From a user's standpoint this is performed entirely transparently and so, for all intents and purposes, Facebook applications appear as embedded, integrated parts of the site.

Perhaps more significantly, in addition to simply appearing within the context of the Facebook site, third-party Facebook applications are also capable of accessing the rich profile information and social connection data of their users. To do this, applications are required to utilise the Facebook Application Programming Interface (API); a freely downloadable Java client library [168] that bridges the gap between application and platform. In particular, by providing a means for asynchronous communication between the two, it exposes methods for handling user- and application-authentication, session handling, and message passing/validation (see Figure 5.4 below). Furthermore, Facebook-styled UI elements such as buttons, tab-bars, input fields and dialogue boxes can be added to pages using static Facebook Markup Language (FBML) tags, an extended form of HTML that Facebook parses at load-time.

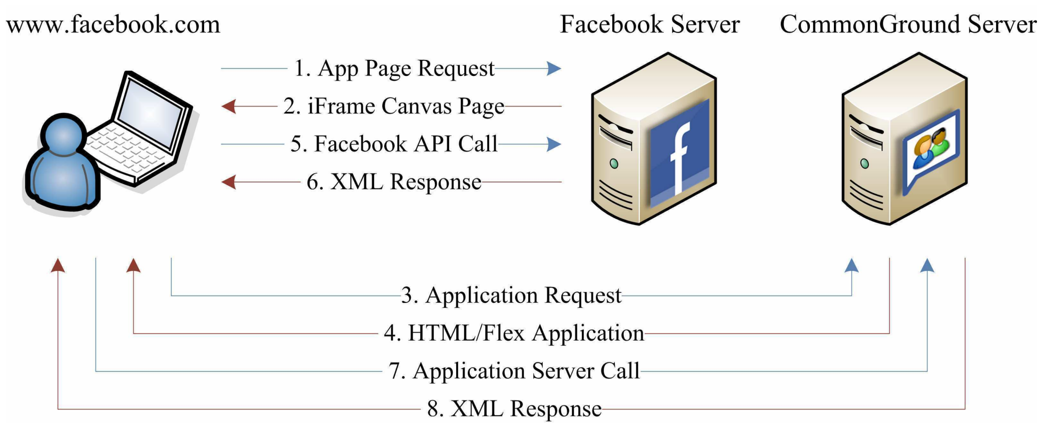

Figure 5.4: CommonGround and Facebook API Architecture

The number of ways an individual application is able to interface and interact with the Facebook platform – known as *integration points* – are many and varied, and this number appears to be growing rapidly (at the time of writing, great efforts are being made to offer more support for mobile access and third-party website integration). However, for the first release of my *CommonGround* RIA, only a small subset of integration points were utilised:

- Access to users' public Facebook identities
- Access to users' basic profile information
- Access to users' bookmarks

A Facebook member's *identity* is simply a public account number that uniquely identifies that individual on the service. Using this identifier, instances of *CommonGround* were able to programmatically target and access the *basic* profile information and bookmarks of its users (all of which will be discussed in-depth, and demonstrated in practice, in section 5.4). However, prior to receiving access to this public data, users were first required to "add" and authorise the application by explicitly allowing it access to their Facebook account (the Facebook Platform uses the OAuth 2.0 protocol for authentication and authorisation). Once added, calls to access profile and bookmark information could be made asynchronously to the Facebook platform via the API.

Admittedly, considering the depth of information and range of communication affordances accessible to third-party applications, the feature set adopted represented a fairly modest use of the Facebook API. The reasoning behind this was simple: recall that in the previous chapter I discussed many of the reservations students expressed regarding the use of Facebook for formal team collaboration; although open to using the service on-project, they were also understandably reluctant to add colleagues as friends and certainly didn't want "work" to interfere with their recreational use of the site. As a result of these findings I felt obliged to avoid any unnecessarily intrusive profile integration techniques, including the adding of application data to profile pages, the posting of feed data to friends' news streams, and – more importantly – any requirement for the "friending" of team-mates. To reiterate that last key point, the use of the *CommonGround* RIA did *not* require users to be friends on the Facebook service – team connections were made, and existed entirely within, the *CommonGround* application itself (or, more precisely, the background JavaDB database). Figure 5.5 overleaf illustrates the application's final supporting server architecture.

Aside from these concessions, however, the Facebook API provided more than enough scope to satisfy the requirements of this study; at the time of writing, no other service can offer such support. Furthermore, one cannot ignore the many communication and collaboration affordances built into the basic Facebook framework, many of which naturally complement my application without being an integrated part of it (such as private one-to-one text and video chat, messaging, profile exploration, etc). Moreover, so long as the action is not forced, the simple one-click ability to *optionally* add team-mates as friends within Facebook as relationships develop only served to strengthen team ties, as I will demonstrate in more detail later.

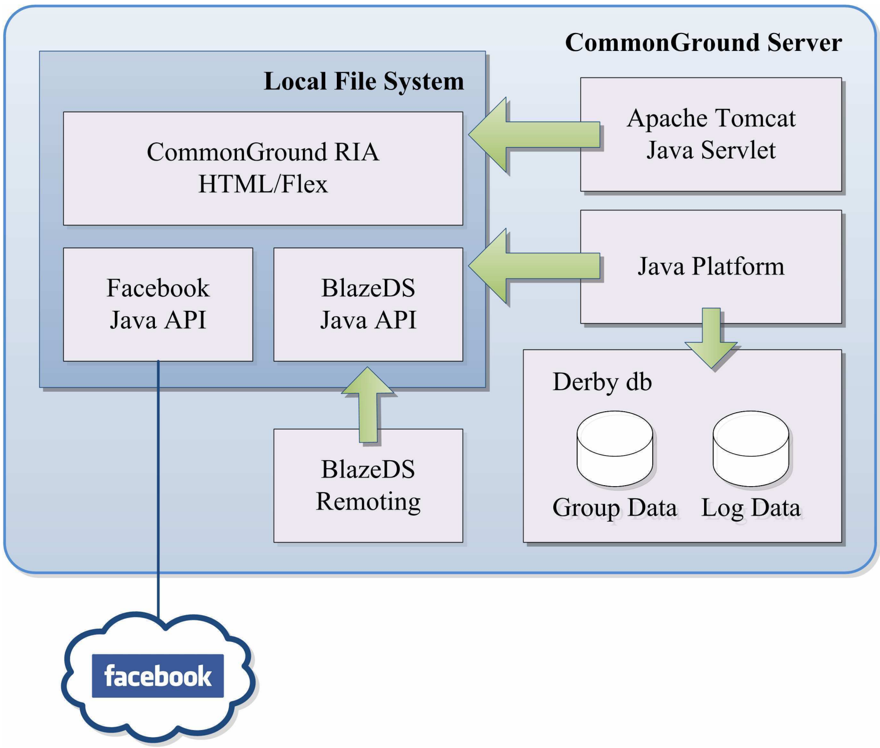

Figure 5.5: CommonGround Server Infrastructure with Facebook

One final note on the use of the Facebook API: terms and conditions imposed by the service require that all third-party applications comply with Facebook's strict set of principles and legal guidelines. These generally require application vendors to respect the privacy of their users and avoid the creation of unlawful, misleading, malicious, discriminatory or misrepresentative content. Needless to say, I made every effort to abide by these policies during this study.

5.4 A Tour of CommonGround

Developed in Adobe Flex, *CommonGround* provided a standards-based interactive experience to the user, utilising and extending the inherent communication and social awareness affordances of the Facebook platform. Designed as a proof-of-concept, the application was able to offer a number of facilities to the student: team building potential (via profile exploration and informal "chance encounters”), team interaction (via synchronous and asynchronous chat facilities and discussion boards), group awareness (via status updates), and greater project planning potential both locally and cross-site (via a simple company-wide project schedule).

Building upon the functional requirements discussed in 5.2, I will now introduce and discuss each of *CommonGround’s* key collaboration and communication features in turn, explain their purpose, and then briefly describe how students made use of them in practice. Where relevant I will also illustrate each feature using run-time screen captures obtained during a recent trial of the application (which will be discussed in detail in the next chapter). Again, fictitious names, e-mail addresses and profile images have been used in all screen captures to maintain anonymity.

5.4.1 Invitations & Account Activation

Deployed on the Facebook platform, the *CommonGround* application was made available to users at the following canvas page URL:

`http://apps.facebook.com/commonground/`

Visiting users were immediately prompted to “add” the *CommonGround* application to their Facebook account. This essential step allowed the user to bookmark and visit the application quickly from their main Facebook homepage and, in turn, permitted the application to access and interact with their personal profile information (Figure 5.6).

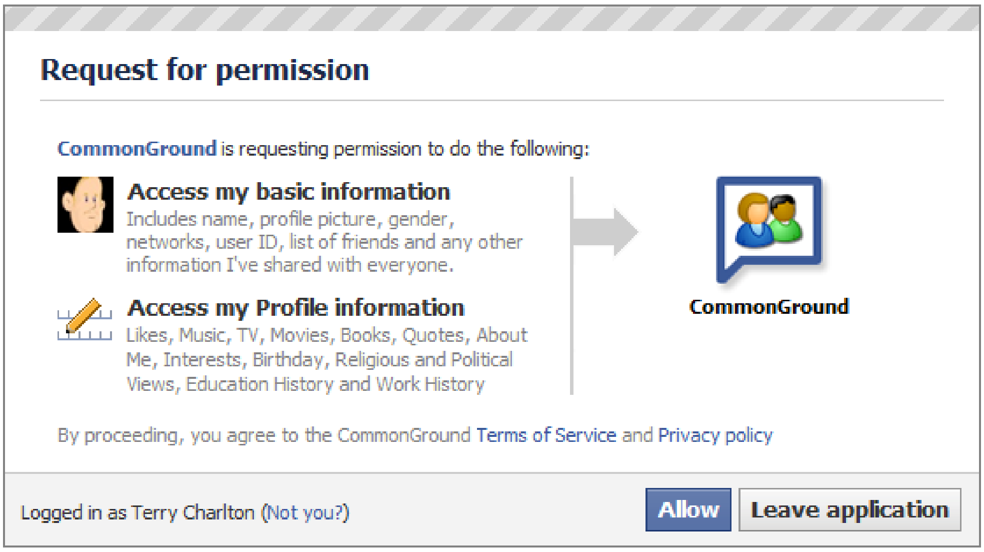

Figure 5.6: CommonGround’s Permission Request (via Facebook)

Importantly, it was a prerequisite to agree electronically to the privacy policy and terms and conditions of this study in order to activate a *CommonGround* user account. As per the application's functional requirements, only a student's most basic personal details (such as name and contact information) were accessed and made available to other team members at runtime.

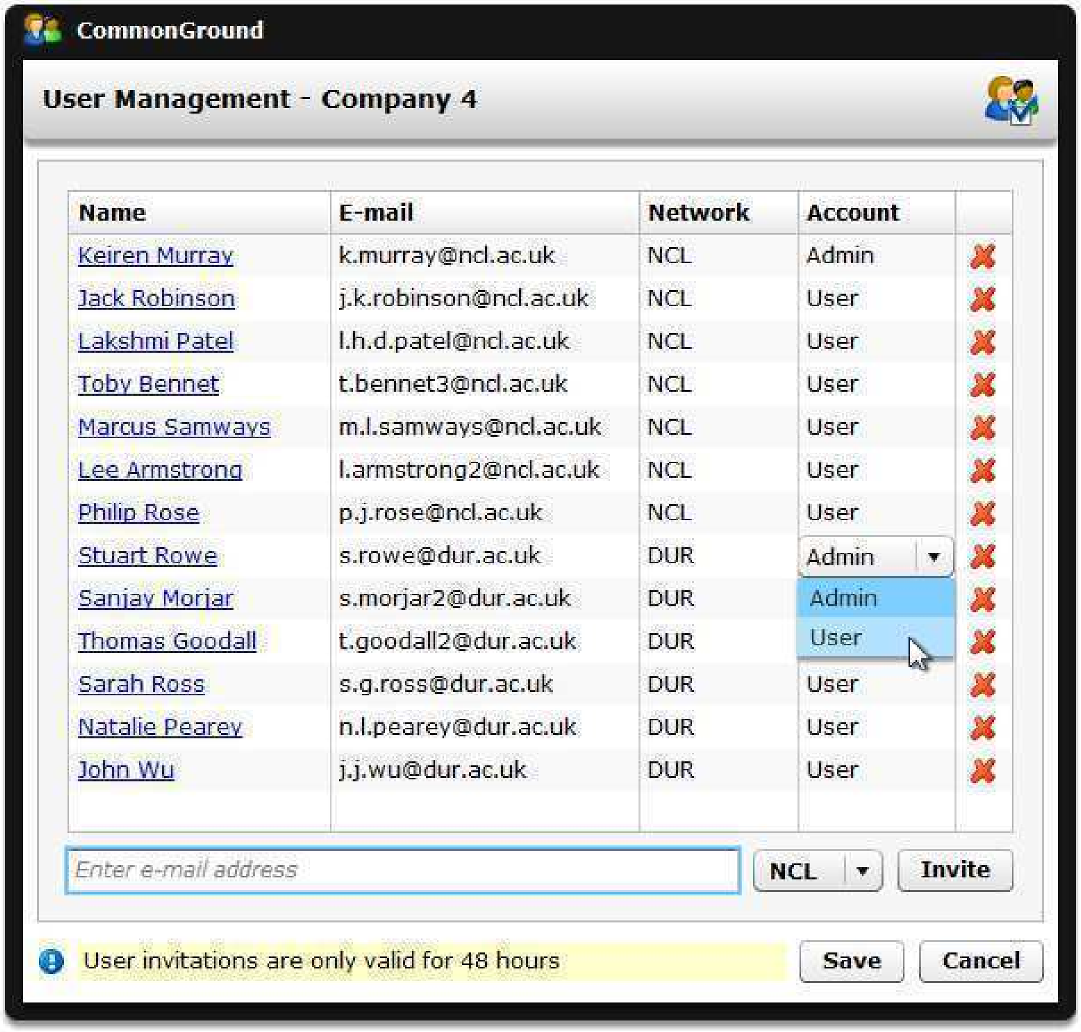

Figure 5.7: CommonGround's User Management Console

Given that *CommonGround* was created specifically to support this study, I decided *not* to submit it to the Facebook Application Directory (and thus make it available to the general public). Instead, to attract suitable users to *CommonGround*, I simply invited one person from each local student team to create a "company account". That person then autonomously invited their own team mates as and when they felt it appropriate to do so (which I will describe in more detail in the next chapter). To briefly expand upon the mechanics of creating a company account, initial invitees were granted administrator rights to *CommonGround's* user management interface (see Figure 5.7 on the previous page). To define their company's infrastructure, they started by forming two sub-teams (referred to as "networks" on *CommonGround*) to represent each cross-site team. Team member e-mail addresses were then entered (and assigned to an appropriate network), whereupon the system automatically issued invitations.

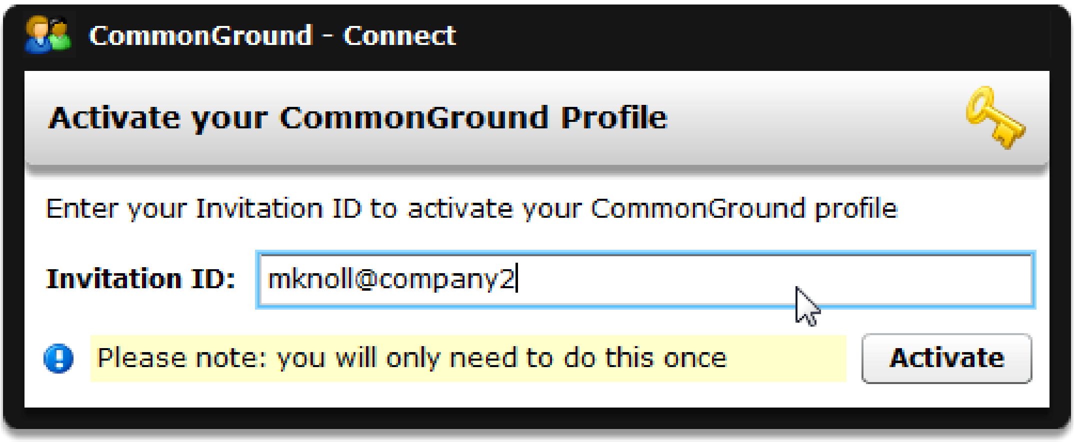

Figure 5.8: CommonGround's Account Activation Console

E-mail invitations prompted students to "join their team" on *CommonGround*, and supplied them with a unique activation code to prevent unauthorised access. On first use of the application the student was required to enter this code to validate their account (Figure 5.8), which in turn paired their unique Facebook identifier with their user account on the local application server. Importantly, and as requested by students in my initial surveys, this would serve to reduce barriers to interaction by allowing automatic log-in on successive visits to the application. Once logged in students were then presented with the main *CommonGround* application interface featuring a Virtual Meeting Room, a real-time text Chat Channel, a Company Member Status list, and a Company Schedule.

5.4.2 Virtual Meeting Room

To stimulate informal interaction via productive chance encounters, and to enable basic online social presence between students, I created a Virtual Meeting Room that displayed connected users and their institutional affiliations (see Figure 5.9 overleaf). The pedagogic motivation underpinning this feature was simple: as touched upon in a previous chapter, researchers indicate that real-life informal and casual social interactions (i.e. impromptu encounters around the "water cooler", the coffee machine, over lunches, in hallways, etc.), are often catalysts for the formation of social capital in professional group collaborations. Likewise, their virtual equivalents also permit distance users to encounter one another casually which helps build community and shared understanding [70] (without which students would be unwilling to take the risks involved in contributing ideas and receiving critique [82, 105]). Moreover, photographs of one's peers also contribute to heightened group awareness [117].

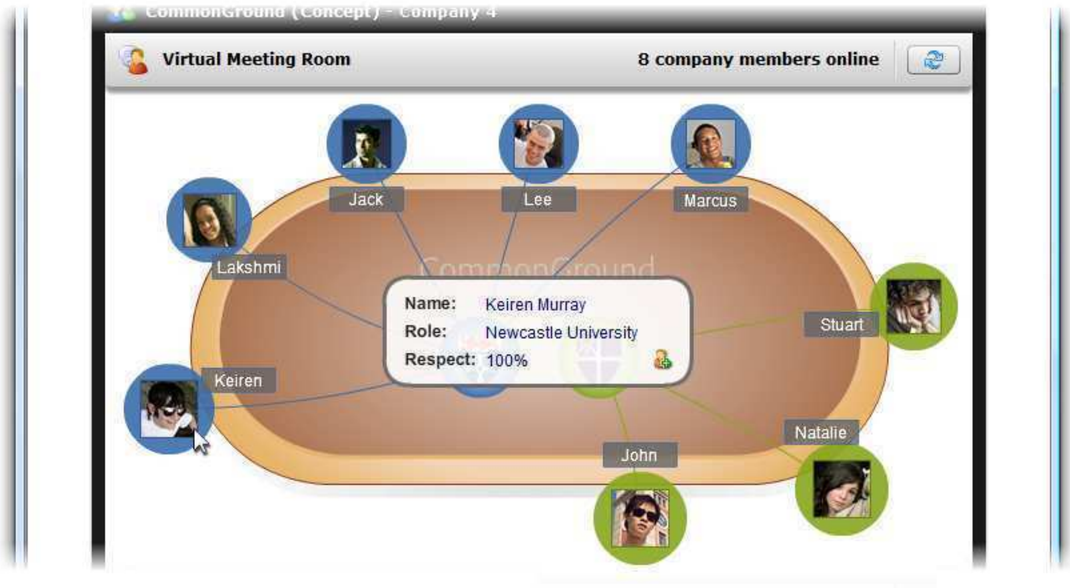

Figure 5.9: CommonGround's Virtual Meeting Room Component

Developed in Flash and embedded within the *CommonGround* Flex application, this custom-made social affordance (or "group/work awareness widget" [118]) was capable of direct communication with the BlazeDS remoting service, affording the ability to build and maintain a real-time roster of room attendees for each distinct company. To employ a congruent visual metaphor to instantly and transparently communicate the tool's purpose, I used a familiar visual setting that was analogous to the students' real-world meeting environment (i.e. an illustrated reproduction of a traditional face-to-face meeting room). The rationale behind this design approach was simple: relevant and recognisable contextual visual cues can often help reduce barriers to interaction [187].

Students accessing the application would appear "online" and their Facebook profile pictures – obtained via the Facebook API – would occupy a vacant "seat" at their company's shared table. This feature was designed to allow active students to see at a glance which team mates were present at any one time. As suggested by Postmes, Spears & Lea [155], profile pictures serve to "individualise" participants and provide a more favourable impression of one's cross-site team mates, many of whom a student may never meet in person. Of course, this advantage was largely dependent on students using representative portrait pictures in their Facebook profiles – an act that my earlier research generally proved to be the case (as discussed in Chapter 4).

To visually connect students to their respective institutions, colour-coded profiles and contribution tags were used. Furthermore, a student's full name and team details could be accessed by rolling over their profile image (and clicked to view a full Facebook profile which, depending on the individual's privacy settings, included detailed contact information). If the student was an existing friend on the service, or their Facebook profile was public, full information could be accessed. If not, only the partial personal details requested by *CommonGround* during activation would be displayed (including a link to add the student as a friend). This simple feature was designed to allow students to "get to know" one another in a way rarely achievable in normal academic group projects, especially where cross-site and "peripheral" team mates were concerned.

Although the motivation for creating a virtual meeting room was to encourage chance encounters and foster the organic building of social capital via profile exploration, it was also envisaged that student teams would conduct online meetings using the facility. As an experimental trial of the application would later show (which will be discussed in the next chapter), all of these predicted uses were borne out in practice.

5.4.3 Chat Channel

Facebook's own integrated chat features were limited to one-to-one discussions with *friends only* – as described earlier, being friends on Facebook was not a requirement for use of *CommonGround*. Therefore, to complement the Virtual Meeting Room facility described above, I developed a simple text-based synchronous chat feature that allowed active *CommonGround* users to interact with one another simultaneously (see Figure 5.10 overleaf). Using the BlazeDS messaging service, chat messages were immediately syndicated in real-time to *all* other active users (in much the same way as web-based chat rooms operate). Following the coding scheme touched upon earlier, the colour of the student's contributions denoted their institutional affiliations.

Developing a custom chat facility also allowed me to capture and log chat utterances, which was not achievable using Facebook's built-in features. All interactions were recorded by the local *CommonGround* application server for later analysis. Discussion pages (provided by the Facebook service and set-up by this author) were also made available for private company-wide asynchronous interaction. I also integrated Newcastle University's virtual learning environment NESS (Newcastle E-learning Support System) into *CommonGround*, allowing local and cross-site students to share files and interact with one another using asynchronous forum facilities. Local Newcastle students could also retrieve course timetables, submit deliverables and receive marks and feedback online. These features, however, were designed as simple "added extras" and are largely outside the scope of this study.

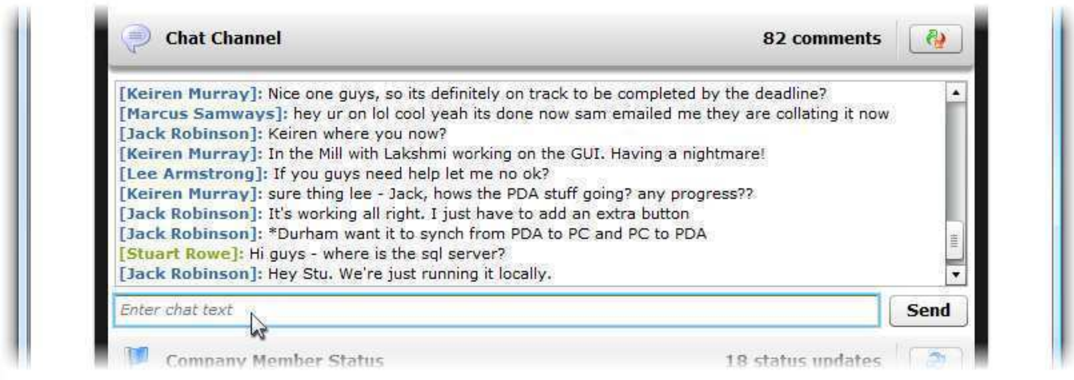

Figure 5.10: CommonGround's Chat Channel Component

5.4.4 Company Schedule

As discussed in Chapter 3, the majority of students participating in the cross-site group activity were surprisingly reluctant to utilise professional project planning software to manage their project schedules and workloads. Although aware of the benefits of using such tools across all stages of the software engineering process (introductory lectures informed students of such), most teams delegated the creation of a project plan – an initial team deliverable – to a single, non-programming team member (who typically complained the least or missed task allocation meetings). Unfortunately, once submitted, this plan was rarely (if ever) referred back to, negating much of its value. Based upon my own observations, this reluctance to create a project plan seemed to stem primarily from a combination of unfamiliarity with the tools available and wariness of their apparent complexity (in addition to an overzealous desire to develop solutions immediately without consideration for appropriate design and planning).

Conscious of the need to equip students with effective project planning skills (and hopefully instil in them an appreciation for effective resource and time management), I thus provided users of

CommonGround with a basic scheduling facility providing a company-wide overview of pending project tasks, responsibilities, due dates and progress percentages (see Figure 5.11). Presented alongside the Virtual Meeting Room and Chat Channel, this shared scheduling tool could be readily viewed and discussed by all active users with roles and timescales collaboratively decided upon.

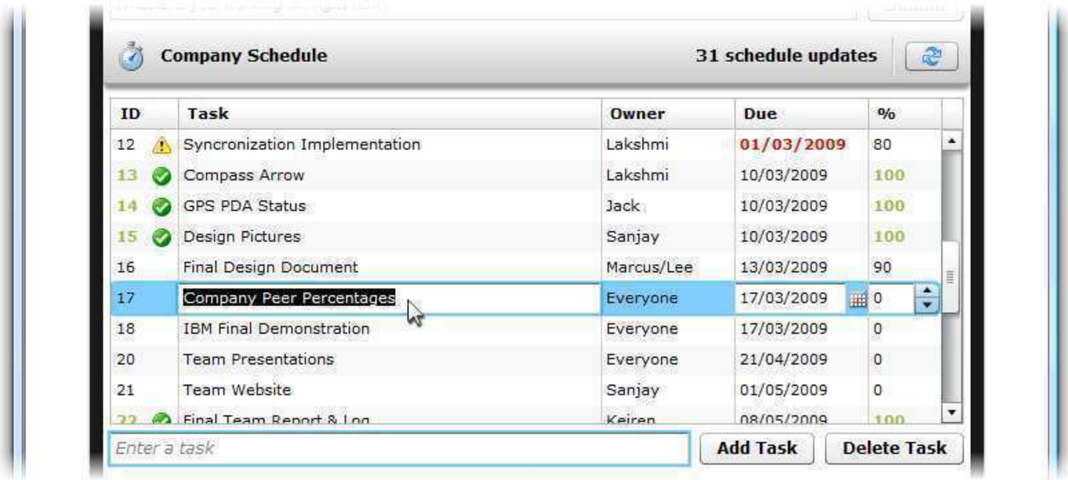

Figure 5.11: CommonGround's Company Schedule Component

Far simpler than many professional project planning tools, *CommonGround* offered an intentionally limited subset of time and resource allocation features. Visitors to the application could see at a glance the tasks assigned to them, their submission dates, and the progress that others were making on their allotted duties. Icons and colours were used to highlight tasks with upcoming due dates and to mark individual tasks as complete, and fast progress, user-assignment and date selection widgets made task creation, allocation and editing simple. A status panel above the schedule drew a user's attention to any recent changes, and the information displayed could be sorted alphabetically, numerically, or by date by clicking the relevant column header.

The BlazeDS remoting service ensured each student's schedule view was bound to the same shared data provider and changes were immediately syndicated to all active users. Again, all interactions were also recorded by the local application server for later analysis.

5.4.5 Company Member Status

During this study, emerging "microblogging" tools represented an area of particular interest to me. As discussed in detail in Chapter 4, the early success of social networking services was largely attributable to the introduction and user-adoption of “status update” facilities (obviously in the case of Twitter, but less so with other services). In terms of user motivation and gratification (i.e. the satisfaction gained from using social media), status updates contribute greatly to the “stickiness” of SNS sites; they encourage repeat visits and represent one of the primary channels though which users are kept aware of the actions of their social graphs. Reciprocally, status updates are one of the primary means by which users disseminate information about themselves. They therefore present a potent means to facilitate network engagement and, ultimately, encourage frequent and repeat use of *CommonGround*.

As described in the broader sense by Lampe et al. [162], status updates provide the means by which users interact with one another and track the actions, beliefs and interests of those in their network. Unfortunately, the popular term “status update” is something of a misnomer; it does not describe the extended capacity of such features to generate social capital in collaborative group contexts – by sharing one’s thoughts and ideas, by asking network-wide questions, by receiving support and advice (via comments), and by achieving consensus with others. Of course, for a status update facility to be considered useful and to be able to foster team interaction, all users must be willing to share knowledge and discuss ideas with others in their network.

Figure 5.12: CommonGround’s Company Member Status Component

Driven by these findings and student familiarity with converging SNS status update facilities, I integrated my own Company Member Status feature into *CommonGround* to foster team interaction and awareness (Figure 5.12 above). Following Facebook and Twitter’s lead (which respectively encourage interactivity by asking the questions "What's on your mind?" and "What's happening?"), I implemented a basic text-based status facility prompting students to answer a more context-specific question: "What are you working on right now?"

During my initial studies it became apparent that students did not wish to have their main Facebook status altered – that is, their primary profile status that is available to their entire friend network – and so a separate, project-specific status was maintained local to the *CommonGround* application. Limited to 140 characters or less to keep contributions punchy and inviting for other team members to read, the Company Member Status feature encouraged users to *frequently* publish a simple and succinct one-line message describing their current work activities. University affiliation and team roles were also included with contributions, and information could be sorted alphabetically by simply clicking the relevant column header. Again, a simple status panel would draw a user's attention to any recent updates.

Once more, the BlazeDS remoting service ensured each student's status view was bound to the same shared data provider. Changes were also immediately syndicated to all active users and recorded by the application's back-end server for later analysis.

5.4.6 Logging Systems

As touched upon for each of the application features detailed in this chapter, all user interaction with *CommonGround* was recorded by the local hosting server. Whenever the BlazeDS remoting service syndicated messages to active users, copies were also time stamped and saved to the system's supporting Java Derby database. In particular, the following interactivity actions were logged:

- Application access dates and durations
- Profile explorations (initiated via *CommonGround*)
- Direct and indirect friending of team mates[5]
- Chat utterances
- Schedule additions and updates
- Status additions and updates

[5] Direct here refers to users who added team mates as friends using the *CommonGround* interface. Indirect refers to users who searched for and added team mates via Facebook's built-in search facilities (which could not be recorded by *CommonGround* directly). However, in the latter case, by taking a snapshot of a user's friend list at the application login stage, any relevant additions or deletions could be automatically detected.

The data logs thus provided the basis for much of the quantitative analysis discussed in Chapter 6. Importantly, the recording of this data was authorised by users of the application as part of the agreed terms and conditions of its use, in addition to signing a consent agreement at the outset the study.

5.5 Achieving a CommonGround

To illustrate each of the *CommonGround* features described in this chapter in-situ, a run-time screen capture of the application is provided in Figure 5.13 at the end of this chapter. As requested by students, all interface elements were presented in a single, comprehensive view (vertical scrolling was favoured over more traditional menu or tab driven interfaces – perhaps because data views requiring vertical scrolling were an accepted design form on Facebook). Each constituent feature of the application was divided into four distinct areas, all of which could be resized as required to increase or decrease a feature's available viewing space. View changes were saved automatically and restored on future visits and, on a standard 1024x768 display, approximately 60% of *CommonGround* could be seen at any one time. During trials of the application, which I will discuss in the next chapter, students reported that this design approach worked well.

As can be seen, eight students were logged on to the application at the time of the screen capture (5 from Newcastle University, 3 from Durham University). The Virtual Meeting Room displays each active user's Facebook profile image and their network affiliation; a snapshot of the Chat Channel, Company Member Status panel and Company Schedule can also be seen. Methods to manage application preferences and user groups – in addition to accessing discussion boards and NESS – were accessible via Facebook tabs outside of the main application (as shown earlier in Figure 5.1).

5.6 Concluding Remarks

Social media and shared online spaces represent an attractive means to foster student interaction and community building on-project. However, as this chapter has highlighted, Facebook and social media services like it are perceived by students to be predominantly personal, private and recreational environments. Consequently, any attempts by third parties to interfere with or alter existing social processes and boundaries on the service will be met with resistance. To demonstrate this point, students voiced considerable concerns with my proposal to embed a formal academic tool on the Facebook platform, stating that they wished to maintain a distinct separation between their social and professional lives. Similarly, students expressed a great deal of anxiety regarding the "forced friending" of team mates on the service, especially where cross-site colleagues were concerned. In response to these concerns, this chapter presented *CommonGround*, a proof-of-concept Web 2.0 application developed to harness, complement and enhance a group's collaborative potential without directly impacting upon its members' social graphs or routine, day-to-day use of the service. By combining project-centric planning facilities with Facebook's built-in communication affordances, I anticipated this approach would help stimulate greater team member cooperation, trust and self-disclosure via productive profile explorations and chance encounters (without the need to adopt new and unfamiliar technologies). In turn, the tool would foster the generation of social capital, group awareness and the inclusion of "peripheral" team members who often presented difficulties forming and maintaining offline relationships with their colleagues.

Created in Adobe Flex, *CommonGround* was hosted on an Apache Tomcat servlet and supported by BlazeDS remoting and messaging technologies. Using the Facebook API, the application was made available to users via the standard Facebook web-interface and appeared as if it was an integrated part of the site. To maintain a separation between social identities, the tool was created as a self-contained "app" that had to be manually launched to be used (there were no unsolicited or invasive prompts to visit the application). Activation of the tool would thus indicate "buy-in" and signify a shift in user expectation and a willingness to engage with team mates professionally. Importantly, by maintaining user connections entirely within the *CommonGround* application itself, use of the RIA did not require team mates to be friends on the Facebook service – a key feature of the tool. Furthermore, in response to student requests, the tool made no attempts to publicise its use to a participant's social network or disseminate detailed personal information to other users.

The design rationale underpinning the key collaborative and group awareness features of the *CommonGround* application – namely the Virtual Meeting Room, Chat Channel, Company Member Status and shared Schedule facility – has been discussed in detail in this chapter. Notably, each feature described was designed to complement Facebook's built-in communication affordances as students did not wish to use any platform-specific communication channels to interact with colleagues (they are generally designed to be used with a user's private social network). The effectiveness of these features and their combined impact on the outcomes of the CETL-ALiC group programming activity will be discussed in detail in the next chapter.

5.7 Summary

In this chapter I have introduced and discussed the development of *CommonGround*, a social tool capable of combining the inherent communication and group awareness features of the Facebook platform (e.g. profile creation, synchronous and asynchronous chat, status updates, etc.) with project-related micro-blogging, meeting, scheduling and planning facilities. Firstly, I provided an overview of the application's design requirements as informed by student survey results and proposal feedback. I then went on to discuss an experimental "proof of concept" implementation of the tool, outlining and justifying the broad range of collaborative features and supporting server-based systems employed. I also discussed in detail the methodologies and approaches used to embed and interface the tool with Facebook's developer platform.

To determine the viability of *CommonGround*, the next chapter will summarise and assess an initial trial of the application conducted during the 2008/09 academic year. Based upon the findings discussed, Chapter 7 will go on to describe the evolution of *CommonGround* and, in Chapter 8, analyse a second release of the application.

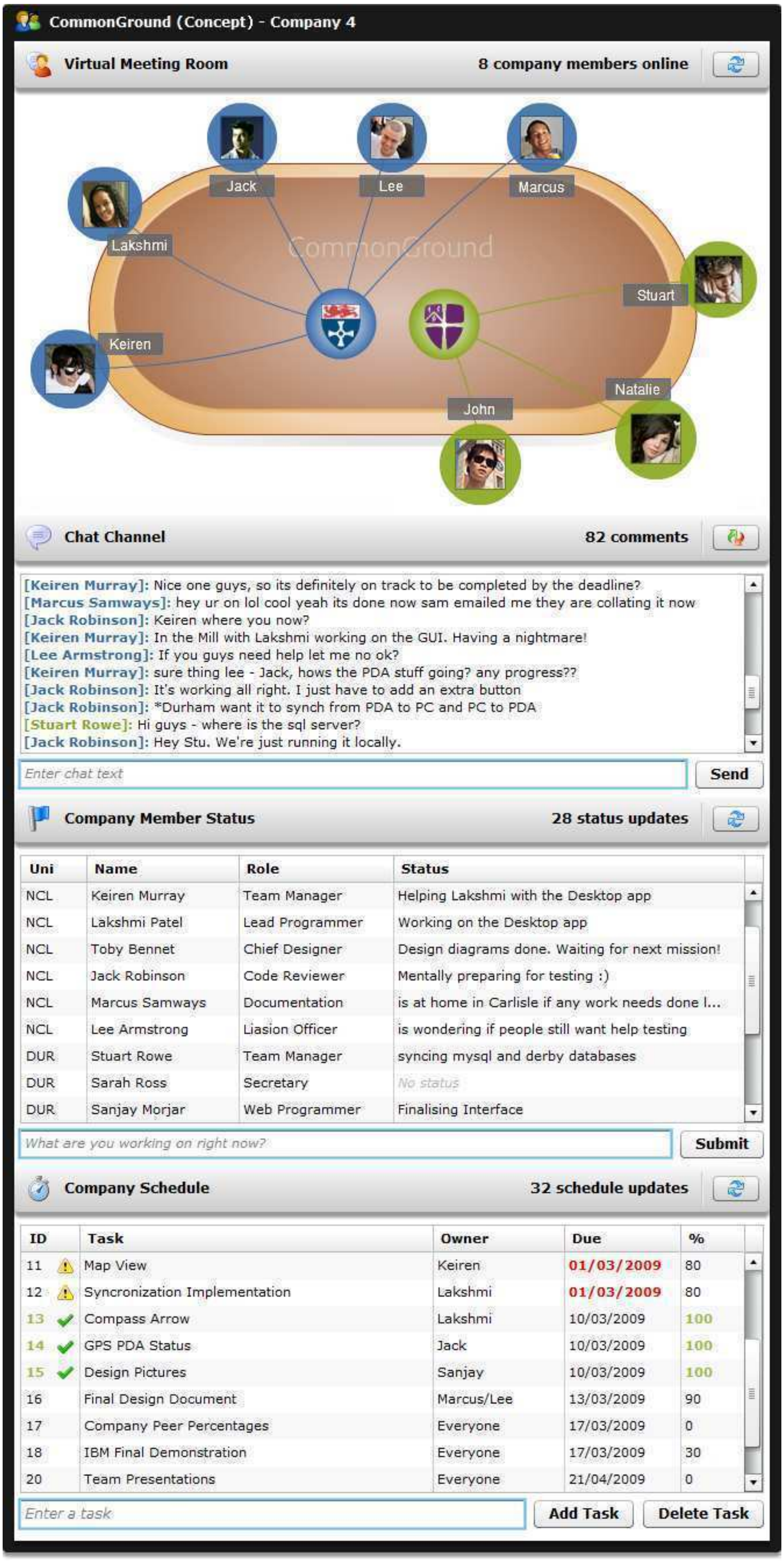

Figure 5.13 CommonGround – Real-time Screen Capture

Chapter 6

Trial 1: Proof of Concept

6.1 Introduction

The previous chapter introduced *CommonGround*, a proof-of-concept RIA developed to support stage two students participating in the CETL-ALiC group programming activity. Seeking to harness their pre-existing engagement with the social networking site Facebook, the application was designed to stimulate greater team member cooperation, trust and self-disclosure by facilitating informal chance encounters, group awareness and profile exploration. To reiterate the closing remarks of the previous chapter, it was also my intention that *CommonGround* would fill the communication void that often arose between formal team interactions and, in doing so, help encourage the inclusion of peripheral team members. Ultimately, this approach would enable me to evaluate the extent to which "sociability" and group awareness factors affect social capital and learning performance on-project.

I now introduce the first of two experimental field-trials of *CommonGround*. Following a brief overview of the trial in 6.2, I go on to provide a summary of my study's research questions and selected instrumentation in 6.3. Based on data collected from participant surveys, 6.4 then investigates the sociability of *CommonGround* and its capacity to foster social presence on-project. In 6.5 I move on to study how *CommonGround* influenced group cohesion, trust and awareness, followed in 6.6 by an analysis of real-time application usage statistics and learner performance outcomes. After a general discussion of results in 6.7, I finish in 6.8 with an overview of participant feedback gathered from post-trial surveys and interviews.

6.2 Overview of 2008/09 Trial

A preliminary pilot study of *CommonGround* was performed during the 2008/09 academic year to determine the viability of the application as a sound collaborative tool and to expose any weaknesses in its design or implementation. 4 companies (out of 12) were invited to join a study group and use the application – both locally and cross-site – during the second semester of the cross-site project (when team relations tended to break down and frequent and friction-free interaction was most required). Running for approximately 16 weeks (12 contact; 4 non-contact), it was during this time that students implemented their final systems and, as one student put it, “the real work started”. A total of 61 representative stage 2 students took part in the trial; 38 from Newcastle University and 23 from Durham University (55 male, 6 female; mean average age of 20.26, standard deviation 2.15). Of the 4 companies randomly invited to use *CommonGround*, all student members unanimously agreed to participate (all companies selected reported previous use of Facebook for communication socially with their team mates, albeit only locally). Students from Newcastle University were initially introduced to the *CommonGround* application during their first formal team meeting of the second semester. Although there was no mandatory requirement to use the application, participants were encouraged to “give it a go” and experiment with its use. Regardless of tool adoption, student participation in surveys and feedback sessions (usually during formal team meetings) was expected.

For comparison purposes, 4 further companies were also chosen at random (from those not participating in the *CommonGround* trial) to join a control group. Applicable to this study from 6.5 onwards, this cohort of students was represented by a further 58 students; 34 from Newcastle University[6] and 24 from Durham University (56 male, 5 female; mean average age of 20.16, standard deviation 1.78). Again, in the 4 companies invited to join the control group, all student members unanimously agreed to participate. Control group participants were also free to use any CMC technologies of their choice (other than the *CommonGround* application) and were required to participate in all surveys and feedback sessions.

6.3 Study Detail

Strijbos et al. posit that the primary process of social interaction should now be the focus for computer-supported collaborative learning researchers [141]. With this in mind, I now investigate how *CommonGround* was able to influence social interaction on-project (via synchronous and asynchronous chat, status updates, profile exploration, chance encounters, etc.), in addition to user perceptions of social presence (i.e. the “degree of salience” of actors in an interaction [107]). Coupled with trust, group awareness and team member cohesion/inclusion, these factors are considered important determinants to successful participation in collaborative educational contexts. More abstractly, they also directly facilitate the generation of social capital (i.e. the information,

[6] 37 students originally started in Newcastle University’s control group but 3 left the course during the activity and have thus been omitted.

knowledge, resources and opportunities perceived to be available through one's network of team members [96]).

6.3.1 Research Questions

To address the exploratory aims of this study, the following research questions will be investigated in this chapter:

RQ1. Is the *CommonGround* tool capable of encouraging and supporting critical interpersonal processes such as affiliation, team interaction, impression formation, social presence, and positive feelings of team-member connectedness?

RQ2. Extending RQ1, does the *CommonGround* tool help to create group awareness and sustain a low-risk environment in which effective, trusting and cohesive working relationships can be established?

RQ3. Does usage of the *CommonGround* environment positively influence an individual's performance and achievement on-project?

Based on the research-led design of *CommonGround* and early feedback from students, my initial expectation was that the tool would establish a "sound" collaborative online space capable of positively affecting social interaction, group awareness, community formation and individual cognitive performance on-project. Of course, this prediction depended entirely upon participant acceptance and adoption of the tool, as I will discuss later in this chapter.

6.3.2 Social Instruments

Although a number of instruments exist to describe the various social aspects of CMC technologies, most attempt to measure an amorphous set of variables with little clarity, construct validity or internal reliability [104]. Indeed, there is little agreement in the literature on how to measure social CMC factors and many instruments exhibit considerable overlap in terms of the specific social characteristics they seek to measure. Fortunately, a great deal of research by Kreijns, Kirschner, Jochems & Van Buuren has sought to disentangle these constructs and provide a more definitive means to operationalise the social climate and potential of online collaborative tools (for a summary see [118]). In particular, their work seeks to analyse and measure three specific qualities of technology-mediated learning environments: *sociability* [188], *social presence* [104] and *social space* [104] (essential qualities for reinforcing social interaction, group awareness, trust, community and impression formation in distributed communities of practice). Given the high degree of construct validity and internal reliability – and noting any weaknesses or limitations therein – I draw on the first two of these scales in 6.4 to explore the quality of interaction and social presence afforded to users of *CommonGround*. I then draw on the third scale in 6.5 to investigate and compare the collaborative potential which exists in and between the study and control groups (the scale is partially derived from non-CMC related scales and thus applies to both use-cases). Similarly, to explore the ability of *CommonGround* to establish and maintain an effective degree of social, action and activity awareness in student teams (i.e. knowledge of co-member roles, activities and work-rhythms), I also employ a simple group awareness scale developed by Daassi & Favier [116] in 6.5.

Each of the selected instruments described here will be discussed in more detail later in this chapter. Importantly, I do not attempt to examine the individual sociability factors of *CommonGround* and the Facebook application-platform separately, but rather the combination of the two. In addition, although the works of Kreijns, Kirschner, Jochems & Van Buuren and Daassi & Favier relate primarily to virtual teams operating in distance learning contexts, I contend that their social scales apply equally well to both distributed and localised teams (and thus to the CETL-ALiC group-programming activity as a whole).

Following the analytical precedents set by the originators of the selected scales, this chapter also uses means, standard deviations and parametric tests to explore central tendencies and compare group averages. Although I believe the scales used have suitable symmetry and equidistance (so an interval-level measurement can be reasonably inferred), only summated scores are analysed as they approximate a Gaussian distribution. Combined with my adequate sample sizes (>30, as per the Central Limit Theory), this data can thus be interpreted normatively. For completeness, however, confirmatory non-parametric Mann–Whitney–Wilcoxon Tests were also conducted that confirmed the findings presented here.

6.4 Sociability & Social Presence

In this section I consider two important socio-psychological dimensions of *CommonGround*. Firstly, I investigate the tool's various communication affordances and their relevance to the social needs and interests of students. To do this, I look at how well the application was able to support social interaction, build strong working relationships, and enhance positive feelings of team member connectedness, community and belonging. Secondly, I investigate the capacity of the *CommonGround* tool to enable a satisfactory degree of social presence on-project, which, as discussed in Chapter 2, permits online interlocutors to project their identities and relate to team mates as "real people" (both synchronously and asynchronously).

6.4.1 Procedure

To assess the collaborative potential of *CommonGround* and address RQ1, I administered a self-report survey to trial participants at both universities to solicit their opinions on a range of sociability and social presence factors. At Newcastle University, a *CommonGround* questionnaire (see Appendix B) was distributed to all members of the study group in their penultimate formal team meeting during week 11 (printed questionnaires were used as Newcastle undergraduate students were often inundated by electronic surveys and thus responses were traditionally very low). As the project was coming to a close and final deadlines were fast approaching, all students were present in team meetings and thus a 100% response rate was observed (with all questions answered). At the same time, an equivalent electronic questionnaire was administered at Durham University to all participating cross-site students; an 87% response rate was achieved (with all questions answered).

6.4.2 Sociability

Expanding on the discussion of social CMC technologies in 2.5.2, I now investigate the sociability of *CommonGround* and its capacity to facilitate critical interpersonal processes such as affiliation, trust, and social cohesiveness on-project. As described by Kreijns et al., social interactions are a dominant factor affecting group collaboration and learning performance in collaborative educational contexts [188]. In fact, it is generally believed that constructivist learning can only take place when students are able to relate to one another, form good working relationships, share a sense of community, and agree upon mutual goals and understanding [72]. Perhaps more importantly, sociability can also positively influence group dynamics and, in turn, help reduce feelings of loneliness and peripheral team member isolation [54]. Thus, to determine how well *CommonGround* was able to perform in these regards (and to highlight any weakness or omissions in the tool's design and implementation), I employed an instrument specifically developed to measure the sociability of computer-supported collaborative environments, as I will now discuss.

6.4.2.1 Instrument Detail

The *Sociability Scale* was developed by Kreijns et al. [188] to measure the perceived sociability of computer-mediated environments (i.e. the extent to which a CMC tool is able to facilitate social interaction, information exchange, impression formation, community building, trust and group cohesion). Reworded slightly to suit this cross-site study (see Table 6.1), the scale is a self-reporting, one-dimensional measure featuring 10 five-point Likert-scale items (opinions are expressed for all items on a continuous 1-5 scale: 1=*not at all applicable*; 2=*rarely applicable*; 3=*moderately applicable*; 4=*largely applicable*, 5=*totally applicable*, with no further scale clarification provided). Each item is designed to assess a student's opinions of the social potential of a CMC tool – *CommonGround* in this case – and how well they were able to use said tool to interact with their learning group. The original scale was refined and validated (via factor analysis, Pearson bivariate correlations and principal component analysis) using a number of well-developed and complementary measures. The reliability of this instrument achieved a Cronbach's coefficient α of .92 in the original report and .87 in this study, suggesting that the scale is able to measure the sociability construct well.

6.4.2.2 Results

Results from the sociability aspect of the survey (i.e. responses to questions derived from the Sociability Scale only) are provided in Table 6.1 below. As this specific part of my investigation relates to the perceived functionality of *CommonGround* rather than any local or cross-site issues, student feedback from both institutions has been combined. However, as I simply intend to investigate the sociability of *CommonGround* as an isolated construct at this stage (and do not wish to compare it against other CMC tools), only descriptive statistics are used to present and summarise the basic characteristics of the data collected.

Sociability Scale *(n=58)*		$\bar{x}$	*s*
Q1	CommonGround enables me to easily contact my team mates.	3.8	1.1
Q2	I do not feel lonely in the CommonGround environment.	3.4	1.1
Q3	The CommonGround environment enables me to get a good impression of my team mates.	3.8	0.9
Q4	The CommonGround environment allows spontaneous informal conversations.	3.4	1.0
Q5	The CommonGround environment enables us to develop into a well performing team.	3.6	0.9
Q6	The CommonGround environment enables me to develop good work relationships with my team mates.	3.8	1.0
Q7	The CommonGround environment enables me to identify myself with the team.	3.7	1.1

Q8	I feel comfortable with the CommonGround environment.	3.4	0.9
Q9	The CommonGround environment allows for non-task-related conversations.	3.5	1.1
Q10	The CommonGround environment enables me to make close friendships with my team mates.	3.3	1.0

Table 6.1: Sociability Scale, Summary Statistics (2008/09)

The results show that students rated the *CommonGround* tool moderate to high on the Sociability Scale, indicating that they felt comfortable using the application to interact with their colleagues (an important finding considering the initial reluctance of students to use Facebook on-project). Although there still remains room for improvement, individual Likert-item responses were largely positive and consistent across the scale, producing an average score of 3.6 (as illustrated in Figure 6.1 below). More specifically, the results suggest that the tool allowed students to develop sound working relationships with their colleagues (at least in terms of impression formation, self-disclosure and online/offline community building), resulting in the development of a more rounded, inclusive and well-performing team. Moreover, students indicated that the tool enabled them to get in contact with their team mates easily and signalled that it facilitated spontaneous informal conversations with colleagues (i.e. chance encounters), an important finding that I will explore in more detail later.

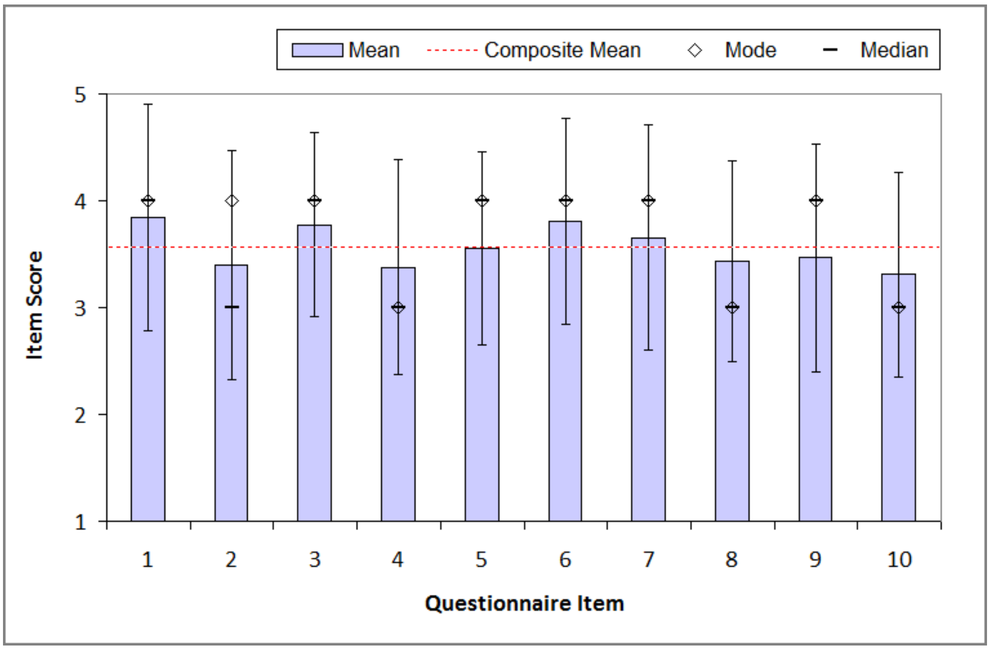

Figure 6.1: Sociability Scale, Average Responses (2008/09)

Thus, with regards to RQ1, the results obtained suggest that the *CommonGround* environment, in the opinion of its users, was capable of creating and sustaining team interaction, information exchange, group cohesion, and positive feelings of community on-project. In addition, these findings correspond with and support feedback from students obtained during post-trial group interviews, as I will return to later.

6.4.3 Social Presence

An important and integral factor of sociability, the concept of social presence refers to the perceived proximity and awareness of other people in a synchronous or asynchronous online communication episode [104]. In computer-mediated communities of practice, a sense of presence (or social awareness) is seen as an important determinant towards participation, social interaction, self-disclosure and relationship building [106, 108]. Furthermore, research indicates that social presence is a key driver of social interaction, inclusion and satisfaction in distributed environments; it supports critical thinking and helps to make group interactions more appealing, engaging and intrinsically more rewarding [112]. Following on from the discussion in 2.5.4, a CMC medium high in social presence is therefore considered to be more appropriate for creating communities of learners [54], conducting interpersonal tasks [110], and building mutual trust and social influence [111]. To determine the degree of perceived social presence that can be established in *CommonGround* (and to again highlight any weakness or omissions in the tool's design), I employed a second instrument.

6.4.3.1 Instrument Detail

Introduced originally in [104] and more recently discussed in [189], the *Social Presence Scale* was developed by Kreijns et al. to measure the perceived degree of social presence afforded by computer-mediated collaborative environments. Reworded slightly to suit this cross-site study (see Table 6.2 overleaf), the scale is a self-reporting, one-dimensional measure featuring 5 five-point Likert-scale items (opinions are expressed on a continuous 1-5 scale: 1=*not at all applicable*; 2=*rarely applicable*; 3=*moderately applicable*; 4=*largely applicable*, 5=*totally applicable*; no further scale clarification was provided). Each item is designed to assess the social-presence potential of a CMC tool and was again refined and validated (via factor analysis, Pearson bivariate correlations and principal component analysis) using a number of well-developed and complementary measures. The reliability of this instrument achieved a Cronbach's coefficient α of .81 in the original report and .80 in this study, suggesting that the scale is able to measure the social presence construct well.

6.4.3.2 Results

Results from the social presence aspect of the survey (i.e. responses to questions derived from the Social Presence Scale only) are provided in Table 6.2 below. Again, as this specific part of my investigation relates to the social presence capacity of *CommonGround* rather than specific local or cross-site issues, student feedback from both institutions has been combined. Descriptive statistics will again be used to summarise the data and explore social presence as an isolated construct.

Social Presence Scale *(n=58)*		$\bar{x}$	*s*
Q1	When I have real-time conversations in CommonGround, I have my team mate(s) in my mind's eye.	3.4	1.1
Q2	When I have asynchronous conversations in CommonGround, I have my team mate(s) in my mind's eye.	2.8	1.1
Q3	When I have real-time conversations in CommonGround, I feel that I deal with very real persons and not with abstract anonymous persons.	3.8	0.9
Q4	When I have asynchronous conversations in CommonGround, I feel that I deal with very real persons and not with abstract anonymous persons.	2.8	1.0
Q5	Real-time conversations in *CommonGround* can hardly be distinguished from face-to-face conversations.	1.6	0.7

Table 6.2: Social Presence Scale, Summary Statistics (2008/09)

The results show that students rated *CommonGround* moderately on the Social Presence Scale, producing a mean average Likert-item score of 2.87 (as illustrated in Figure 6.2 overleaf). Although there is clearly more work to do in this regard, the data positively indicates that the *CommonGround* environment was somewhat able to establish a sense of social presence during online communications, supporting social interaction, trust building and critical knowledge exchange on-project. Specifically, students rated the tool moderate to high in terms of its ability to articulate their team mates' presence during real-time synchronous encounters. To a lesser extent, students also indicated that the tool helped to communicate a degree of delayed user-presence in asynchronous conversations (often during forum-style discussions). As participants would later suggest in post-trial interviews, which I will return to later, Facebook profile information surfaced by the tool (including portrait photograph thumbnails) greatly helped in this regard, but a lack of in-tool "chat history" unfortunately did not. Given my desire to encourage increased asynchronous interaction on-project, this is one aspect of *CommonGround* which I felt could be improved.

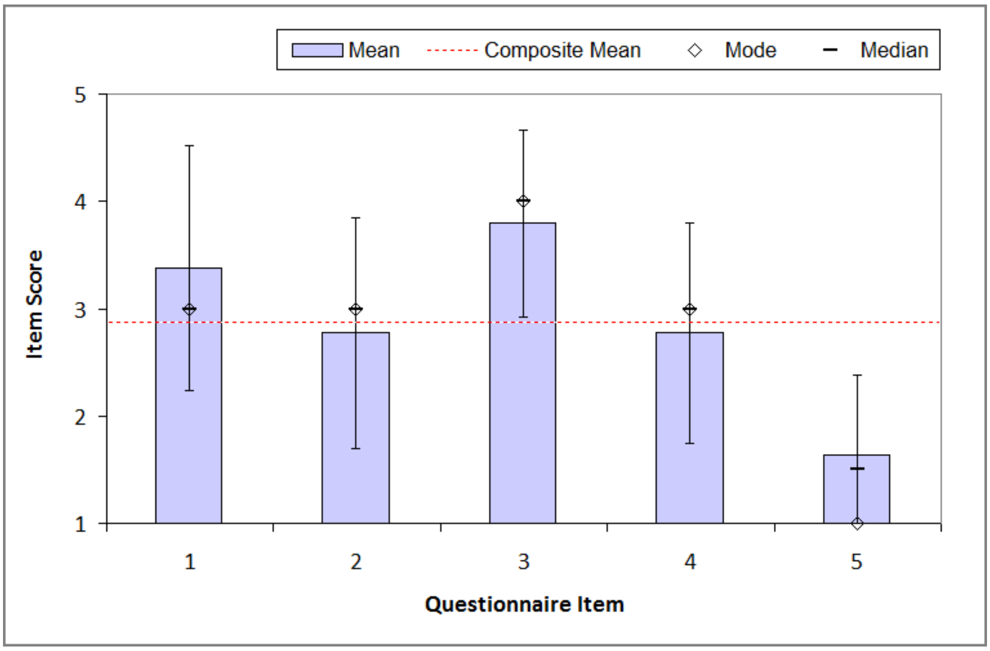

Figure 6.2: Social Presence Scale, Average Responses (2008/09)

Students rated *CommonGround* fairly low in terms of its capacity to facilitate conversations that were "indistinguishable" from face-to-face dialogue – a result that I expected and was quite prepared to concede given the simple real-time chat affordances built into the application. Taking this consideration into account, however, the results obtained suggest that *CommonGround*, in the opinion of its users, was somewhat capable of creating and sustaining a degree of social-presence on-project, thus supporting the Sociability Scale's positive outcome to RQ1.

6.5 Social Space & Group Awareness

In this section I address RQ2 and, firstly, investigate *CommonGround's* potential to establish and sustain a "sound" social space capable of building and reinforcing effective, trusting, and cohesive working relationships on-project. Complementing the earlier discussion of sociability and social presence (which addressed the specific social capacities of *CommonGround's* communication affordances), social space relates to the non-latent group dynamics and structures that underlie group collaboration. As a concept, it operationalises the perceived degree of social climate in a group, providing an important basis for describing and analysing the success of an online community in a collaborative context. Secondly, I go on to investigate the capacity of *CommonGround* to enable basic group awareness on-project (i.e. up-to-the-minute knowledge of what one's team members have done so far, what they are doing now, and what they will do next).

6.5.1 Procedure

In week 12 of the 2008/09 CETL-ALiC group project, a simple paper-and-pencil self-report *Teamwork* questionnaire (see Appendix B) was administered to members of both the study and control groups. Designed to solicit opinions on a range of general social space and group awareness factors (which are not specific to the *CommonGround* application), a 100% study group and 91.2% control group response rate was observed at Newcastle with all questions answered (again, the high response rate was due to distribution of the survey in critical final team meetings). An identical electronic questionnaire was administered at Durham University; an 87% response rate was achieved for the study group and 79.2% for the control group with all questions answered.

6.5.2 Social Space

The term "social space" refers to the extent to which a collaborative environment is able to give rise to the conditions required to generate social capital and foster effective, trusting and cohesive working relationships (both online and off). As discussed in 2.5, the concept of social space is embedded in the norms, values, rules, roles, beliefs and ideals of a group's network of social relationships [104]. Thus, for a social space to be considered "sound" it must successfully promote, reinforce and sustain interaction [54] and contribute to a positive, low-risk climate where commitment to shared goals and mutual understanding is achievable [105]. Such environments encourage the flow of information between learners and, in turn, support critical thinking, inclusion, knowledge-construction and competency acquisition [104]. Naturally, technologies which successfully address these criteria are deemed to be inherently capable of facilitating the emergence of a sound social space; thus, to allow me to determine how well *CommonGround* was able to perform in this regard, I employed a third instrument.

6.5.2.1 Instrument Detail

In order to assess the quality of a collaborative space and the social potential that exists within it (i.e. the capacity for a computer-mediated learning group's structure to enable robust working relationships, a strong sense of community and group cohesion, and effective levels of trust, respect, belonging and satisfaction), the *Social Space Scale* was developed by Kreijns et al. [104]. With items reworded slightly to suit this study (see Table 6.3 and 6.4), the scale is a self-reporting, two-dimensional measure featuring 20 five-point Likert-items designed to assess a student's opinions of both their own and their group's collaborative behaviour (opinions were expressed for all items on a continuous 1-5 scale: 1=*not at all applicable*; 2=*rarely applicable*; 3=*moderately applicable*; 4=*largely applicable*, 5=*totally applicable*; no further scale clarification was provided). Items Q1 to Q10 relate to positive group behaviour with Q11 to Q20 relating to negative group behaviour. Unlike the previous two measures discussed in 6.4, this scale is not CMC or application-specific and instead aims to describe the social climate that exists within local and distributed collaborative teams (whether facilitated by CMC media or not). Again, this instrument was refined (via factor analysis, Pearson bivariate correlations and principal component analysis) using a number of well-developed and complementary measures. The reliability of this instrument achieved a Cronbach's coefficient α of .81 in the original report and, in this investigation, .89 for the study group and .87 for the control group (suggesting that the scale is able to measure the social space construct well).

6.5.2.2 Results

Results from the social space survey (i.e. responses to questions derived from the Social Space Scale) are provided below in Table 6.3 (study group) and, later, Table 6.4 (control group). Unlike the previous two scales, here I explore local and cross-site judgements separately. Each institution's local scores are also combined, as are both sets of cross-site scores.

Social Space Scale (Study Group, n=58)		*Local*		*Cross-site*	
Positive Group Behaviour		$\bar{x}$	*s*	$\bar{x}$	*s*
Q1	Company members felt free to criticise the ideas, statements, and/or opinions of others.	3.4	1.0	3.0	0.9
Q2	We reached a good understanding on how we had to function as a team.	3.2	1.2	2.8	1.2
Q3	Company members ensured that we kept in touch with each other.	4.0	0.9	3.1	1.1
Q4	Company members worked hard on the project assignment.	3.2	1.1	2.9	1.1
Q5	I maintained contact with all other company members.	4.0	0.8	3.1	1.1
Q6	Company members gave personal information about themselves.	3.6	1.0	2.7	0.9

Q7	The company conducted open and lively conversations and/or discussions.	3.8	1.0	3.2	1.1
Q8	Company members took the initiative to get in touch with others.	3.8	0.9	3.6	1.0
Q9	Company members spontaneously started conversations with others.	3.6	1.2	3.2	1.1
Q10	Company members asked others how the work was going.	3.8	1.0	3.3	1.1
Negative Group Behaviour					
Q11	Company members felt attacked personally when their ideas/statements/opinions were criticised.	1.6	0.7	3.1	0.9
Q12	Company members were suspicious of others.	1.5	0.7	2.2	0.9
Q13	Company members grew to dislike others.	2.2	1.2	2.8	1.0
Q14	I did the lion's share of the work.	2.7	1.1	2.9	0.9
Q15	Company members obstructed the progress of the work.	1.6	0.8	2.6	1.0
Q16	Company members were unreasonable.	3.0	1.1	3.0	1.0
Q17	Company members disagreed amongst each other.	3.3	1.0	3.5	1.1
Q18	The team had conflicts.	3.0	1.1	3.6	1.0
Q19	Company members gossiped about each other.	1.7	0.8	2.4	1.0
Q20	Company members did not take others seriously.	2.2	0.9	2.4	1.0

Table 6.3: Social Space Scale, Summary Statistics (Study Group, 2008/09)

Locally, these results reveal that students in the study group reported a moderate to high degree of perceived “social space”. Scores were encouraging and largely consistent across the scale, producing a mean average Likert-item score of 3.7 with negative items reversed (as illustrated in Figure 6.3). Cross-site scores were slightly lower, producing an average Likert-item score of 3.1 with negative items reversed (Figure 6.4). In particular, students in the study group reported a positive, lively and low-risk social climate – both locally and cross-site – capable of promoting and maintaining social interaction, self-disclosure and shared understanding. Moreover, students indicated moderately strong levels of community and group cohesion on-project (and thus, in turn, strong levels of respect, commitment and trust). And although disagreements were high, it is evident that these conflicts did not severely reduce the students’ ability to function as a team; an extremely positive outcome.

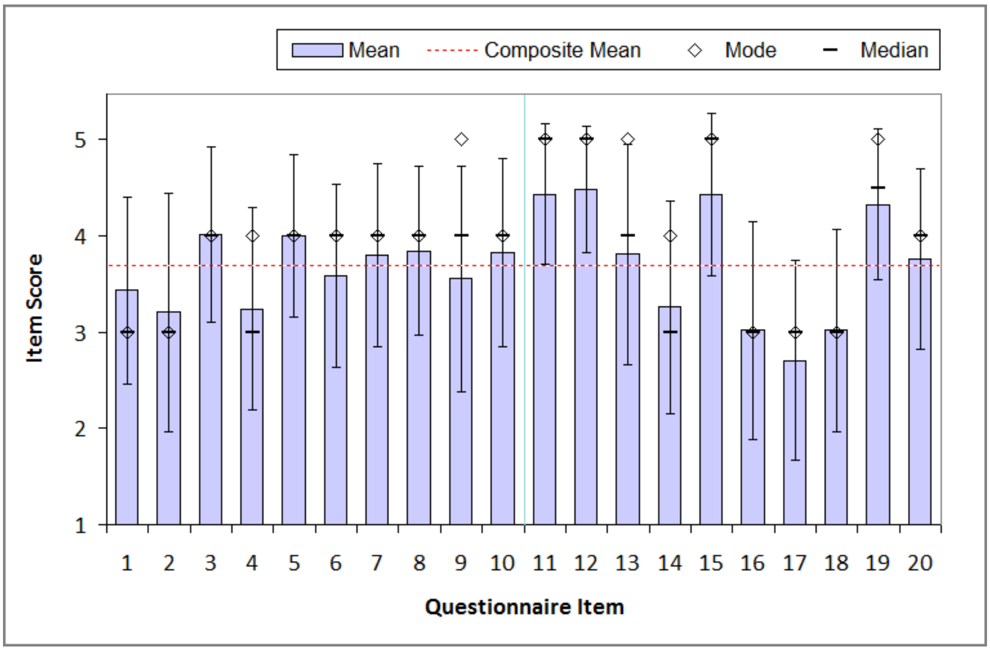

Figure 6.3: Social Space Scale, Average Local Responses (Study Group, 2008/09)

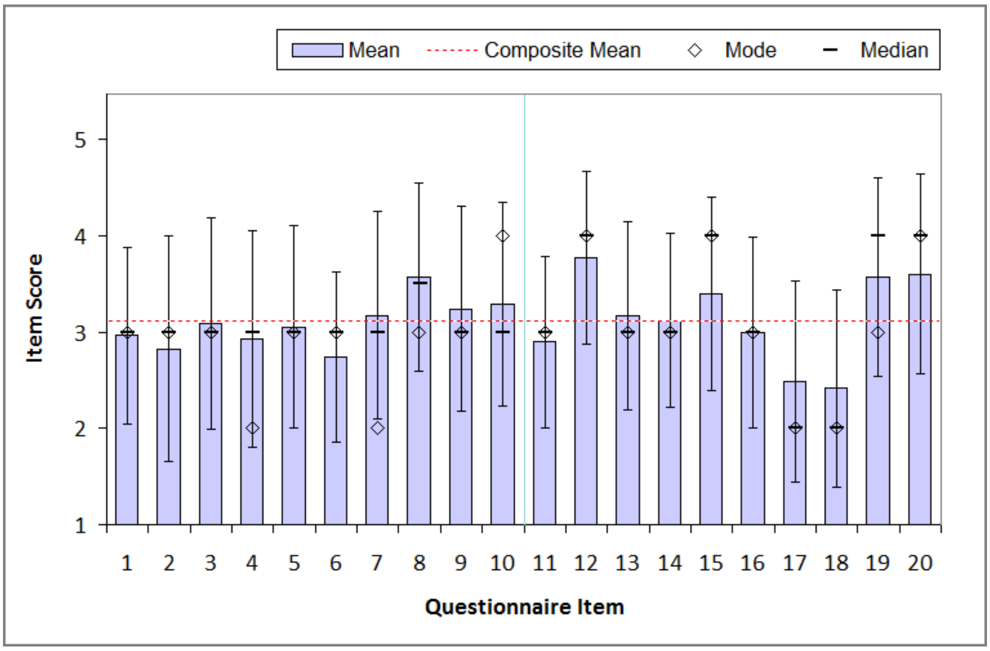

Figure 6.4: Social Space Scale, Average Cross-Site Responses (Study Group, 2008/09)

To allow me to better gauge the specific role of *CommonGround* in the establishment of a sound social space on-project, student feedback from non-participating teams must also be considered and compared. The results provided by the control group are therefore given in Table 6.4 below. Again, each institution's local scores were combined, as were both sets of cross-site scores.

Social Space Scale (Control Group, n=50)		*Local*		*Cross-site*	
Positive Group Behaviour		$\bar{x}$	s	$\bar{x}$	s
Q1	Company members felt free to criticise the ideas, statements, and/or opinions of others.	2.9	1.0	2.0	0.9
Q2	We reached a good understanding on how we had to function as a team.	2.4	1.0	2.1	0.9
Q3	Company members ensured that we kept in touch with each other.	3.1	0.9	1.7	0.8
Q4	Company members worked hard on the project assignment.	3.6	0.8	2.6	1.0
Q5	I maintained contact with all other company members.	3.2	1.0	2.0	1.0
Q6	Company members gave personal information about themselves.	1.9	0.9	1.7	0.8
Q7	The company conducted open and lively conversations and/or discussions.	2.5	1.1	1.9	0.9
Q8	Company members took the initiative to get in touch with others.	3.0	1.1	1.6	0.8
Q9	Company members spontaneously started conversations with others.	2.3	1.0	1.9	0.8
Q10	Company members asked others how the work was going.	3.1	1.0	1.7	0.8
Negative Group Behaviour					
Q11	Company members felt attacked personally when their ideas/statements/opinions were criticised.	3.5	0.9	3.9	1.0
Q12	Company members were suspicious of others.	2.2	1.0	3.1	1.1
Q13	Company members grew to dislike others.	2.9	1.0	4.1	0.8
Q14	I did the lion's share of the work.	3.3	1.0	3.8	1.0
Q15	Company members obstructed the progress of the work.	2.5	1.0	4.2	0.9

Q16	Company members were unreasonable.	3.7	1.0	3.8	0.9
Q17	Company members disagreed amongst each other.	4.0	0.9	3.9	1.1
Q18	The team had conflicts.	4.1	0.9	3.7	0.9
Q19	Company members gossiped about each other.	2.9	1.0	2.1	1.0
Q20	Company members did not take others seriously.	2.4	0.9	3.7	0.9

Table 6.4: Social Space Scale, Summary Statistics (Control Group, 2008/09)

These results show that non-users of *CommonGround* reported a poorer local social climate than that of the study group, scoring their perceived degree of social space low to moderate (producing a mean average Likert-item score of 2.8 with negative items reversed, as illustrated in Figure 6.5). This represents a drop in average score of 0.9 (-23.7%) when compared to study group results. Although the majority of items scored more negatively, of particular note were reduced team interaction, reduced self-disclosure, and heightened team conflict. However, cross-site scores for non-users of *CommonGround* were markedly lower than those reported by the study group, producing an average Likert-item score of 2.1 with negative items reversed (Figure 6.6). This represents a drop in average score of 1.0 (-31.4%) with students indicating lower levels of group cohesion and community.

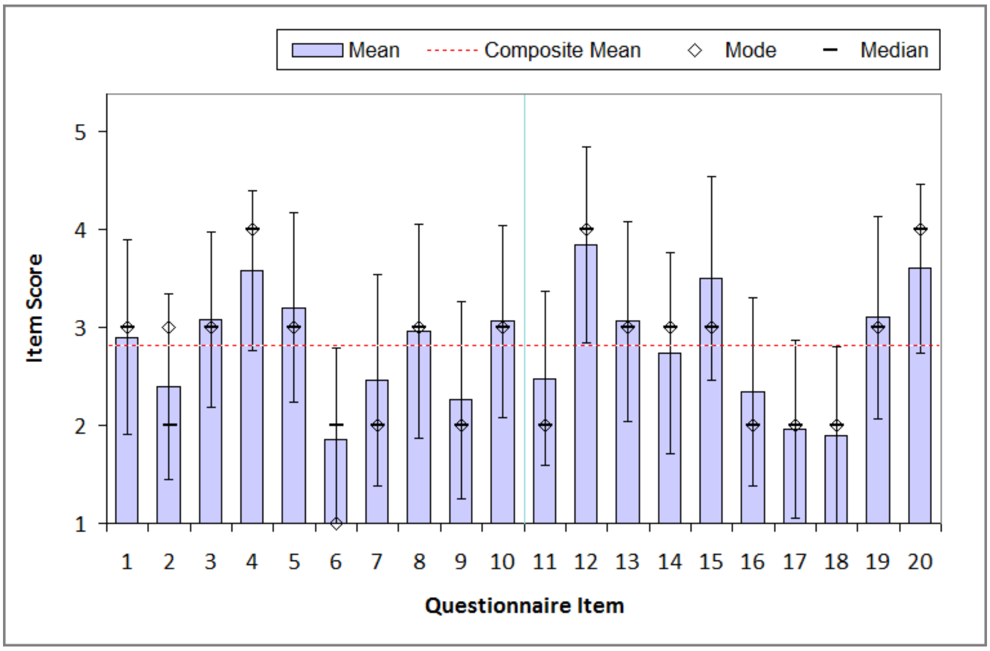

Figure 6.5: Social Space Scale, Average Local Responses (Control Group, 2008/09)

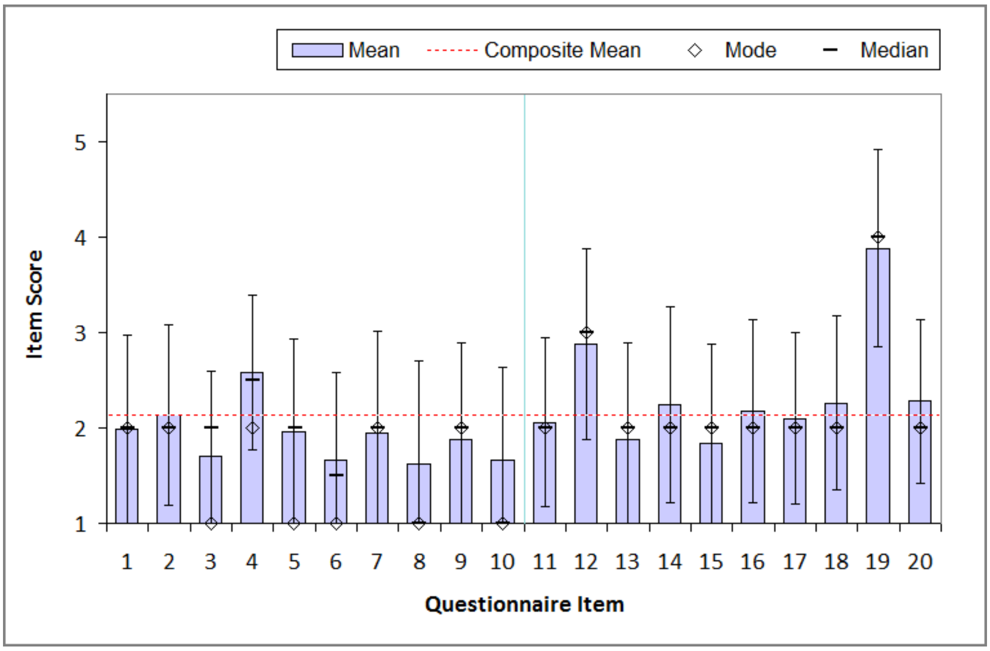

Figure 6.6: Social Space Scale, Average Cross-Site Responses (Control Group, 2008/09)

Although the majority of items again scored more negatively, it is in the areas of team interaction and self-disclosure that the biggest reductions were evident (particularly in terms of spontaneous interaction and group/task awareness). As a result, students grew to dislike and distrust one another and expressed feelings that cross-site colleagues obstructed progress and did not contribute to the project sufficiently. Paradoxically, conflict levels across sites were lower in the control group than the study group; an anomaly students later attributed (in post-trial interviews) to a lack of direct interaction of *any* kind with cross-site team members.

Although not entirely necessary given the clear difference in average summated scores, I nevertheless performed two separate two-tailed independent sample t-tests to compare results between the two trial conditions in more detail. In the first test, T_1, the null hypothesis (H_0) was *local study group score = local control group score*; the alternative hypothesis (H_1) was *local study group score ≠ local control group score* (with study/control group membership as the independent variable and the summated Social Space Likert-scale as the dependent variable). Similarly, in the second test, T_2, H_0: *cross-site study group score = cross-site control group score*; H_1: *cross-site study group score ≠ cross-site control group score*. Results, provided in Table 6.5 overleaf, reveal a significant statistical difference (with large effect sizes, *d*, as per Cohen [190]) between the mean summated scores of students in the study group and the control group. I am therefore able to reject H_0 and accept H_1 for both T_1 and T_2.

	Group Statistics			Significance		
Local Scores	*n*	$\bar{x}$	*s*	*t (df)*	*p*	*d*
T_1 Study Group	58	73.74	9.43	9.64	<.001	1.87
T_1 Control Group	50	56.28	9.33	(106)		
Cross-site Scores						
T_2 Study Group	58	62.31	11.57	9.69	<.001	1.88
T_2 Control Group	50	42.72	9.04	(106)		

Table 6.5: Differences Between Study and Control Group Social Space Scores (2008/09)

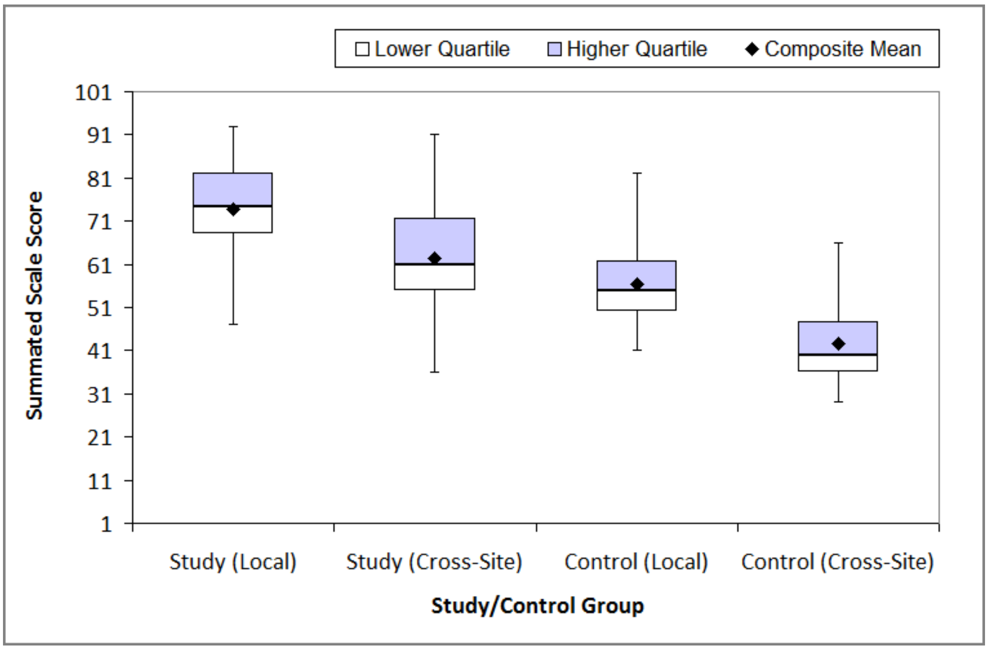

Figure 6.7: Social Space Scale, Summated Scores (2008/09)

The results presented in Table 6.5 (and illustrated in Figure 6.7) indicate a positive outcome to RQ2 and suggest that the *CommonGround* environment did help to establish a sound social space both locally and cross-site. Local interaction was demonstrably improved in teams that employed and embraced the tool, driven by greater social interaction (whether on-task or not) and lower levels of conflict and mistrust. In turn, the Social Space Scale indicates that the group dynamics created in this environment gave rise to the generation of social capital and the creation of effective, trusting and cohesive/inclusive working relationships where knowledge-construction, competency acquisition and commitment to shared goals and mutual understanding is achievable. However, it is in specific relation to cross-site team interaction that the most significant impact is observed, with users of *CommonGround* reporting more positive feelings of community and a far higher degree of professional collaboration, satisfaction and self-disclosure. Importantly, the findings discussed here correspond with and support feedback from students obtained during post-trial group interviews, as I will return to later.

6.5.3 Group Awareness

Often taken for granted in face-to-face interactions [114], group awareness refers to the up-to-date knowledge of the status, roles and current activities of one's team mates (i.e. what everyone in a collaborative group has done so far, what they are doing now, and what they will do next). Necessary for effective collaboration, it demonstrably leads to an increase in overall levels of interaction and course satisfaction [115]. Naturally, the capacity of *CommonGround* to establish a sense of group-awareness on-project – with an emphasis on reciprocacy and dissemination of student activities – is one of the primary motivations behind my work (recall that, in Chapter 4, students reported that they were frequently unable to keep track of the activities of their team mates – especially cross-site – and this inevitably led to duplication of work and increased frustration). Encouraging awareness of co-member activities and work-rhythms (i.e. social, action and activity awareness) therefore represents an area of particular interest.

So far, the Sociability, Social Presence and Social Space scales used in this study have demonstrated *CommonGround's* potential to create group awareness in collaborative team contexts (as stated by Kreijns et al., group awareness is one of the key factors contributing to the perception of social presence and sociability [188]). However, to more specifically target and examine the effectiveness of *CommonGround's* social awareness and status-dissemination affordances (and, in turn, their ability to enhance inclusion and positive interpersonal behaviour on-project – an important determinant of a group's social and cognitive performance [29]), I performed an explorative investigation into perceived group awareness during the 2008/09 trial. To operationalise the group awareness construct, I employed a fourth and final instrument.

6.5.4.1 Instrument Detail

Developed by Daassi & Favier [116], the *Group Awareness Scale* is a self-reporting, one-dimensional measure featuring 5 seven-point Likert-scale items designed to gauge a student's cognisance of team-mate activity, progress, availability, and willingness to communicate (opinions were expressed on a continuous 1-7 scale: 1=*Strongly disagree*; 2=*Disagree*; 3=*Somewhat disagree*; 4=*Neutral (neither agree nor disagree)*, 5= *Somewhat agree*; 6=*Agree*; 7=*Strongly agree*; no further scale clarification was provided). Adapted mainly from recognised instruments from prior studies, the measure was checked for validity using exploratory and confirmatory factor analyses and produced strong reliability estimates for internal consistency (the items that comprise the instrument, reworded slightly to suit this cross-site study, are provided in Tables 6.6 and 6.7). A Cronbach's coefficient α between .84 and .87 was achieved in the original report and, in this investigation, .86 for the study group and .90 for the control group; I thus found the scale to be a satisfactory measure of the group awareness construct.

6.5.4.2 Results

Results from the team awareness survey (i.e. responses to questions derived from the Group Awareness Scale) are provided overleaf in Table 6.6 (study group) and, later, Table 6.7 (control group). Again, each institution's local scores were combined, as were both sets of cross-site scores.

Group Awareness Scale *(Study Group, n=58)*		*Local*		*Cross-site*	
		$\bar{x}$	*s*	$\bar{x}$	*s*
Q1	I am usually aware of the progress of our project.	5.8	1.1	5.2	1.3
Q2	I am usually aware of the activities of my team mates.	5.7	1.2	5.1	1.2
Q3	I am usually aware of my team mates' availability.	4.9	1.2	4.6	1.2
Q4	I am usually aware of how willing my team mates are to communicate.	4.8	1.1	4.3	1.5
Q5	I am usually informed of what occurs in our company or shared workspace.	5.6	1.2	5.0	1.3

Table 6.6: Group Awareness Scale, Summary Statistics (Study Group, 2008/09)

A brief evaluation of the results reveals that students in the study group scored their perceived degree of group awareness moderate to high. Individual local Likert-item scores, as illustrated in Figure 6.8, were positive and consistent across the scale, producing a mean average score of 5.36 (note that, unlike the previous three 5-point scales used in this study, the group awareness scale uses

7 points). Surprisingly, cross-site scores were only slightly lower and achieved a very encouraging average Likert-item score of 4.83 (Figure 6.9). Although there once again remains considerable scope for improvement, these results do suggest that the *CommonGround* tool helped students to maintain critical awareness of overall project progress and up-to-date knowledge of the day-to-day activities and availability of their team mates (i.e. their work rhythms). In post-trial interviews, students supported these findings by claiming that they felt “in the loop” on-project and aware of their team mates’ tasks, roles and responsibilities both locally and cross-site.

Group Awareness Scale (*Control Group, n=50*)		*Local*		*Cross-site*	
		$\bar{x}$	*s*	$\bar{x}$	*s*
Q1	I am usually aware of the progress of our project.	4.7	1.4	3.3	1.3
Q2	I am usually aware of the activities of my team mates.	3.6	1.2	2.3	1.2
Q3	I am usually aware of my team mates’ availability.	3.1	1.2	2.1	0.9
Q4	I am usually aware of how willing my team mates are to communicate.	3.1	1.0	1.9	0.8
Q5	I am usually informed of what occurs in our company or shared workspace.	4.2	1.0	2.3	1.2

Table 6.7: Group Awareness Scale, Summary Statistics (Control Group, 2008/09)

However, to help ascertain the degree to which *CommonGround* was able to help establish group awareness during the CETL-ALiC project, control group student feedback must again be considered. The results provided in Table 6.7 show that control group students scored their perceived degree of local group awareness low to moderate, reporting an average Likert-item score of 3.73 (as illustrated in Figure 6.10). Cross-site scores were again markedly lower than those reported by the study group, producing an average Likert-item score of 2.38 (Figure 6.11).

These results reveal that students in the control group reported lower group awareness than that of the study group, reporting a drop in average Likert-item score of 1.6 (-30.4%). Although all items scored consistently poorer in comparison to the study group, of particular interest to this study is the noticeable drop in local activity and availability awareness. However, this drop is trumped somewhat by the markedly lower group awareness scores achieved cross-site, represented by a decrease in average Likert-item score of 2.5 (-50.8%). Continuing the trend typically observed in previous years, these results indicate poor levels of perceived activity and availability awareness across sites.

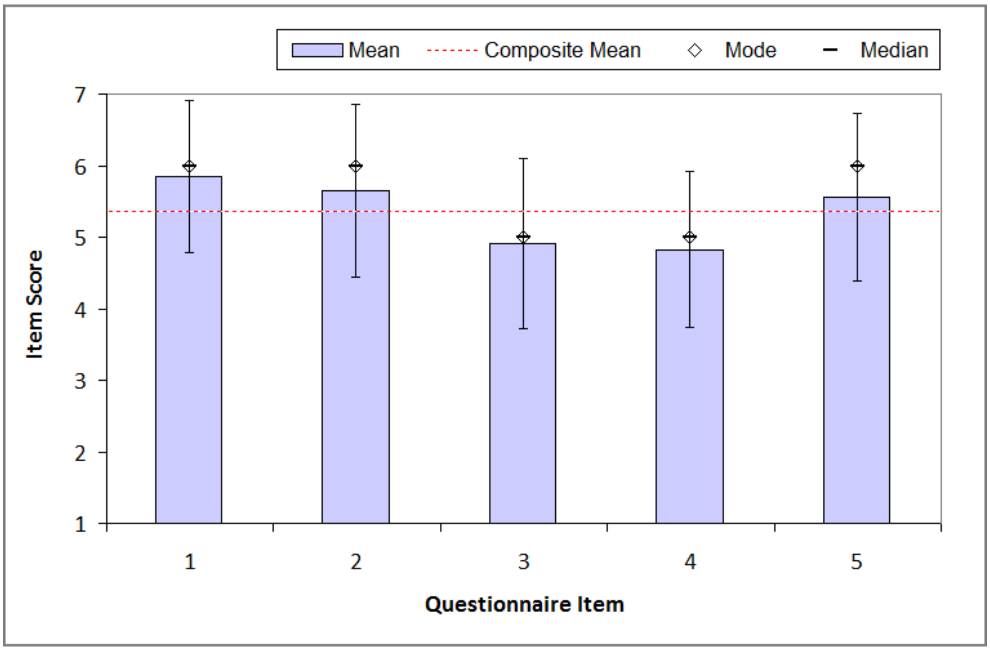

Figure 6.8: Group Awareness Scale, Average Local Responses (Study Group, 2008/09)

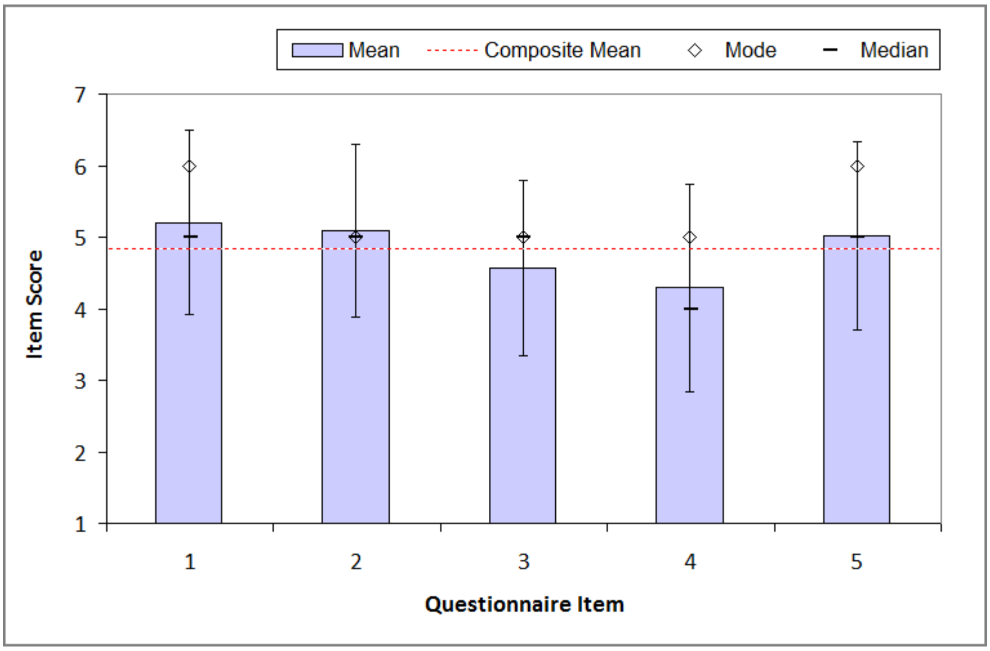

Figure 6.9: Group Awareness Scale, Average Cross-Site Responses (Study Group, 2008/09)

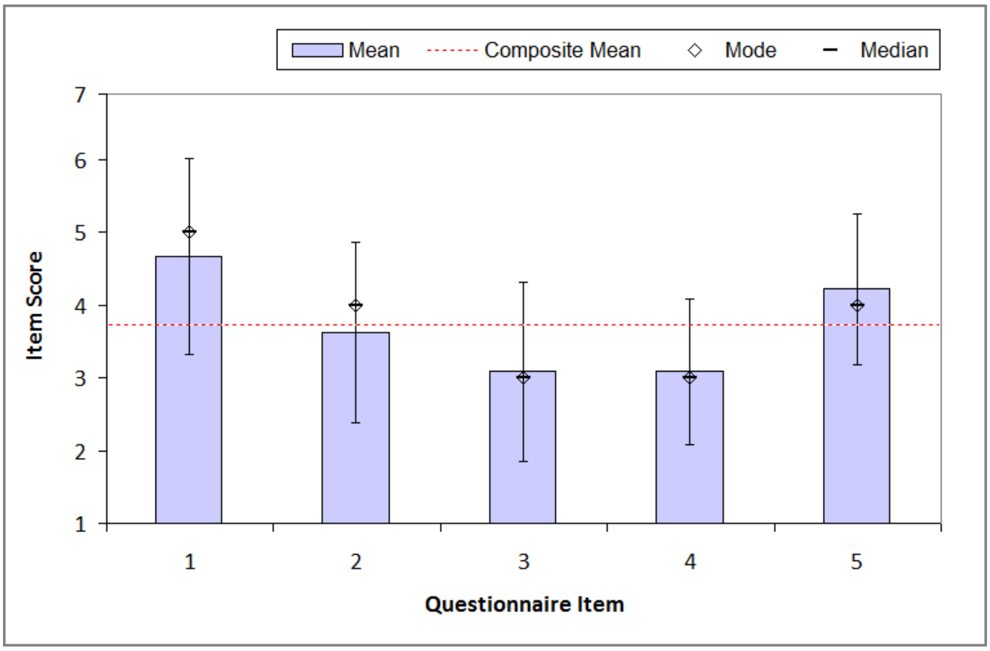

Figure 6.10: Group Awareness Scale, Average Local Responses (Control Group, 2008/09)

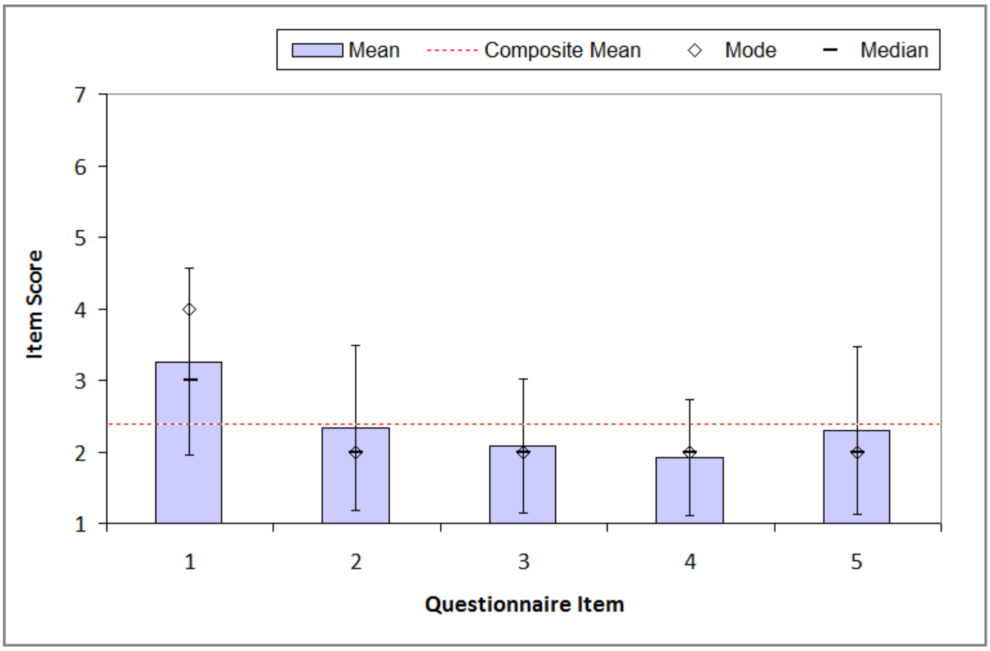

Figure 6.11: Group Awareness Scale, Average Cross-Site Responses (Control Group, 2008/09)

Feedback obtained from post-trial interviews confirmed that – in comparison to the study group – control group students struggled greatly to monitor the actions, progress and work rhythms of their cross-site team mates. In turn, as team relations and communications broke down under the strain (as they invariably did), students often completely lost touch with their remote team mates. Unfortunately, as I discussed in Chapter 4, such a collapse in communications often led to duplication of work, increased frustration and reduced team morale. Far more troublingly, a lack of general team awareness and community spirit also occasionally led to the isolation of peripheral team members and to decreases in personal motivation that could potentially affect a student's final grade (the latter of which I will explore in more depth later in this chapter).

To compare results between the two trial conditions in more detail, I again performed two separate two-tailed independent sample t-tests. In the first test, T_1, the null hypothesis (H_0) was *local study group score = local control group score*; the alternative hypothesis (H_1) was *local study group score ≠ local control group score* (with study/control group membership as the independent variable and the summated group awareness Likert-scale as the dependent variable). Similarly, in the second test, T_2, H_0: *cross-site study group score = cross-site control group score*; H_1: *cross-site study group score ≠ cross-site control group score*. The results, provided in Table 6.8 below, revealed a statistically reliable difference (with large effect sizes, *d*) between the mean summated scores of students in the study group and the control group. I am therefore able to again reject H_0 and accept H_1 for both T_1 and T_2.

	Group Statistics			*Significance*		
Local Scores	n	$\bar{x}$	s	t (df)	p	d
T_1 Study Group	58	26.81	4.58	9.03	<.001	1.75
T_1 Control Group	50	18.70	4.74	(106)		
Cross-site Scores						
T_2 Study Group	58	24.19	5.53	12.57	<.001	2.44
T_2 Control Group	50	11.94	4.43	(106)		

Table 6.8: Differences Between Study and Control Group Awareness Scores (2008/09)

In summary, the findings presented (and illustrated in Figure 6.12 overleaf) again indicate a positive outcome to RQ2 and suggest that the *CommonGround* environment positively contributes towards the establishment of general group awareness on-project – or, as distinguished by Carroll et al. in [117]: action, activity, and social cognisance. As prior research suggests, the establishment of group awareness directly influences overall levels of interaction, inclusion and course satisfaction in collaborative educational contexts [115], allowing participants to build shared understanding around a common goal (establishing a climate of group awareness needs time, interaction and experience of working together [116]). In this regard, the social and status affordances of the *CommonGround* tool appear to have had a positive affect on the dissemination of critical "awareness information" both locally and cross-site, allowing students to better keep track of the actions, roles and beliefs of local and distributed colleagues (and of task progress as a whole).

However, it is in specific relation to cross-site social, action and activity awareness that the most significant impact was observed during the study, with users of *CommonGround* reporting a far higher degree of team and task awareness than non-users. Going forward, I will extend the results provided here by investigating the real-time usage statistics recorded by *CommonGround* during the CETL-ALiC group programming activity, and, in turn, their wider effect on student performance.

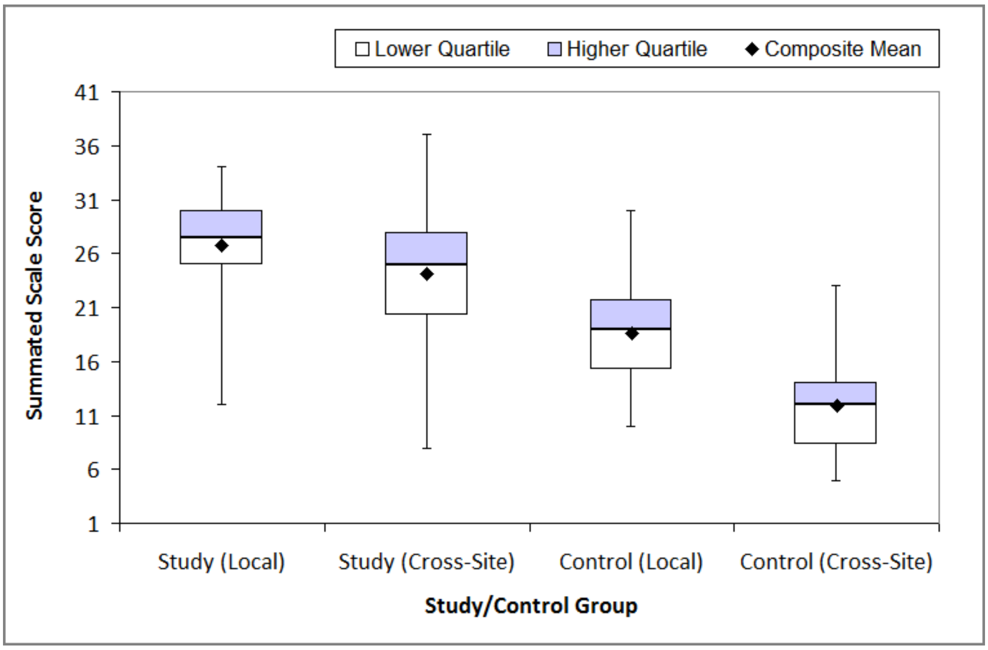

Figure 6.12: Group Awareness Scale, Summated Scores (2008/09)

6.6 Usage Statistics & Cognitive Performance

The results from the sociability, social presence, social space and group awareness surveys all suggest that *CommonGround* is an effective tool for generating social capital and reducing the geographic and temporal barriers to participation on-project. By building upon and leveraging the power of pre-existing social networks, the application fosters group interaction and community-formation by providing a persistent and centralised space in which students can interact and explore the personal profiles and work patterns of their team mates. More importantly, by allowing students to maintain their interactive cohesiveness and project planning potential beyond face-to-face meetings, *CommonGround* also potentially strengthens weak ties and aids in the inclusion of peripheral team members. However, to support these findings and demonstrate a positive correlation between use of *CommonGround* and cognitive performance (and thus address RQ3), I now provide an analysis of real-time application usage statistics and learner performance outcomes.

6.6.1 Data Log Discussion

As discussed in the previous chapter, most user-interaction with *CommonGround* was captured by the local hosting server and recorded in data logs for analysis post-project. Following the 2008/09 trial, these logs indicated positive, heavy use of the application, as described below in Table 6.9 and illustrated in Figure 6.13. The user activity shown was taken from a 91 day window of activity between weeks 3 and 11 (i.e. starting after all team members had accepted invitations to join and ending on the day of the final team deliverable, including a four week vacation).

Average Weekly User Interactions *(n=58)*		
Activity Event	$\overline{x}$	*s*
Impressions (i.e. application loads)	14.61	2.09
Chat utterances	24.22	5.33
Status updates	4.52	1.07
Schedule additions/updates	0.98	0.27
Chance encounters	14.74	3.62
(of which led to a chat conversation)	3.14	1.14
Profile explorations (initiated via *CommonGround*)	2.50	0.66
Application visit duration (minutes per visit)	1.57	0.50
Average Total In-Tool Friend Connection Requests		
Local team member friend requests (Newcastle)	5.16	1.73
Local team member friend requests (Durham)	4.11	0.94

Cross-site team member friend requests (Newcastle)	3.38	1.78
Cross-site team member friend requests (Durham)	4.35	1.03
Average Total Friend Connections		
Local team member friends (Newcastle)	8.18	1.29
Local team member friends (Durham)	4.37	1.01
Cross-site team member friends (Newcastle)	3.71	1.47
Cross-site team member friends (Durham)	4.96	1.52

Table 6.9: Average CommonGround Interactivity Statistics (2008/09)

Team members accessed the application a little over twice each day on average (2.09 daily mean), if only to "check in" and view the activities and status updates of others. Impressions, or application loads, peaked at a little under 6 daily views by week 10. Visit duration remained fairly constant during the trial at slightly under 1.6 minutes per impression, indicating students frequently "dipped in and out" of the application (notably, where chance encounters led to chat interactions, this visit time increased to an average of 8.7 minutes). Considering that user activity occurs as a direct consequence of application impressions, increased use of *CommonGround* also naturally led to more valuable interactions such as chance encounters (i.e. ad-hoc informal meetings with members of one's group). On average, students chanced upon two members of their team each day in the *CommonGround* environment (2.11 daily average), of which 21.3% resulted in a chat conversation. Of importance to asynchronous interactions, status updates occurred approximately once every two days (0.65 daily average), with schedule updates occurring less frequently at approximately once per week (0.14 daily average).

I was admittedly surprised by the relatively high usage of the status update feature, a social awareness widget that prompted students to publish a concise one-line statement about their current activities (and which one would assume would not change on a day-to-day basis). However, in post-trial interviews, students commented that this feature was the primary motivation for frequent return visits to the application (both to publish and consume informal and on-task updates). As an observer, I believe this high level of adoption was largely attributable to the feature's mimicry of Facebook's own built-in, simple, instantly recognisable and frequently used status affordance (and the gratifications thereof). On average, students also initiated exploration of other team members' profile information approximately twice weekly (0.33 daily average), enabling participants to better "get to know" their colleagues.

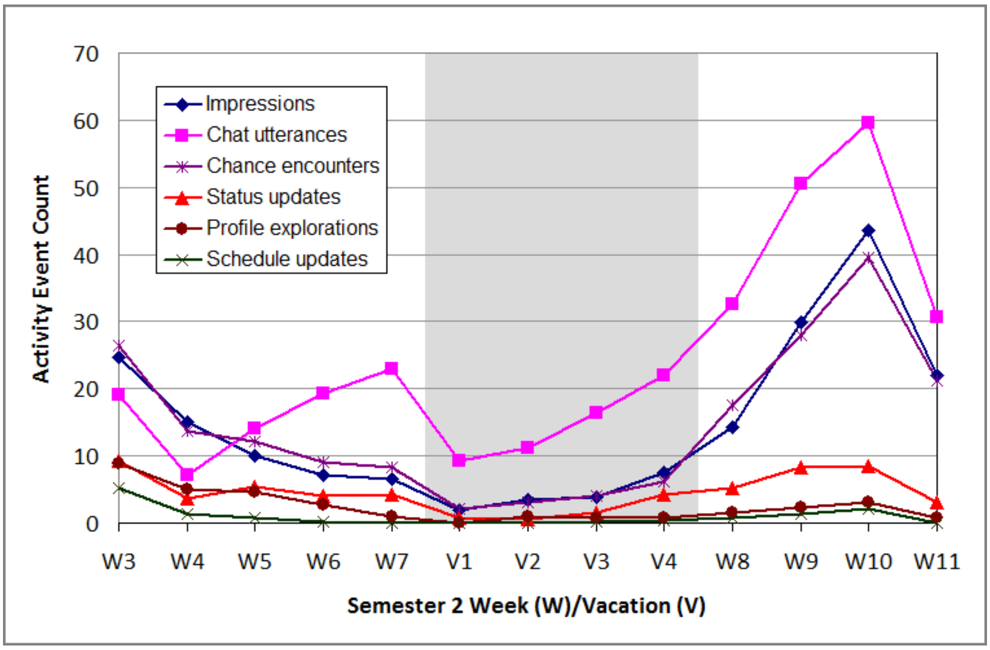

Figure 6.13: Weekly CommonGround Interaction Trends (2008/09)[7]

By week 11, students had also added approximately 87% of local team members as friends on the Facebook service (66.2% of which were requested via the *CommonGround* tool[8]), thus enabling full exploration of their profile. Across institutions, students had added almost 62% of their cross-site team mates (52.2% via the *CommonGround* tool), a considerably high number given the mistrust and conflict typically observed between collaborative CETL-ALiC teams. Thus, despite initial resistance, students appeared to be happy to add their team mates as friends on the Facebook service once they had become better acquainted.

6.6.2 Data Log Trends

As outlined in Figure 6.13, data logs indicate that *CommonGround* usage generally started slowly (following an initial peak of interest when participants experimented with the tool and first populated schedule/status information), but then grew steadily throughout the trial. Interestingly, at least from a

[7] Interactions have also been plotted individually by type in Appendix A. This helps to demonstrate weekly trends for relatively low frequency series (e.g. status updates, schedule updates and profile explorations).

[8] It was possible to add team mates using Facebook's built-in search facilities (which could not be recorded by *CommonGround* directly). However, by taking a snapshot of a user's friend list at the application log-in stage, any relevant additions or deletions could be automatically detected.

social perspective, there was often a small delay between inviting local team mates and cross-site team mates (of at most five days), which suggested that local teams sought to "find their feet" first before inviting their cross-site colleagues to join them. During the second term (i.e. weeks 8 to 11), when final individual and team deliverable due dates were approaching, interactivity markedly increased in line with the need for clear local and cross-site communication, collaboration and group/task awareness. Notably, interaction levels fell slightly in the first quarter of a four week vacation period (as indicated by the shaded area in Figure 6.13). However, despite not achieving term-time levels, data does show that participant communications continued during this time; a significant finding considering students typically did not interact during vacation periods. Usage levels then grew steadily again until, in week 10 – when final system demonstrations were due – interaction peaked.

6.6.3 Student Performance

To answer RQ3, I now investigate the relationship between usage of *CommonGround* and student achievement on-project. For this study, learning performance will be measured by the final grades of Newcastle University students only (calculated through a combination of individual/team deliverables and assessor/peer assessments, as discussed in Chapter 3). Although the measurement of student performance in this context is open to debate, final grades have been used to measure learning achievement in various computer-supported collaborative learning contexts previously [191], and as such I believe it represents an appropriate form of performance measurement here. Table 6.10 below thus provides a summary of average student marks across both study and control groups.

Final Average/Min/Max Student Marks				
Newcastle Study Group (n=38)	$\bar{x}$	*s*	*Min*	*Max*
Study Team 1	57.80	21.42	33	86
Study Team 2	72.60	8.40	59	84
Study Team 3	77.50	3.63	71	83
Study Team 4	72.00	6.46	59	81
Total	69.87	14.07		
Newcastle Control Group (n=34)	$\bar{x}$	*s*	*Min*	*Max*
Control Team 1	49.00	15.96	28	72

Control Team 2	63.38	20.63	17	79
Control Team 3	62.89	13.09	44	84
Control Team 4	60.00	11.70	45	77
Total	58.97	15.88		

Table 6.10: Study/Control Group Team Performance, Summary Statistics (2008/09)

A brief examination of the results provided in Table 6.10 reveals that teams in the study group achieved higher average combined grades than the control group, with a total mean difference between groups of 10.90 (equating, in real terms, to a difference in degree classification for the module). To compare individual final grades between the two trial conditions in more detail, I performed a two-tailed independent sample t-test to compare results between the two trial conditions. The null hypothesis, H_0, was *local study group grades = local control group grades*; the alternative hypothesis, H_1, was *local study group grades ≠ local control group grades* (with study/control group membership as the independent variable and individual final grades as the dependent variable). As one would expect given the results in Table 6.10, a significant difference was found in grades between study group participants (M = 69.87, SD = 14.07) and control group participants (M = 58.97, SD = 15.88; t (70) = 3.088, p = 0.003) with a medium to large effect size (Cohen's d = 0.74). I therefore reject H_0 and accept H_1. Of course, these results do not strictly indicate a causal relationship; however, they do indicate a strong connection between use of *CommonGround* and higher learning performance on-project, thus suggesting a positive outcome to RQ3.

Admittedly, it is not so much *CommonGround* that directly improves learning performance on-project, but rather a whole company's willingness to embrace the information and resources exposed by it. The tool may create a low-friction space in which to generate social capital, but it remains entirely in the hands of students as to whether they fully invest in and exploit its latent potential. Although the results provided in this section do demonstrate a positive connection between use of *CommonGround* and higher achievement on-project, these findings do need to be considered with care. Firstly, I do not control for students using other CMC tools; as my tool serves to support and enhance co-located face-to-face collaboration and traditional distributed CMC, and in no way precludes the use of other tools for local or cross-site communication, the usage data presented cannot offer a complete view of student interaction. Secondly, a student's team performance is subject to a great many academic factors and interpersonal influences that exist beyond the scope of this work. However, despite these considerations, the results provided nevertheless suggest that *CommonGround* – or more so the sociability it encourages – positively influences student performance and learning outcomes on-project.

6.6.4 Feature-Performance Correlations

Previous findings discussed in this chapter have suggested a positive connection between use of the *CommonGround* tool and individual performance on-project. To conclude this chapter, I now briefly investigate the specific *CommonGround* features and use-statistics that appear to have had the greatest impact in this regard. To do this, Pearson bivariate correlation coefficients were calculated to explore the linear relationship between each primary social-affordance of *CommonGround* (as measured and described earlier in Table 6.9) and final Newcastle University student grades. The results, which will serve to inform my development efforts going forward (see Chapter 7), are provided below in Table 6.11.

CommonGround Feature *(n=38)*	*r*	*p*
Impressions (i.e. application loads)	.424*	.008
Chat utterances	.310	.058
Status updates	.329**	.043
Schedule additions/updates	.416*	.009
Chance encounters	.446*	.005
Profile explorations (initiated via *CommonGround*)	.349**	.032
Application visit duration	.365**	.024
Local team member friends	.079	.638
Cross-site team member friends	.149	.372

Table 6.11: Pearson Correlations Between Feature Measures and Final Grade (2008/09)

Although I cannot establish causality between the factors considered and final student grades, a medium positive correlation between the two is nonetheless apparent. As one would perhaps expect (assuming *CommonGround* has a beneficial influence on student achievement, as my findings thus far would indicate), impressions and chance encounters correlate best with overall performance on-project. Surprisingly, a medium to large relationship between schedule updates is evident, with status updates and chance encounters correlating slightly lower – potentially indicating areas where more work is required. Interestingly, the number of local "friends" on the Facebook service appears to have little effect on overall achievement, with cross-site friends correlating only slightly better. Overall, aside from the friending of team mates, each of the features and uses measured appear to have had a

* Correlation is significant at the 0.01 level (two-tailed).
** Correlation is significant at the 0.05 level (two-tailed).

significant impact on student performance on-project; a determination supported by feedback obtained in post-trial interviews (as I will return to in 6.8).

6.7 Discussion

A crucial prerequisite for efficient computer-supported collaboration and learning is the willingness of the participants involved to share their knowledge [192]. However, as discussed in Chapter 2, most functional, task-based computer-mediated tools fail to provide the collaborative depth and social affordances needed to significantly influence group dynamics and the acquisition, building and exchange of mutual understanding. Learning and group interaction are inherently social processes, but many developers and researchers simply forget, neglect or ignore these psychological and emotional aspects of collaboration (assuming they will occur simply because the environment makes it possible) [70, 188]. As Gunawardena posits, constructivist group learning can only take place when team members are able to relate to one another, form good working relationships, share a sense of community, and agree upon mutual goals and understanding [72]. Similarly, Haythornthwaite contends that knowledge is not created in an individual vacuum but in the myriad interactions that occur via one's network of connections [79] (with "the social process of developing shared understanding through interaction" being the natural way for people to learn [80]). Hence, computer-mediated learning and collaboration tools which seek to encourage student interaction must facilitate these important socio-psychological processes; if they do not, research warns that the resultant feelings of isolation will likely reduce a user's willingness to take the risks involved in learning [82].

With respect to the CETL-ALiC project, this chapter has sought to determine the viability of the *CommonGround* RIA as an effective social collaboration and group awareness tool (and, in doing so, expose any weaknesses in the concept's design or implementation – issues which I will discuss in more detail in 6.8.2). In particular, the closely related measures developed by Kreijns et al. to determine the social potential of computer-supported collaborative environments (namely the Sociability Scale [188], Social Presence Scale [189] and Social Space Scale [104]) were used to show that *CommonGround* – embedded on the Facebook platform – can facilitate the establishment of a "sound social space". As the results presented in this chapter have shown, *CommonGround* helped students create effective collaborative relationships capable of sustaining and supporting group cohesiveness, task awareness, shared understanding, trust, empathy, respect and course satisfaction. Encouragingly, these positive results were obtained despite introducing the tool mid-project when student communication strategies were already partially established (admittedly, it is during this time that most development work was performed and, traditionally, local and cross-site communications deteriorated – as control group results once again attest to).

Simply placing students in groups and providing them with a collaborative tool does not always guarantee successful interaction, open dialogue, and important cognitive processes such as elaborating, questioning and defining. However, my investigation into group awareness using Daassi & Favier's Group Awareness Scale [116] (supported by high levels of application usage statistics) confirms that *CommonGround* is an environment which builds community and encourages student cooperation, coordination and cohesion. In particular, status updates and chance encounters allow students to get to know one another and exchange information that directly influences impression formation and affiliation (i.e. the propensity for students to keep in touch with each other). In turn, research indicates that the mutual dependencies created encourage team roles to be learned, group values understood, and individual identities shaped. Furthermore, students can access, visualise and continuously reflect upon their group's dynamic, thus returning strong payoffs in terms of social support and access to expertise, resources and knowledge (i.e. social capital). Perhaps more importantly, the informal connections formed allow students to monitor how their actions affect the team, reducing barriers to interaction both locally and cross-site, strengthening team ties, and encouraging the inclusion of peripheral, passive team members. Finally, although my focus has been on social interaction rather than educational performance (measuring the acquisition of declarative knowledge is outside the scope of this thesis), the results given do indicate that increased use of the *CommonGround* application results in higher overall achievement on-project.

6.8 Student Feedback

As I will now discuss, post-trial group interviews were conducted to gather general feedback from users of *CommonGround* regarding the tool's effectiveness. Coupled with comments included in reflective end-of-project individual/team reports, this information was collected to inform my development work going forward. The main findings from these two sources – both positive and negative – will now be briefly discussed.

6.8.1 Post Project Interviews

To gather qualitative feedback from students on a broad spectrum of CETL-ALiC project-related topics, two unstructured group interviews were conducted at Newcastle University in week 12 of the 2008/09 academic year (chaired by this author). The first of these hour-long sessions, as described in detail in 4.3.1, sought to obtain general feedback on the relative successes and failures of the group project, from team formation and communication issues to facility provision and mandate quality. With the pressure of project deadlines removed, students were able to reflect and focus on the practical successes and failures of the project, expanding on issues mentioned in reports and exposing serious problems that affected the quality and learning outcomes of the project. Again, although open to all project participants, at least two students were required to attend from each team to ensure that the experiences of every company were represented (n=51). A representative of IBM (acting as client) was also in attendance to field questions relating to the project's mandate.

The second session sought to gather more specific feedback from users of CommonGround regarding the tool's functionality, quality and usability. All study group participants were invited to attend, 72% of which took up the offer (n=27). Once again, questions were kept intentionally open-ended to encourage two-way communication and allow students to express their opinions freely on whichever topics they felt mattered most. However, a broad framework of questions asked:

- How did you use *CommonGround* on-project? Did you encounter any problems?
- Did you like the tool? Was it genuinely useful?
- Did the tool in any way intrude on your normal use of Facebook?
- What features of the tool did you find worked best and why?
- What features were least used and why?
- What features could be improved?
- What new features could be added?
- Did you find it easy to communicate with your local team mates via the tool?
- Did you find it easy to communicate with your cross-site team mates via the tool?
- Do you feel the tool helped you to stay in touch with all of your team mates?
- Do you feel the tool helped you get to know all of your team mates better?
- Was the tool used primarily for informal chat or for task-related discussion (or both)?

The feedback gathered, although anecdotal at times, again served to crystallise my understanding of how students used *CommonGround* on-project, as I will now discuss.

6.8.2 Positive Remarks

By and large, most students commented positively on the professional design of *CommonGround* and its ease of use, reporting that they had utilised the application as a "one-stop-shop" to contact and collaborate with team mates during the project. Following are brief excerpts from individual/team end-of-project reports:

> *"CommonGround allowed us to post what we were currently working on and this was viewable by all company members. This proved to be invaluable to us, especially during holidays when it wasn't possible to meet up face to face."*

> *"The team's communication was the most prominent problem [early in the project]. The situation improved significantly and was aided further by the use of CommonGround, a social networking tool. By semester 2 the communication between the team members had improved significantly and thus resulted in enhanced teamwork."*

> *"I feel that the use of CommonGround to communicate and share work and constructive criticism was a great addition to our project. If we were to do such a project again I would definitely be keen on using CommonGround from the very beginning as our main medium of communication. It increased our productivity, organization, tracking of progress and awareness of one another's activities."*

> *"CommonGround was an ideal medium of communication and I found it very useful as I could just leave few messages on my plans or ideas for the team project before I started working on them. Then I could fully concentrate on my work for an hour or so before taking a break to look at CommonGround for any update or comment from [my team]. From them I could find out what other team members thought of my plans or ideas."*

> *"CommonGround was a much more relaxed and informal method of communication; we could chat and help each other with problems at any point in the day."*

> *"CommonGround was quite important as we were always in the know when a team member was doing any work. We would always know when anyone was working on something and we could advise them on the task."*

> *"I found CommonGround very useful for telling my team what I was currently doing and how far off I was finishing certain parts of the project. It was also very useful to see what the other team members were doing and where they were in terms of their parts of the project. Updating and reading updates on CommonGround made it easier to stay a part of the team."*

The majority of students also stated that they were comfortable using Facebook and *CommonGround* on-project both locally and cross-site, and appeared to integrate the application into their working practices with little resistance (in stark contrast to the technologies originally mandated by the CETL-ALiC partnership). When reminded of their initial concerns regarding aggressive Facebook profile integration techniques and the "forced" friending of team mates, all interviewees conceded that this resistance was quickly forgotten once they had familiarised themselves with the sandbox nature of the application (most participants added their team mates as friends by choice and also requested deeper *CommonGround* integration with their profiles). Perhaps of more importance, however, was that most participants reported that they felt "part of a team."

In terms of functionality, students stated that the combined communication affordances of *CommonGround* and Facebook, in addition to readily accessible profile contact information, allowed them to get in touch with colleagues quickly and easily (with standard e-mail used only for less pressing matters). Students also rated the Virtual Meeting Room affordance highly, suggesting that it greatly improved feelings of online presence and community. Where chance encounters were concerned, students agreed that the meeting room metaphor helped to situate interaction, encouraging the exploration of personal profiles and the initiation of informal and on-task chat (interestingly, all teams indicated that they held a number of informal company meetings using the tool, often conducted on an impromptu and ad-hoc basis. The status update facility also received positive comments from students, with many suggesting this feature was singly responsible for keeping them aware of the activities of their team mates (and was thus the primary motivational factor for frequent return visits to the application). However, although participants reported that *CommonGround's* simple chat and project planning features were effective, a number of improvements were also suggested (as I will discuss in the following section).

Significantly, many of the CMC facilities offered by *CommonGround* and Facebook (such as messaging and chat) were already provided by the CETL-ALiC partnership in other technologies/applications, but the students simply chose to ignore them. The fact that this functionality was centralised on Facebook seems to have greatly influenced its adoption and use.

Indeed, e-mail (which often tends to dominate students' local and cross-site communication strategies) appears threatened somewhat by Facebook's built-in messaging and communication facilities. In a wider context, this finding is supported by reports of social networking message traffic overtaking that of web-based e-mail [26]. Evidently, students no longer e-mail but "Facebook" each other. Interestingly, students were also more inclined to formally report team communications via Facebook and *CommonGround* once they realised "it was okay to do so". As feedback shows, they did not initially perceive social networking sites to be an acceptable form of professional communication, despite awareness of large corporate networks who were operating successfully on the service. This finding is further highlighted by teams' end-of-project reports which make only anecdotal reference to the trial use of *CommonGround* for formal collaboration (even though the majority of participants stated that it had helped communications in post-project interviews). As one team member commented: "I thought Facebook was too informal to be a valid tool for use during work." Going forward, it is perhaps unavoidable that students will perceive the use of *CommonGround* – and social networking services as a whole – in an entirely informal and non-professional manner.

One final note of importance: during the trial period, non-study groups reported use of alternate social-networking platforms such as FriendFeed [176] and Presently/Socialspring [177]. However, all participants abandoned these services within the first few weeks, stating in post-project interviews that they were poor imitations of Facebook and therefore of little standalone benefit. In all cases reported, students simply chose to follow the path of least resistance and use Facebook; it was convenient, free, required no learning overheads, and was already in frequent use (the main reasons that I chose to target the platform in the first place).

6.8.3 Criticism

In addition to the positive feedback outlined above, students also highlighted a number of functional issues with *CommonGround* that they felt could be improved. In particular, despite the limited number of participants involved in the trial, a variety of technical problems were encountered which caused considerable frustration for students. In particular, the inefficient BlazeDS messaging service – used for chat, presence and data logging – generated significant amounts of local network traffic and severely slowed server response times (recall that *CommonGround* was hosted on a non-dedicated Newcastle University campus desktop computer). To exacerbate matters, high bandwidth usage periodically caught the attention of automatic load-balancing and security systems monitoring the network which resulted in the restricted movement of data to and from the server. Although very much a local issue, the “down-time” experienced as a result of these occasional restrictions nevertheless inhibited interaction and frustrated participants (especially as students explicitly requested a stable and reliable tool for the duration of the study). Fortunately, due to the modest participant numbers involved in the trial, these issues rarely manifested in practice and did not affect general use of the application.

On a more functional level, students also described occasions when they visited the application to find no other team members present. This in itself was to be expected, but of importance here was the request for chat and event data to persist between sessions – “history awareness” – effectively leaving a footprint of activity for absent team members to catch-up on (during the initial trial, conversations and activity notices were ephemeral and visible only to team members concurrently logged in). In hindsight, this conspicuously absent feature, in addition to component-specific activity log access, would certainly have helped reduce the temporal barriers to team interaction (and attract repeat visits to the application). As suggested by Fono & Baecker [193], persistent chat systems encourage both synchronous and asynchronous interaction, creating an invaluable record of organisational knowledge and conversational style for participants to refer back to. Supporting this finding, Ribak et al. [194] also suggests that chat persistence fosters group dialogue and the generation of new ideas.

Students also found the status update features of *CommonGround* rather limited in their potential for encouraging topic-specific interactions. Although undeniably useful for announcing and monitoring team-wide activities, the component simply lacked the capacity for direct comments and asynchronous discussion around a single issue. Questions were frequently posed in a participant’s status that were difficult to reply to globally; when coupled with a lack of history, these simple omissions often stifled effective communication. Of course, these perfectly valid observations were largely informed by the common usability features of the de-facto, built-in affordances and gratifications of Facebook’s own communication and status update features – a point students were quick to acknowledge.

In stark contrast to the reservations raised at the outset of this study, students also suggested that team-wide activity updates would be useful if posted to their private Facebook News Feed. Importantly, students remained adamant that the application must not interfere with any private or recreational uses of the service, but felt a daily update sent to their own personal news streams would be useful (especially for elucidating team member status information and upcoming deadlines recorded in the scheduling component). In addition to a number of trivial but useful interface improvements, students also felt a built-in file sharing feature and whiteboard facility would be beneficial, particular for co-creating and documenting system flow diagrams. Finally, participants stated that users and groups were difficult to manage without administrator assistance and thus requested a means to independently create and moderate their own team accounts.

6.9 Concluding Remarks

This chapter presented the first of two experimental trials of *CommonGround*, a proof-of-concept Web 2.0 RIA developed as part of my study to support students participating in the CETL-ALiC group programming activity. Conducted during the 2008/09 academic year, this initial trial was designed to test the viability of the application as a sound collaborative tool and expose any weaknesses in the concept's design or implementation. To address these aims, the following three research questions were investigated:

RQ1. Is the *CommonGround* tool capable of encouraging and supporting critical interpersonal processes such as affiliation, team interaction, impression formation, social presence, and positive feelings of team-member connectedness?

RQ2. Extending RQ1, does the *CommonGround* tool help to create group awareness and sustain a low-risk environment in which effective, trusting and cohesive working relationships can be established?

RQ3. Does usage of the *CommonGround* environment positively influence an individual's performance and achievement on-project?

As described in this chapter, four instruments (with high degrees of construct validity and internal reliability) were used to examine student participation during the trial: the Sociability Scale [188], Social Presence Scale [189], Social Space Scale [104], and Group Awareness Scale [116]. Each provided an insight into the social climate of student teams collaborating on-project, thus allowing me to answer the research objectives outlined above. Results from this exploratory study, as presented in this chapter and discussed in detail in 6.7, indicated that *CommonGround* was indeed able to establish a "sound" collaborative space on-project capable of promoting social interaction, group awareness, community formation and individual cognitive performance (supported by high levels of application usage statistics). The results therefore allow me to conclude with a positive result to RQ1, RQ2 and RQ3.

Naturally, I was very encouraged by both the positive outcomes of the trial and the constructive criticism provided by participants in 6.8. The *CommonGround* application had been shown to reduce barriers to team interaction both locally and cross-site, had helped to strengthen team ties and include peripheral team members, had heightened social presence and group awareness, and had contributed to an overall increase in social capital and individual achievement. I was thus motivated to take the next logical step and create a second version of the application; a more robust, flexible and refined tool that would build upon the moderate successes of the first trial.

6.10 Summary

In this chapter I presented the first of two experimental field-trials of *CommonGround*. Following an overview of the trial and the research questions posed, I provided a detailed discussion of the selected instrumentation used to analyse the sociability of *CommonGround* and its capacity to foster social presence and group awareness on-project. An analysis of real-time application usage statistics and learner performance outcomes was also provided, together with a detailed discussion of participant feedback gathered from post-trial surveys and focus group interviews.

The next chapter presents and discusses this evolution of *CommonGround* and, in Chapter 8, goes on to describe a second trial performed during the 2009/10 academic year.

Chapter 7

Evolution of CommonGround

7.1 Introduction

So far this thesis has investigated student adoption of CMC technologies in the CETL-ALiC cross-site group programming activity and explored the role that social networking technologies had on the outcome of that interaction. In Chapter 5 I introduced a team collaboration tool named *CommonGround*, a social Web 2.0 application capable of harnessing student engagement with the popular social networking site Facebook. Designed to strengthen both local and cross-site team ties, and in turn generate increased sociability, group interaction and social capital, the application coupled the communication and networking features of the Facebook platform with basic meeting, scheduling and project planning facilities. Leading on from this, a proof-of-concept trial designed to assess the efficacy of the application was performed during the 2008/09 academic year (as discussed in detail in the previous chapter).

Student feedback from the trial highlighted a number of areas where improvements to *CommonGround* could be made. Motivated by these insights I thus developed a more robust, flexible and refined version of the application (which was completed in time for comprehensive trials during the 2009/10 academic year). Redesigned to better achieve the goals of my study, this second release represented an important step in the tool's evolution from proof-of-concept to fully-featured Web 2.0 social "app". I now provide an overview of the revised *CommonGround* application and discuss in detail the design rationale which directed its evolution. Firstly, in 7.2, I provide a summary of the updated design requirements raised in the previous chapter, and then in 7.3 discuss how these considerations informed the redevelopment of *CommonGround* and its back-end server support systems. In 7.4 a new "sociability" incentive metric is introduced (which was used to quantitatively rank each student's contribution levels during the study), followed by a complete overview of the application's redesigned feature set in 7.5. Finally, in 7.6, I include a brief discussion of how the new application performed in practice.

7.2 Requirements

In addition to a number of functional requirements and interface improvements, the previous chapter touched upon a number of run-time performance issues which affected the initial trial of *CommonGround*, thus placing a question mark over the application's scalability. In particular, the chat, presence and data logging systems were inefficient, users and groups were difficult to manage without administrator assistance, and unforeseen network security restrictions hampered the application's remoting and message syndication systems. Given my desire to conduct a more comprehensive trial of *CommonGround* during the 2009/10 academic year, these performance limitations represented a significant concern; I was therefore obliged to make considerable improvements to both the application itself and the back-end server systems that supported it. A number of improvements to extend and enhance *CommonGround's* supporting server infrastructure, status update facilities, state persistence and activity logging mechanisms were thus proposed. I now provide an overview of these revised functional requirements below (which extend the previous application requirements unless otherwise stated):

- The *CommonGround* application must be hosted on a suitably robust and rigorous platform capable of handling high levels of network traffic
- Group and user management interfaces must be easier for teams to understand and administer independently
- Status update features must better resemble Facebook's own built-in status affordances (this includes a streamed history of status updates in reverse chronological order with item-specific commenting facilities)
- The tool must preserve the run-time state of the chat and activity event component between sessions (i.e. history awareness), allowing users to "catch-up" on missed activities
- Daily activity logs must be exposed for each key collaborative feature to provide an audit trail of companywide contributions
- The tool must feature an easy to use file sharing facility and, if possible, a shared whiteboard
- News Feed posts regarding team status updates and pending schedule deadlines would be beneficial (but must be sent only to participants and not their social graphs)

Redeveloped to realise and accommodate the functional requirements proposed above, I will now discuss the design and implementation of a second version of the proof-of-concept tool *CommonGround*.

7.3 Server Improvements

As described in detail in previous chapters, third-party Facebook web applications are hosted on a content provider's servers and not on the Facebook platform itself. Although applications appear in the context of Facebook (and inherit many of its visual styles), the social networking site itself simply acts as a proxy between user and provider. In addition, an extensive API framework grants developers programmatic access to their users' social data, thus enabling the powerful personalised experiences that make Facebook "apps" so popular. Indeed, it is this popularity and the prevalence of Facebook and social applications in the day-to-day lives of students that attracted me to the collaborative potential of the platform in the first place.

Thus, to support the first release of *CommonGround*, a local server implementation was required to both host the application and manage user and group account data (including interactivity logs). However, as a result of the performance issues and functional design requirements outlined earlier – in addition to considerable advances in remoting and messaging technologies – I was moved to make considerable improvements to both the application itself and the back-end server systems that supported it. The latter of these improvements will be discussed first.

7.3.1 Revised Server Implementation

The first trial release of *CommonGround* was hosted on an instance of the open-source servlet Apache Tomcat which was implemented on a non-dedicated desktop computer connected to the Newcastle University campus network. Database functionality was provided by a Java Derby database for storage of application-specific user information, including detailed auto-generated interactivity logs. The motivation behind this choice of software was largely driven by the requirements of the BlazeDS messaging and remoting system which was written in Java (and thus required compatible servlet technology). As described in Chapter 5, the BlazeDS technology enabled me to realise the real-time collaborative features of *CommonGround* – namely distributed message syndication and user-presence detection (i.e. the process of monitoring and detecting user connection states).

However, as I will discus in detail in the following section, a more attractive alternative to BlazeDS was discovered with no such dependencies on the Java platform. Given my pre-existing familiarity with more mainstream web-scripting and database technologies, I thus decided to redesign the back-end server implementation in its entirety (see Figure 7.1 overleaf). Alongside the full Apache HTTP web server (again distributed by the Apache Software Foundation [195]), I installed standard, open-source and freely available MySQL services and PHP components; the MySQL relational database to host user and group data as before (in addition to interactivity log files), and the PHP scripting language to provide the back-end server connection between instances of *CommonGround* and the database. Provision for Facebook connectivity was also provided by the Facebook API PHP client libraries (replacing the previous Java versions).

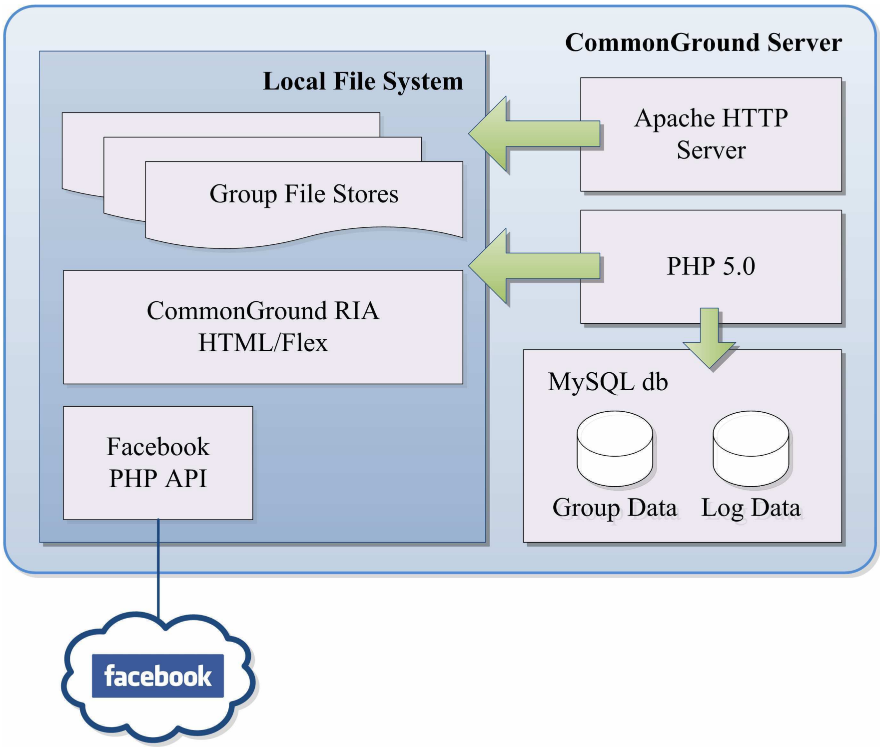

Figure 7.1: Revised CommonGround Server Infrastructure

Again, the system was implemented on a local non-dedicated desktop computer connected by way of Newcastle University's campus network to JANET (and was thus once again protected by the same firewall and internet security safeguards).

7.3.2 Adobe LiveCycle Collaboration Service (LCCS)

As previously noted, a number of issues affected the performance and scalability of *CommonGround* in its first form. In particular, the chat and presence systems were inefficient and users and groups were difficult to manage without administrator assistance. The large amounts of network traffic generated by the system also presented a significant cause for concern.

To resolve these issues I identified and investigated the use of Adobe’s LiveCycle Collaboration Service (LCCS), which is part of Adobe’s server software suite LiveCycle ES2 [196]. Hosted in the cloud at Adobe's Acrobat.com, LCCS provides an enterprise-grade “platform as a service” to developers seeking to integrate real-time multiuser “social features” within their Flash/Flex applications. As touched upon in a previous chapter, such “back-end” custom server support is not trivial to implement or maintain; as such the LCCS represents a simple and ready-to-use alternative platform upon which developers (who are often reluctant or unable to invest in their own server systems) can rapidly build and implement data-intensive collaborative applications. For me, the LCCS service would remove much of the message syndication overheads of my previous implementation of *CommonGround*, thus negating the need to deploy its second release on a more robust server (as was originally envisaged).

At its core, LCCS permits a data-driven Flash/Flex application to pass simple messages between multiple clients in real-time, similar in form to BlazeDS. In particular, the service provides an infrastructure to support the following collaborative features:

- Real-time push messaging
- Data logging
- Distributed text-chat
- Shared whiteboards
- File sharing
- Presence detection
- VoIP audio
- Webcam broadcasting

The LCCS platform therefore offered an attractive means to streamline my redevelopment of *CommonGround’s* group collaboration features, freeing up time to concentrate on improving the overall user experience. In particular, it provided the means to implement a more robust and professional collaborative feature set – one which could not easily be achieved with BlazeDS alone – including distributed chat, file-sharing, user-presence detection, whiteboard and data-capture facilities. Of course, it was also assumed that these new features would require less time to integrate into *CommonGround* than it would take to completely reimplement the application's existing underlying server-side systems (with a more favourable end result likely). In addition – and perhaps more importantly – the service mitigated many of my hosting, maintenance and scalability concerns; the primary reason an alternative to a custom back-end solution was sought. Given these incentives, I therefore decided to replace BlazeDS with LCCS (see Figure 7.2 overleaf).

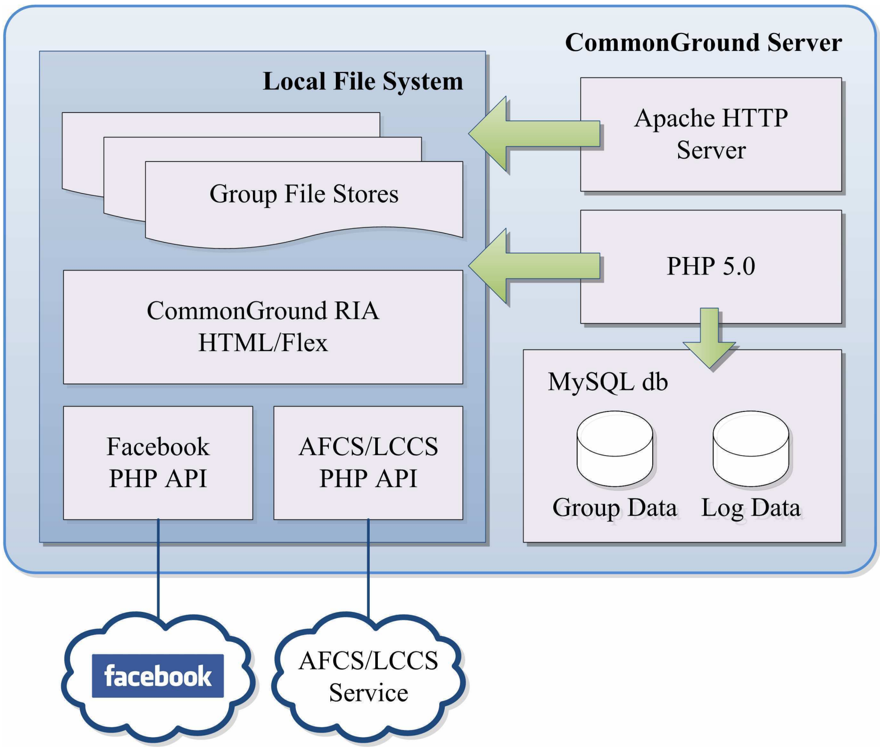

Figure 7.2: Revised CommonGround Server Infrastructure with LCCS

7.3.3 Integration of CommonGround and LCCS

Similar in form and functionality to the BlazeDS platform described in Chapter 5, the LCCS acts as a central host for client connections, receiving and then passing (or rather "pushing") simple data messages between multiple applications in real-time. Applications which target Adobe's LCCS do so via a proprietary SDK, which at the time of writing is available for free download at Adobe [197]. In addition to a number of development tools, the SDK provides an API that allows Flash/Flex applications to asynchronously connect to and interact with the LCCS.

By integrating the API with *CommonGround* I was thus able to access and leverage the data-hosting and message-handling capabilities of the LCCS platform (see Figure 7.3 overleaf). More specifically, I was able to utilise the service to programmatically create private "rooms" on-the-fly; shared virtual locations accessible to specified sets of users (i.e. authorised *CommonGround* groups). This approach enabled my application to automatically syndicate a user's activities (e.g. chat messages, status updates, schedule posts, file updates, whiteboard illustrations) to all other active users in a room, and to also log this activity for inactive, offline users who would visit later. As a change to the back-end system supporting *CommonGround*, this use of LCCS proved entirely transparent to the end-user.

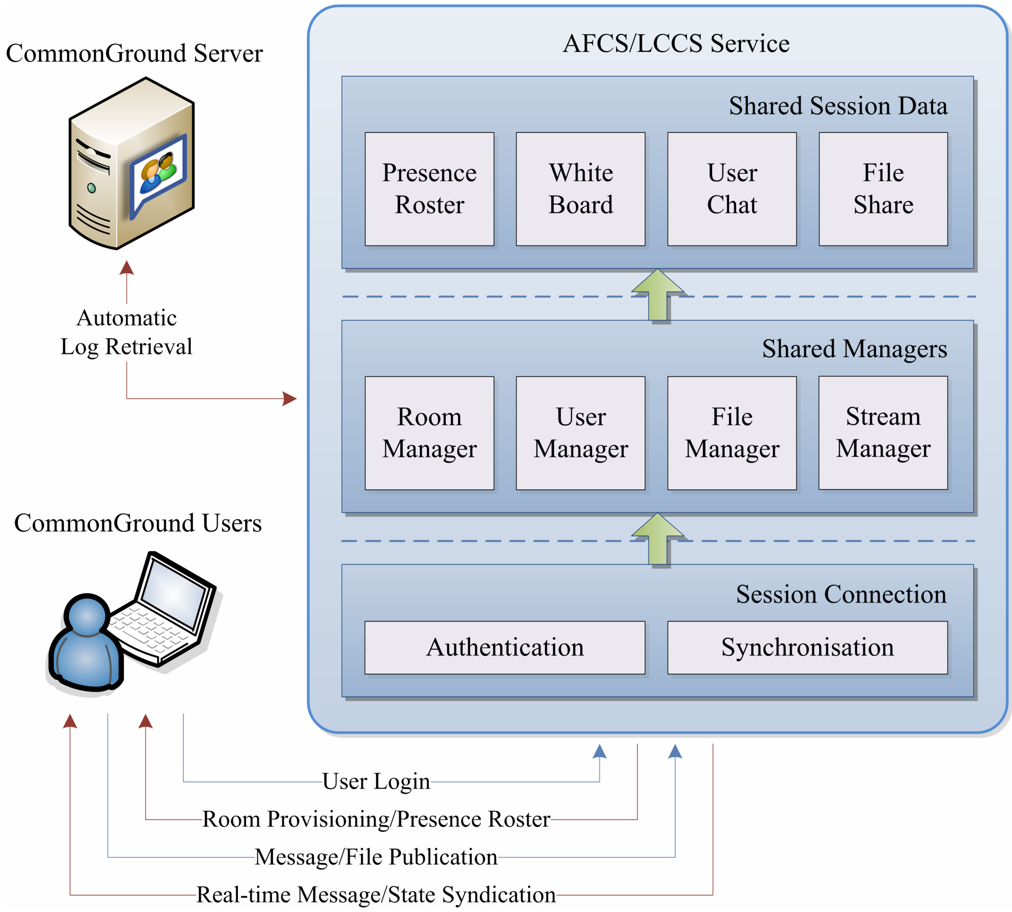

Figure 7.3: CommonGround and LCCS Integration

The systems governing group and user management on the local server were also considerably redeveloped. To briefly expand upon the revised mechanics of group management, a company account was created by one team member who then invited colleagues to join. However, during the process of creating an account, a corresponding "room" was additionally generated on the LCCS (automatically via the API and again unseen by the end-user). Sharing the name of the company, the room would persist indefinitely and would handle all real-time collaborative data handling for its members.

Continuing my desire to maintain a single login for *CommonGround*, programmatic access and authentication on the LCCS was automatically achieved via a "shared secret key" provided to *authorised* instances of *CommonGround* by the local server at runtime (avoiding the bad practice of embedding the key in the application code). Negating the need for a password, this approach provided *guest* access to specific rooms on the LCCS by username only. Although the LCCS offers full individual user-account provision, in practice guest privileges proved perfectly suitable for use in this context (the service is designed with such use-cases in mind).

As an aside, a number of pre-built "ready-to use" objects are shipped with the LCCS SDK for licence-free use in third party applications. Included in this selection are chat, whiteboard and file-sharing UI components designed to "greatly reduce the time it takes to build complex applications" [197]. Naturally, these components proved entirely unsuitable for use within the pre-existing application architecture of *CommonGround* and thus custom implementations were developed.

7.3.4 LCCS Considerations

Enrolment with the LCCS is achieved via the creation of a simple web-based developer account at Adobe's LCCS Developer Portal [197]. A basic management console (web or desktop based) grants administrative access to the account, providing a means to remotely monitor and manage room and user settings (see Figure 7.4 overleaf). The management console can also be used to view and download usage logs and to administer account-wide settings.

In terms of administrative overheads, each individual room on the service requires a degree of configuration before use. For example, maximum users, storage allowances, bandwidth limits and collaborative features all need to be set and explicitly enabled before use. Fortunately, the LCCS Management Console permits provisioning of room *templates*; custom, pre-configured rooms that can be instantiated at run-time with a single call to the API. Quick to set up, this feature greatly simplified *CommonGround's* on-the-fly creation of new rooms. In fact, considering users only accessed the LCCS as guests, very little day-to-day administrative intervention was required.

With respect to the collaborative data capture and usage logging mechanisms of the LCCS, I found these to be sufficiently comprehensive for the needs of this study. Offering little in the way of report generation or visualisation, the service nevertheless captures all user-interaction events for export and statistical analysis elsewhere. In particular, the LCCS records full usage details for:

- Bandwidth consumption (by kilobytes-per-user)
- Chat logs
- Roster logs (measuring user presence)
- Whiteboard interaction logs (including images in PNG format)
- File sharing logs

Of relevance to future work in this area, this study utilised an unrestricted beta version of the LCCS by arrangement with Adobe. The service has since been released to the general public and, at the time of writing, now applies usage charges above and beyond specific limits. Although still suitable for most use-cases, for large-scale deployments the costs incurred may become a significant limiting factor.

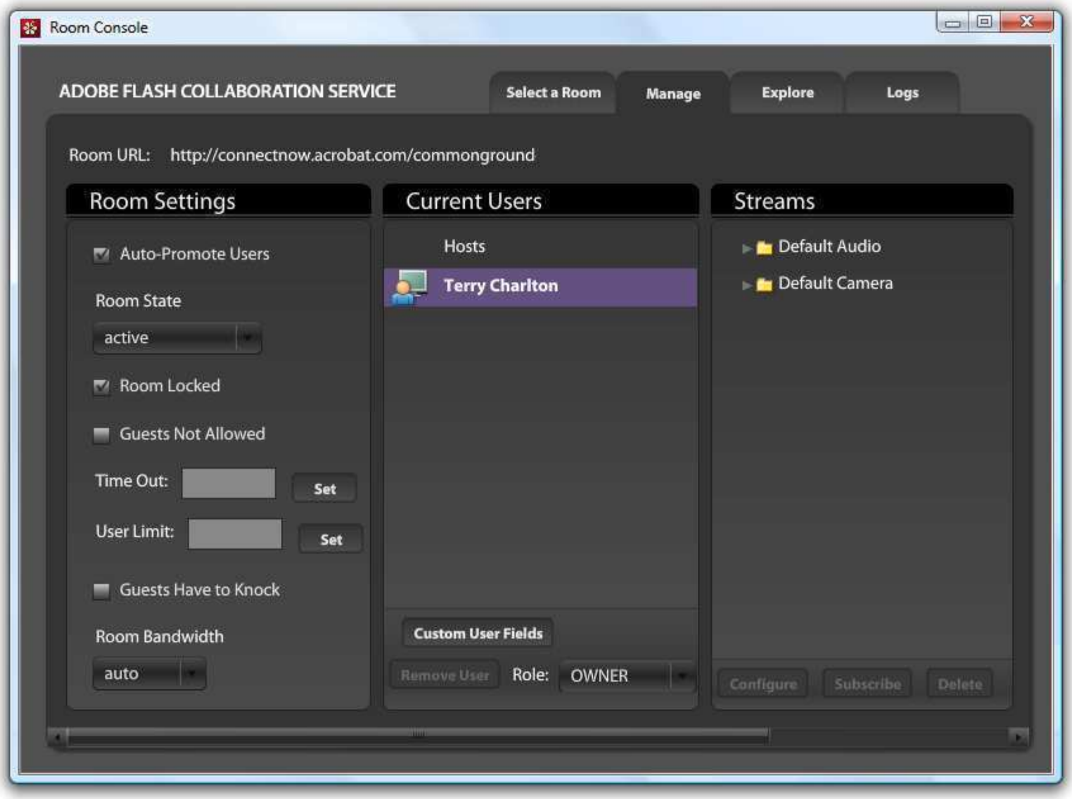

Figure 7.4: Adobe LCCS Management Console

7.4 Sociability Measurements

To motivate student interactivity and continued participation on *CommonGround* – and perhaps elicit a little healthy competition both locally and cross-site – I designed and implemented an incentive metric to quantitatively rank each student's contribution levels during the study (automatically in relation to their team peers). In this section I will discuss that measure in detail and describe the rationale that motivated my decision to develop it.

7.4.1 Experience Points & Sociability Levels

Inspired by the work of Cheng and Vassileva [e.g. 198], team members were rewarded with "experience points" for participatory actions which equated to "sociability" levels within *CommonGround*. Each of the five levels shown in Table 7.1 below could be gained depending upon the volume and type of contributions; in essence, the more a user contributed, the higher his or her membership level become. A special "Star" award was also given to the most highly ranked contributor at any one time (relative to peer performance and regardless of level). One star award was available per team (or "network"), and so two were available per company. Individual rankings and related statistics were then exposed to all team members via *CommonGround's* new usage visualisations and reflected in the Virtual Meeting Room profile summaries. These features will be described in more detail in section 7.5.

Sociability Levels	
Level 1:	Bronze Contributor
Level 2:	Silver Contributor
Level 3:	Gold Contributor
Level 4:	Platinum Contributor
Level 5:	Diamond Contributor

Table 7.1: CommonGround Sociability Levels

Adapting Cheng and Vassileva's motivation strategy for this study, my sociability calculation was based upon – and therefore designed to encourage – the following collaborative activities (in no particular order):

1. Logging on to *CommonGround* frequently (and remaining connected)
2. Updating one's *CommonGround* status regularly
3. Commenting on other people's statuses
4. Sending chat messages[9] (or interacting with the whiteboard)
5. Contributing to the team schedule
6. Sharing files with others
7. Attracting comments to one's own status updates

[9] It was not possible to capture student interaction using Facebook's built-in chat facility. However, this feature only provided private one-to-one chat with registered "friends" and, as students indicated, was rarely used.

7.4.2 Experience Point Calculations & Level Thresholds

To calculate experience points (*Exp*), each of the seven simple activities described above were translated into single "interaction events" which *CommonGround* could record at runtime (V_i). As each event had a varying degree of importance, separate weights (W_i) were introduced to reflect each event's relative significance and to balance contributions proportionately. For example, posting a status update produced a higher experience point return than a single chat utterance (a status update was seen as more important and was expected to occur less frequently than a chat utterance). Thus, evaluation of individual user participation was initially calculated as follows:

$$Exp = \sum_{i=1}^{7} W_i * V_i$$

Naturally, my chosen weightings (as shown below in Table 7.2) were initially informed by the interaction patterns discovered during the first trial of *CommonGround*, as discussed in Chapter 6. As can be seen, I particularly wanted participants to benefit from contributing status updates that attracted further discussion in the form of comments or "I like this" tags (users could "like" a status update by simply clicking its *Like* button). Both were considered to be rudimentary but effective indicators of a contribution's quality. All chat utterances and whiteboard interactions generated experience points, as did individual schedule updates and file uploads. Credit was also given for both frequency and duration of visit, but contribution lengths were not considered; as I will discuss later, shorter contributions were in fact encouraged.

Activity (V_i)		**Weight (W_i)**
V_1	Application load/duration spent active[10]	0.5
V_2	*CommonGround* status update	2.0
V_3	Comment on/like other *CommonGround* status	2.0
V_4	Chat utterance or whiteboard interaction	0.5
V_5	Team schedule update	10.0
V_6	File upload	20.0
V_7	Comment/Like received	2.0

Table 7.2: CommonGround Activity Weightings

[10] Visit event (V_1) was recorded once per day at logon and then cumulatively added to after 5 minute intervals of *continued* activity.

To encourage participation in all seven activities (and to prevent users from performing repetitive trivial actions in order to gain experience points), I introduced a logarithmic function of V_i to naturally diminish returns from each activity. A base 2 logarithm was chosen simply because it gave a more satisfactory growth rate (1 was also added to avoid early negative logarithms). *CommonGround's* final evaluation of individual user participation – sociability expressed in terms of "experience points" – was therefore calculated using the following:

$$Exp = \sum_{i=1}^{7} \log_2(W_i * V_i + 1)$$

In addition to the weightings, sociability level thresholds were also initially informed by the interaction patterns discovered during the previous trial of *CommonGround* (it was my intention to refine these levels after deployment, but this turned out to be unnecessary as the initial weightings and threshold values proved adequate). A more accessible summary of activity weightings and level thresholds was also made available to participants via the application to elucidate my expectations. Importantly, unlike Cheng and Vassileva's work where only a fixed percentile of users could attain and occupy each achievement level, a participant's sociability level was *not* determined by their achievements relative to other users. Due to the short nature of the study and the effort required to attain the highest sociability level, I felt such techniques were unnecessary and potentially discouraging (due to constantly moving goal posts). Hence, by accumulating experience points, participants could achieve the sociability levels described in Table 7.3.

Sociability Level		**Point Range**
1	Bronze Contributor	1-29
2	Silver Contributor	30-39
3	Gold Contributor	40-49
4	Platinum Contributor	50-59
5	Diamond Contributor	60+

Table 7.3: CommonGround Sociability Level Thresholds

7.4.3 Experience Points in Practice

I provide in Table 7.4 overleaf a generalised example of the relationship between user contributions and level attainment. As shown, the average weekly effort required by participants to reach each successive sociability level grows exponentially (all values for V_i produce approximately the same number of experience points, as dictated by the chosen weightings show in Table 7.2). In practice, of course, it is extremely unlikely that such an even distribution of participatory actions would occur. However, this example does provide a glimpse into the general growth pattern of a user's sociability level and the contributions expected/encouraged over each seven day period of the project.

Average Contributions (per 7 day period)							**Level Attainment**	
V_1	V_2	V_3	V_4	V_5	V_6	V_7	*Exp*	*Level*
1.19	0.30	0.30	1.19	0.06	0.03	0.30	30	Silver
3.17	0.79	0.79	3.17	0.16	0.08	0.79	40	Gold
8.55	2.14	2.14	8.55	0.43	0.21	2.14	50	Platinum
23.0	5.75	5.75	23.0	1.15	0.58	5.75	60	Diamond

Table 7.4: Example of Average Expected Contributions and Level Attainment

Bronze level was attained almost immediately once any form of contribution was recorded (thus it has been omitted from the above example). To achieve Silver level, however, a user simply needed to login twice each week over the 33-week life of the project, post approximately one status message and comment each month, submit two chat-utterances per week, and so on. To reach Gold level, logarithmically more contributions were required.

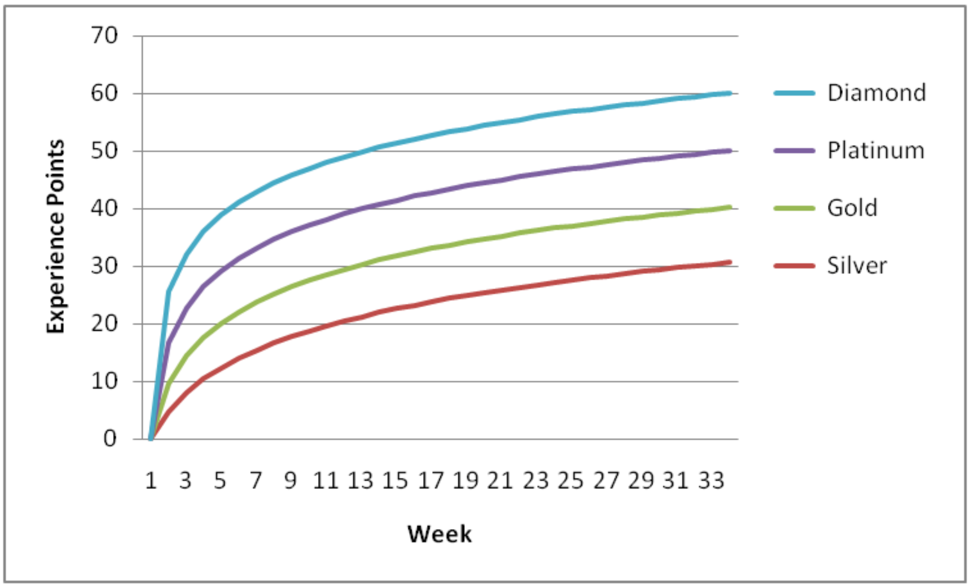

Figure 7.5: Illustrated Example of Experience Point Growth and Level Attainment

This is better illustrated in Figure 7.5 on the previous page which demonstrates the evaluation of user participation and level achievement in terms of experience point growth over time (based upon the activity values shown in Table 7.4). As shown, *CommonGround* users needed to strive more and more at each level to attain the next, but fast early growth would increase gratification and encourage participation. Perhaps more importantly, a user's level could be viewed by other team mates, allowing direct comparison between participants and further encouraging interaction.

The quantitative technique outlined here provided a rather flawed determinant to the success (or otherwise) of a participant's contributions. For example, it offered no insight into the threaded nature, content or reciprocity of a message; was it on-topic, was it a question or answer, how much further discussion did it generate? However, it did provide a reasonable measure of a team member's *basic* interactivity levels which proved more than suitable for elucidating team collaboration statistics at run-time. Indeed, it generally holds true that, as the number of online student interactions increase, so too does achievement, ties and satisfaction levels [e.g. 198]; thus even the most simplest of indicators can provide an insight into community development.

Figure 7.6: Notification of Experience Point Deductions

Finally, to deter sporadic participation and motivate regular use of the application, users were automatically penalised for each 24 hour period that they failed to log in. This was achieved by reducing their "login time" event count (V_1) which equated directly to a reduction in experience points (a dialog was displayed at start-up to inform users that points had been lost – see Figure 7.6).

7.5 The Evolution of CommonGround

Redesigned to better achieve the goals of this study, a second release of *CommonGround* was developed to further enhance and extend the functionality, usefulness and social potential of the application. Driven by student feedback and the revised functional requirements of 7.2, this second release represented an evolutionary step in the development of the tool rather than a complete rework; the application was again built in Adobe Flex and was again deployed on the Facebook platform. Although a number of the key collaboration and communication features were improved upon and a number of new components added, these simply extended the functionality already in place. However, as described earlier, a significant amount of development work was required "behind the scenes" to accommodate the new Adobe LCCS message syndication and remoting technologies.

Perhaps more significantly, findings from the first trial indicated that I was able to integrate *CommonGround* far deeper into the Facebook profiles of participants. Despite a number of reasonable trust concerns voiced by students in response to initial proposals, participants in practice rarely considered the integration techniques and data requests made by third-party applications (the clear privacy implications of this apparent carelessness, although not ignored during the project, are largely outside the primary scope of this thesis). I therefore felt free to implement a far richer feature set this time around, which I will explore in detail in this section.

Wherever relevant I will again illustrate each new or revised feature of *CommonGround* using run-time screen captures obtained during a second trial of the application (conducted during the 2009/10 academic year, which will be discussed in detail in the next chapter). I will explain the purpose of each feature in turn, the rationale behind its design, and also how students were able to make use of it. Once more, names, e-mail addresses and profile images have been used in all screen captures to maintain student anonymity.

7.5.1 Account Activation & Group Management

Replacing the former trial version of the application, the second release of *CommonGround* was made available to users at the following canvas page URL:

`http://apps.facebook.com/commonground/`

Again, visiting users were prompted to agree electronically to the privacy policy and terms and conditions of this study, and to explicitly allow *CommonGround* access to specific aspects of their Facebook account. However, in a marked difference to the previous version of the application (where only the most basic profile data was required), a far greater level of access to user profile information was requested (Figure 7.7). As will become clearer later in this chapter, the primary reason for the increase in profile data access was to accommodate new collaborative features and to permit access to the news streams of users. Notably, this change was accepted without complaint by participants.

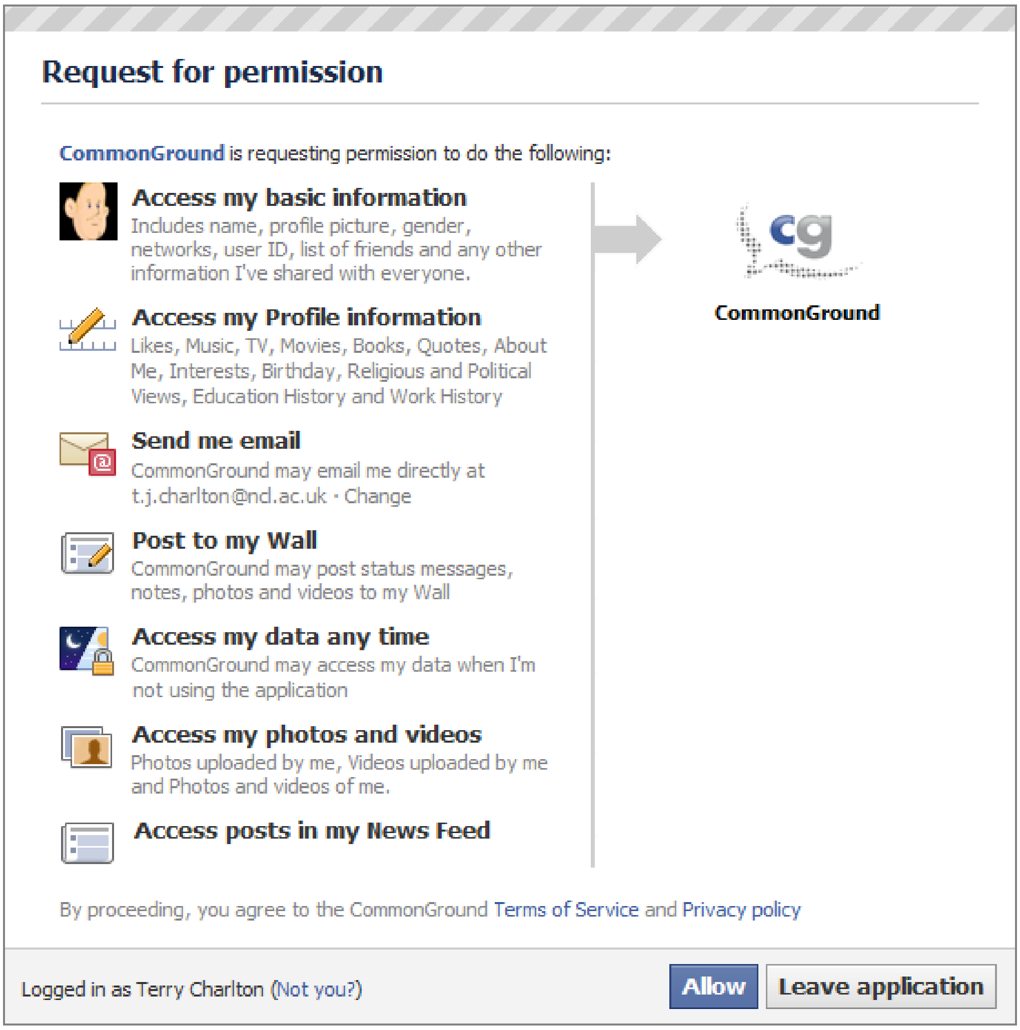

Figure 7.7: Extended CommonGround Permission Request (via Facebook)

As with the previous version of *CommonGround*, I decided once more to avoid submitting the application to the Facebook directory (and thus make it available to the general public). Given that I did not experience any problems enlisting participants during the first trial, I again intended to invite one person from each student team to create a company account. That person would then autonomously invite their own team mates as and when they felt it appropriate to do so.

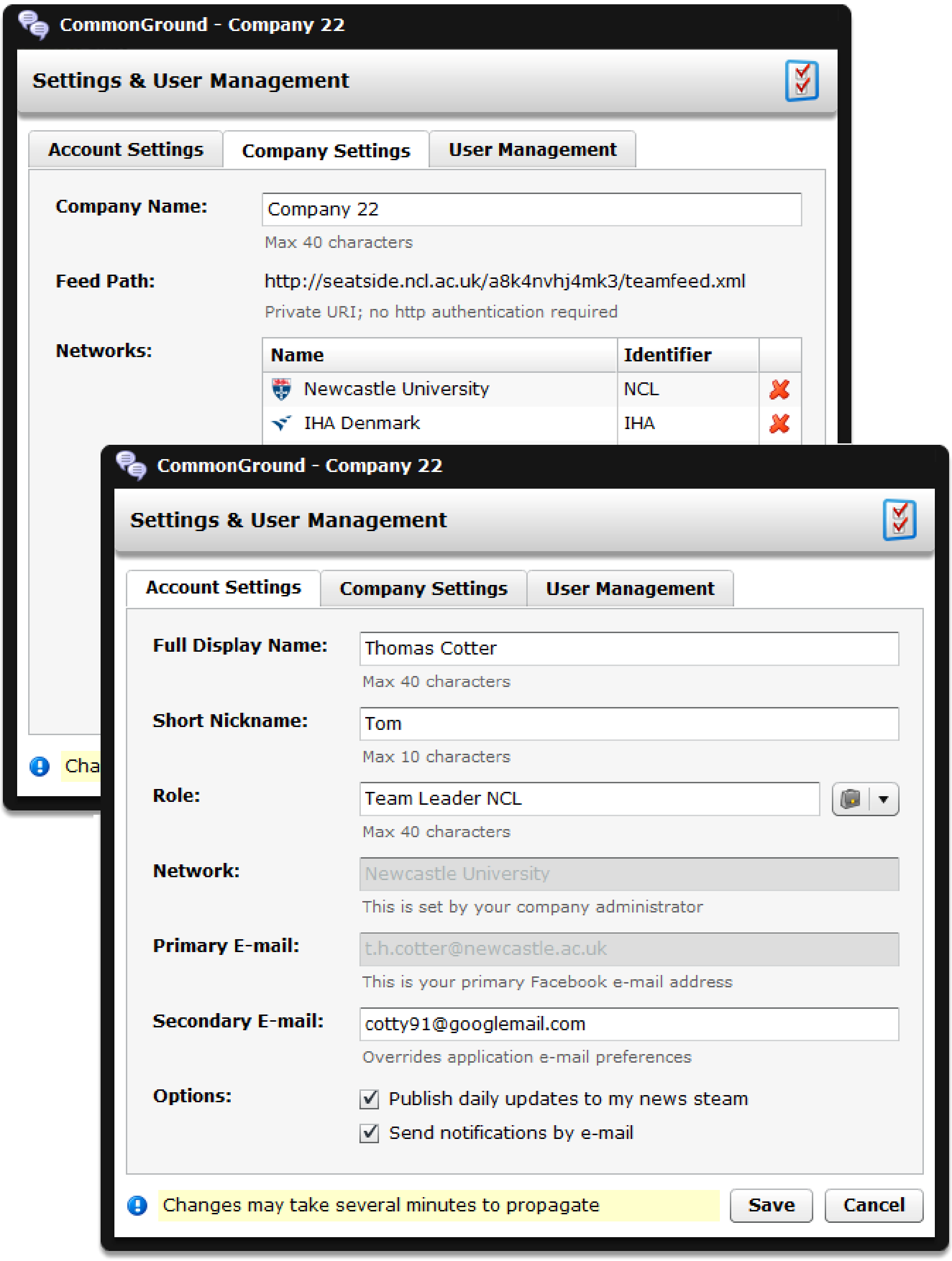

Figure 7.8: CommonGround's Account Management Console

The procedure for creating a company account and defining a team's organisational structure remained largely unchanged from the first trial; however, I provided a much more robust system for managing application settings (see Figure 7.8 on the previous page). Provided as an embedded part of the main *CommonGround* interface, all user and company preferences were accessible from one simple dialog box, greatly streamlining the creation and management of a company account; an important improvement requested by students.

The mechanism for inviting team mates and assigning them to specific "networks" also remained unchanged (even though the underlying server support systems had been redeveloped). Students still received invitation e-mails containing a unique activation code to validate their account and prevent unauthorised access to their company network. Again, this allowed the pairing of a participant's unique Facebook identifier with their corresponding user account on the local application server, thus allowing automatic log-in on successive visits to the application (a requested feature of the first trial application which received positive remarks in student feedback sessions).

Once logged in, participating students were presented with a reworked *CommonGround* application interface featuring a combination of upgraded and new collaborative features. These features were categorised into four logical groups: Company Connect, Company Chat, Company Schedule, and finally the new Company Feed.

7.5.2 Company Connect

Company Connect was the collective name given to three distinct presence, whiteboard and file sharing facilities, each of which was individually accessible via tabbed buttons on the feature-group's title toolbar. The first was a slightly improved version of the Virtual Meeting Room (see Figure 7.9 overleaf); a custom component created to maintain and visualise a real-time roster of room attendees (and their institutional affiliations) for each distinct company.

Based upon the metaphor of a real-world meeting room, this tool was developed in Adobe Flash and was intended to encourage and support impromptu chance encounters between students (as described fully in Chapter 5). The primary motivation behind this feature was to help build community, trust and social capital between group members – within and across company teams – via informal "water cooler" encounters and Facebook profile exploration. Furthermore, it was intended that this simple feature would help strengthen weak ties, especially where more peripheral team members were concerned. Given the relative success of this feature during earlier trials, I therefore made only aesthetic changes to it; in particular, a user's sociability level was now displayed on roll-over, as was a more explicit link to their Facebook profile (including a button to directly add that user as a friend). An icon depicting each person's team role was also displayed alongside their profile images, as was a special star award icon for users possessing the highest experience points (as described earlier in 7.4). Participants could now also access the personal profile information of offline team mates via the user management console (or by clicking a username attached to any chat, schedule or status contribution). Behind the scenes, however, the Virtual Meeting Room component required considerable alterations to permit direct communication with the new LCCS messaging service (as opposed to the original local BlazeDS implementation).

Figure 7.9: CommonGround's Updated Virtual Meeting Room Component

The LCCS also supported the creation of a shared Company Whiteboard (see Figure 7.10 overleaf), the second component in the Company Connect feature-group, which allowed multiple team mates to collaboratively create vector-based illustrations and diagrams on a common canvas (the LCCS API provided a simple and effective means to push messages containing shape information between multiple clients at run time). Developed to allow users to better explore simple ideas and construct shared understanding of basic concepts, only a limited set of drawing tools were implemented (more complex tools would have arguably reduced the accessibility and ease-of-use of the component). In addition to freehand sketching, users could add lines, notes, text and shapes. Basic editing operations such as copy, delete and redo were also available, as was the ability to move, resize and recolour objects. To aid collaboration, the mouse pointer positions and motions of each active user of the tool were also multicast to all other participants and appeared as independent cursors on each user's canvas.

In practice, and as I will discuss in the next chapter, participants found the Company Whiteboard system simple to use and of genuine use during the planning and design stages of the project. For simplicity purposes, however, only a single shared canvas was provided for each individual company account (and its contents persisted across sessions). Illustrations could be created, viewed or edited by any company member, could be cleared at any time, and – perhaps more importantly – could be saved in PNG format to a shared location with a single mouse click. Stored illustrations then appeared automatically in the Company File Repository, the third component in the Company Connect feature-group.

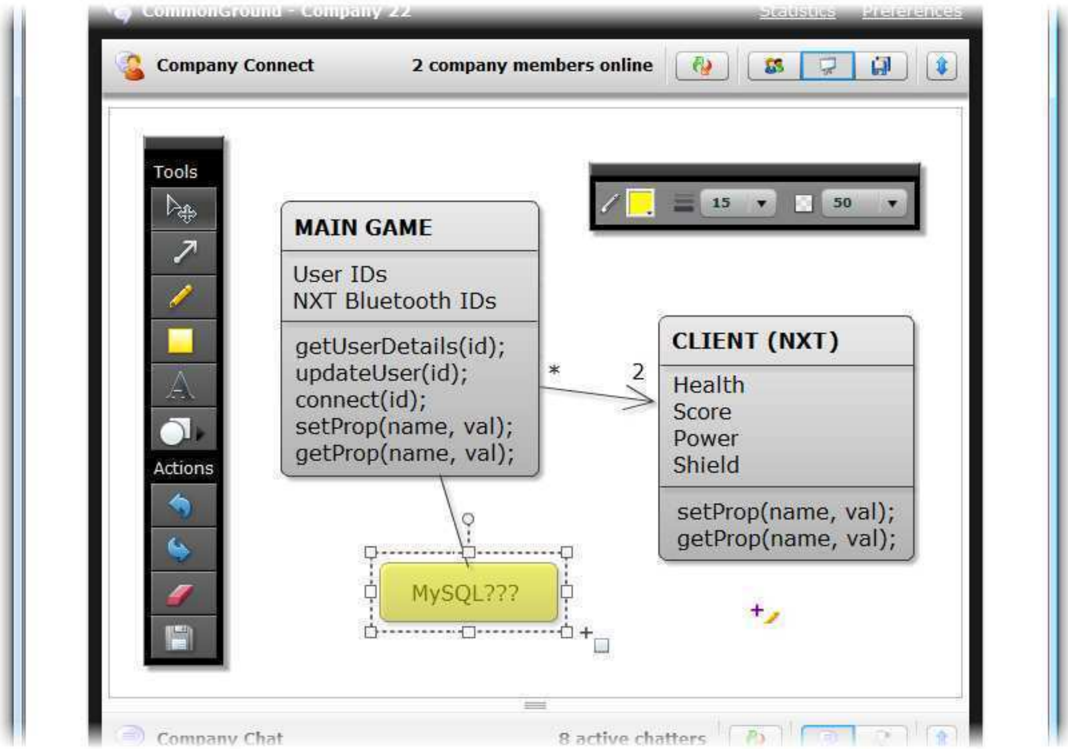

Figure 7.10: CommonGround's Shared Company Whiteboard Component

The shared Company File Repository feature (Figure 7.11) was created to allow participants to store and share project-related files in a common and easily accessible area. Files of any type could be uploaded to the repository and a basic version control system maintained a history list of document updates. Submitted files with names that matched pre-existing uploads were simply placed at the top of this list; thus, an entry in the repository represented the most up-to-date version of a file (with previous revisions retrievable if required). Importantly, this facility was intended to support information dissemination and was in no way meant to replace professional document and software version control systems.

In practice, and again discussed in the next chapter, participants used the system primarily to store research documentation and to collaboratively construct team deliverables (e.g. project plans and design specifications).

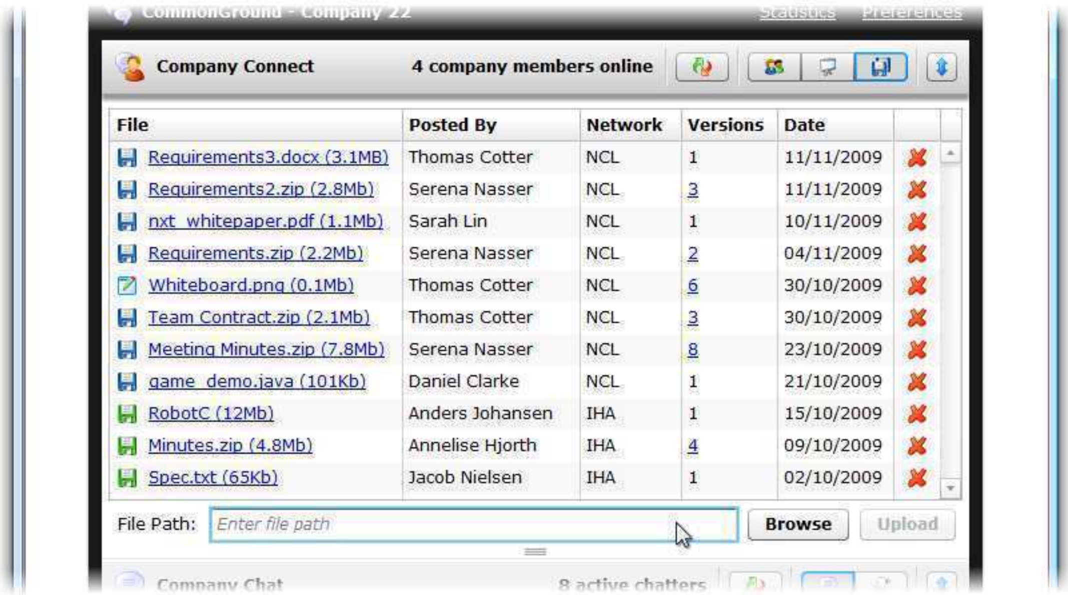

Figure 7.11: CommonGround's Company File Repository Component

7.5.3 Company Chat

The simple text-based synchronous chat feature created for the first trial version of *CommonGround* allowed users to interact with one another without needing to use Facebook's own integrated chat features. The second version of *CommonGround's* chat facility (see Figure 7.12 overleaf) remained largely unchanged aesthetically but saw the introduction of a new history log. Visible for all views selected in the Company Connect feature-group, this requested facility simply listed transcripts of daily chat utterances in date order, thus allowing participants to access and review previous team interactions and, in turn, communicate asynchronous social presence (although all chat posts were recorded in the first trial release, they were never exposed to students). Single line summaries of user activities also appeared in the chat window, alerting team members to the actions of others. For example, alerts were generated for login and logout events, file uploads, status updates, and so on.

Furthermore, student feedback from the first trial of *CommonGround* suggested a need for chat and event data to persist across sessions. As participants would rarely find their entire team online at any given time, this simple addition would effectively allow absent members to "catch-up" with the recent activities of team mates. Mirroring these sentiments, several studies have shown that persistent chat facilities support team awareness and help foster the on-going narrative of group conversation [e.g. 193, 194, 199]. To achieve this for the second release of *CommonGround*, the chat component maintained a permanent, shared state for all instances of the application. Thus, the current day's log recording appeared automatically in the chat window at login allowing conversations to persist across sessions (rather than start each individual session with a blank history, as was previously the case).

Importantly, a *Suspend Recording* toggle button could be activated to prevent log recording in the event that participants wished to converse privately (the back-end server support system continued to log chat statistics but no content was recorded). Furthermore, as with the Virtual Meeting Room component, the chat facility was reworked slightly to accommodate the new LCCS messaging service and logging system.

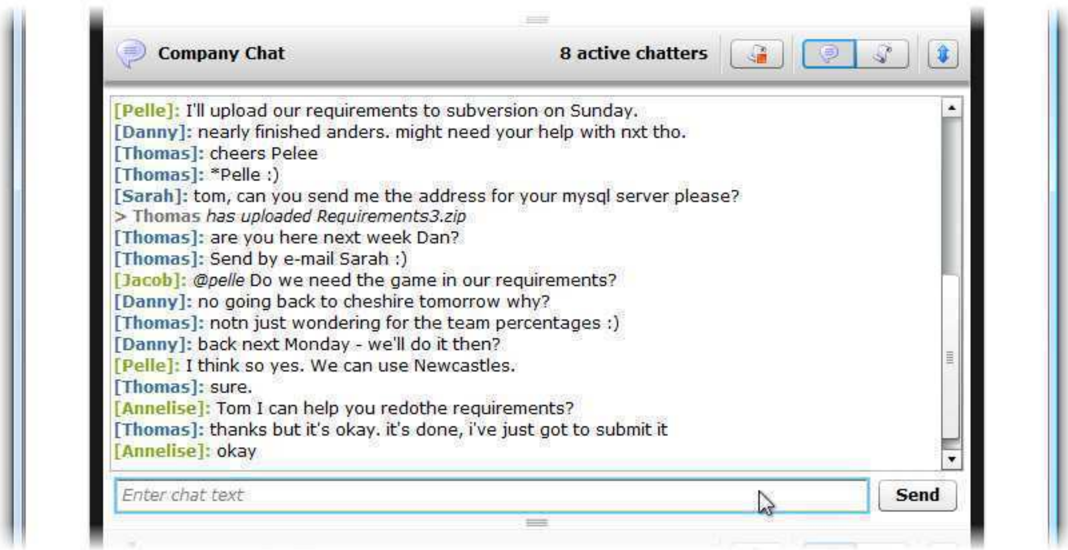

Figure 7.12: CommonGround's Updated Company Chat Component

These simple additions to *CommonGround's* chat feature were designed to further strengthen team ties by reducing the temporal barriers to interaction that were inherent in the first trial version of the application. It was no longer such a disadvantage to miss interactions between team mates, and therefore students were far better equipped to access and explore the activities and work rhythms of their colleagues (whether or not they met online by chance encounter or not).

7.5.4 Company Schedule

Endeavouring to instil professional project planning skills in the technical repertoires of students, *CommonGround's* original scheduling facility encouraged participants to manage their time and project resources effectively (as touched upon in Chapter 5, students were surprisingly averse to using professional project management software and avoided it wherever possible). Thus, by maintaining a list of pending project tasks, responsibilities, due dates and completion percentages, participants could see at a glance how their team was progressing. As discussed in the previous chapter, student teams made good use of this facility and feedback was positive.

Therefore, aside from a small number of usability improvements (tasks could be reordered by drag-and-drop, for example), the basic Company Schedule facility remained largely unchanged for the second release of the application. However, to provide an alternative view of a company's project plan data, I extended the Company Schedule feature-group to include a new data visualisation (Figure 7.13). By illustrating project progress as an interactive Gantt chart, participants could better identify the relationships between tasks and then edit start dates, end dates and progress completion percentages accordingly (this could be achieved by simply dragging the relevant sliders on the chart).

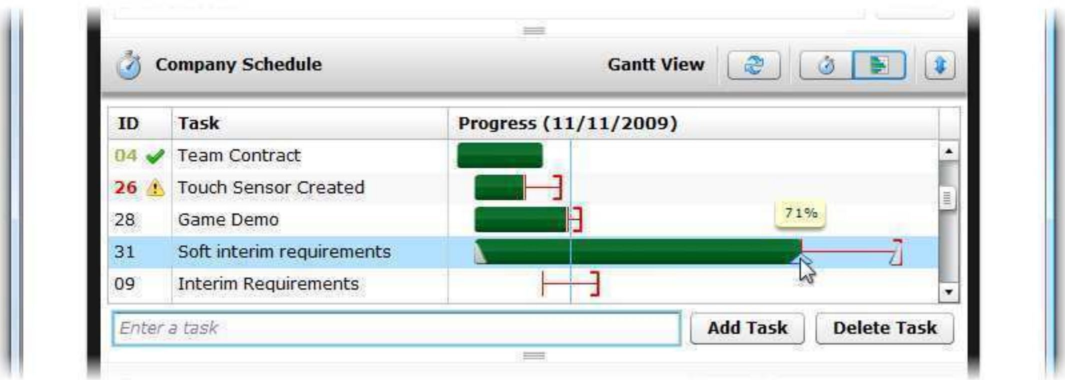

Figure 7.13: CommonGround's Updated Company Schedule Component

Again, as with the majority of features described thus far, the original schedule facility was reworked slightly to accommodate the new LCCS back-end technologies and server logging systems. The data provider for the Company Schedule was also populated automatically with primary module deliverable data to save the need for students to enter this information from scratch (which they all did as a matter of course during the first trial of the application). Finally, to alert team members of upcoming deadlines and deliverables (where percentage completion was less than 100%), reminder messages were also sent automatically to the relevant participant's primary e-mail addresses 7 days before each task's due date.

7.5.5 Company Feed

As discussed in detail in Chapter 5, the "status update" features of popular online social networking services represented an area of particular interest. In the specific context of Facebook, a person's status – a short text-based reply to the question "What's on your mind?" – was one of the primary means by which users disseminated information about themselves and their interests. From ideas and beliefs to activities and locations, simple and undemanding status updates represented one of the principal channels though which users reciprocally tracked the actions and consumed the opinions of those in their social graphs. Due to the frequency by which updates were generally posted on Facebook, they also exerted a strong pull on the attentions of its members, ultimately driving frequent and repeat visits to the service.

Given the status update's inherent capacity for generating social capital in collaborative contexts (e.g. by allowing students to share thoughts and ideas, ask network-wide questions, receive support and advice via comments, and achieve consensus with others), I therefore integrated my own Company Member Status feature into the first trial of *CommonGround* to foster team interaction and on-task activity awareness (by asking the question "What are you working on right now?"). This feature provided students with a project-specific status local to the *CommonGround* application, which – as requested – did not interfere with their primary Facebook profile status. Significantly, as I discussed in the previous chapter, the results from the first trial indicated that this one feature in particular produced an increase in interaction and group awareness between both local and cross-site teams; a positive finding which I was very keen to explore further.

For the second version of *CommonGround* I considerably altered the look and feel of the Company Member Status feature. Rather than providing a simple table of participant names and current statuses, my reworked version was functionally expanded to "stream" activity updates in the same way as Facebook's instantly recognisable and easy-to-use News Feed feature.

Figure 7.14: CommonGround's Company Feed Component

Rebranded as the Company Feed, all participatory actions performed by team members (e.g. status update posts, file uploads, sociability level increases, etc.) appeared in an event list and were displayed in reverse chronological order with the most recent activities shown first (see Figure 7.14 on the previous page). A participant's own status always appeared in a reserved area at the top of the list, with the statuses of others (and any event messages) appearing directly below. Hence, participants could see at a glance all recent team activities in the precise order that they occurred and could follow the history of events and team interactions as they evolved over time. This audit trail afforded newcomers to a team the opportunity to "catch-up" with company developments by tracking back online conversations, activities, file exchanges and decision making processes to day one of the project. Filters could also be applied to the list to display particular message subtypes, including activity announcements, status updates posted by local team members, status updates or comments featuring specific participant names, and status updates or comments that posed questions. To display questions only, a rudimentary filtering mechanism simply looked for question mark characters in the text of status updates. Given the concise form of general status updates, this technique proved surprisingly accurate in practice.

One notable addition to *CommonGround's* status update facility was the inclusion of status comments and "I like this" indicators (which again mirrored the recognisable and easy-to-use features of Facebook's built-in News Feed facilities). Whereas the latter simply allowed a participant to click a button to announce their general approval of a team mate's activities, the former afforded the team as a whole the ability to interact with one another around a crystallised topic. In addition to disseminating information about the progress of one's allocated tasks, participants could seed debates by asking specific questions, raising issues, making points, suggesting resources, and making general, informal and social comments upon topics. Crucially, given my primary goal of encouraging student interaction on-project, I envisaged that these two simple features would potentially represent key motivators of team collaboration. As I will discuss in the next chapter, this was generally found to be the case.

7.5.6 Data Visualisations

As discussed earlier in this chapter, an incentive metric was developed for the second release of *CommonGround* to motivate student participation and to increase both local and cross-site collaboration. Each student's contributions were recorded during the study and were then rewarded with "experience points" depending on the type and frequency of the activity. Although rudimentary, this simple technique provided participants with a simple yet effective measure of their basic interactivity levels (and that of their peers), which proved more than suitable for elucidating team collaboration statistics at run-time.

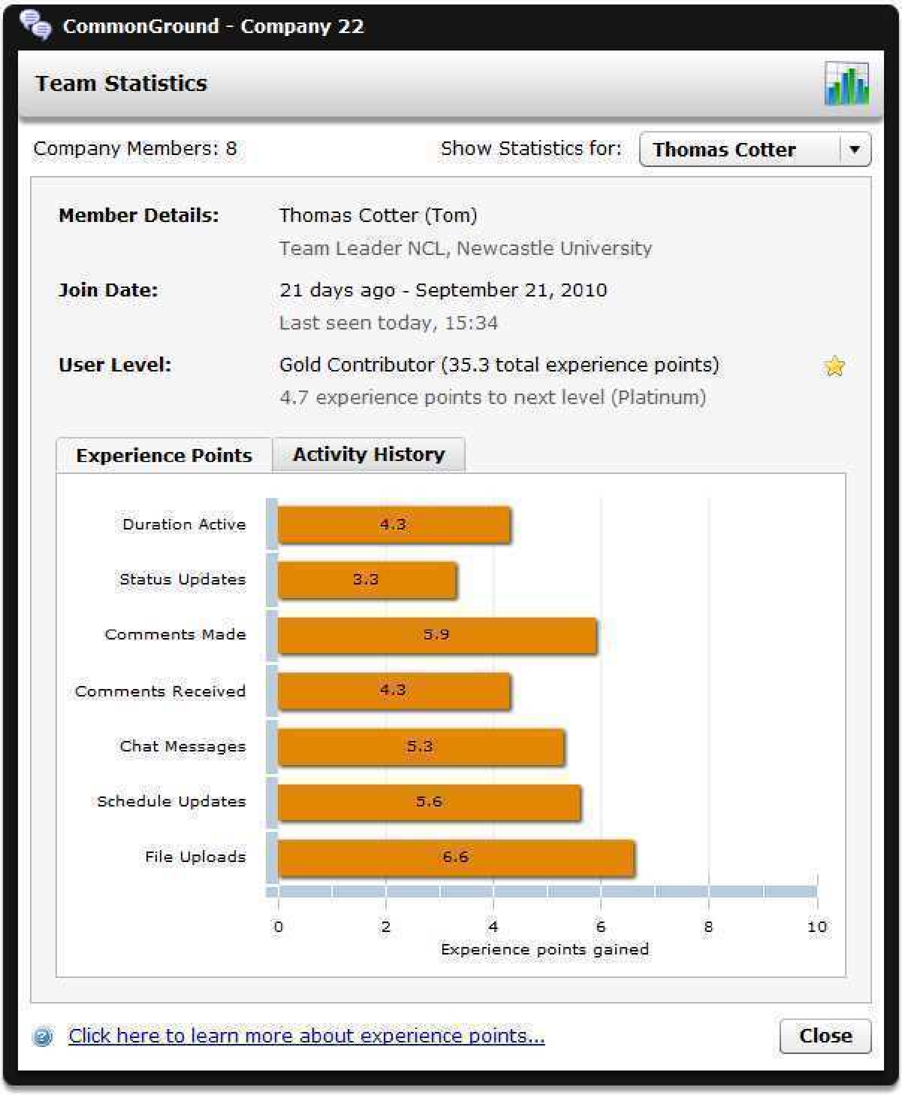

Figure 7.15: CommonGround's Experience and Level Statistics

As discussed in 7.4, experience points – once gained – also equated directly to one of five distinct sociability (or membership) levels in *CommonGround*. Put simply, the more a user contributed and achieved, the higher his or her level, mirroring somewhat the recognisable progression systems commonly used in computer games (levels started at Bronze and then increased through Silver, Gold and Platinum to Diamond). Level and experience point statistics were then exposed to participants via

CommonGround's new data-visualisation screens (Figure 7.15) and reflected in the Company Connect profile summaries for other team members to explore.

Experience points were broken down by activity to highlight the collaborative areas where each participant was weakest. The rationale underpinning this approach was simple: to encourage students to explore all areas of potential team interaction and to make more balanced, well-rounded contributions. Naturally, as each team member's strengths and weaknesses were exposed to their colleagues, I envisaged – and sought – a degree of competition between team mates. In addition, to further incentivise students to explore and compare their respective achievements, a seven day snapshot of activity was provided that described each team member's recent experience point increases (Figure 7.16). Importantly, detailed help files pertaining to experience point achievement and level attainment techniques were provided to participants.

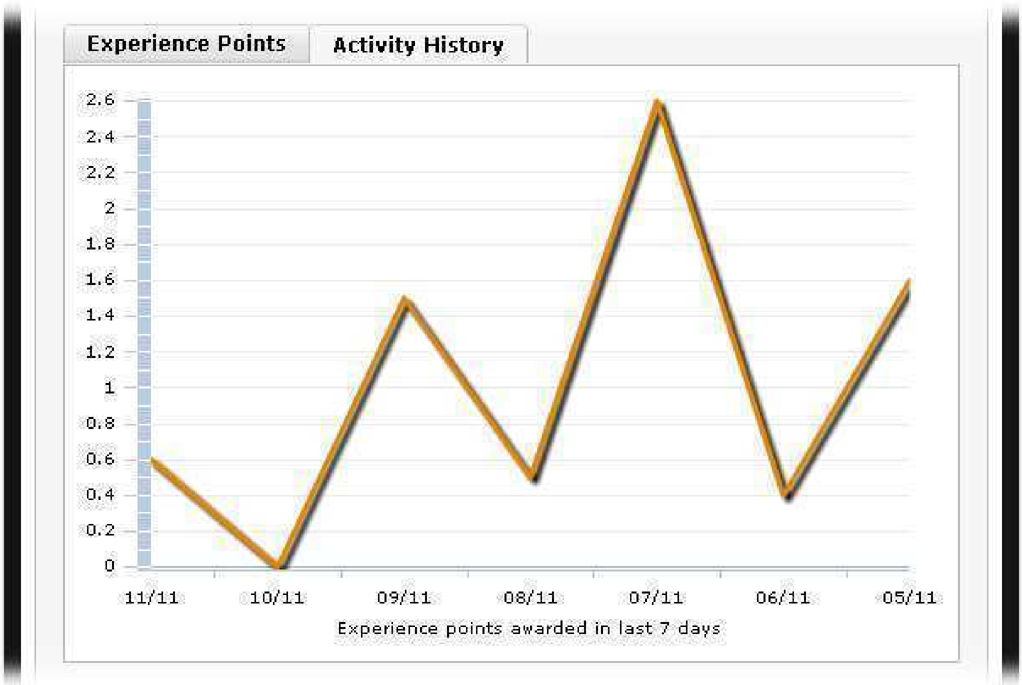

Figure 7.16: CommonGround's Experience Points Activity History

7.5.7 News & RSS Feeds

During my initial investigation into the proposed use of Facebook for local and cross-site team collaboration, students made it very clear that they did not want me to interfere with any private or recreational uses of the service. In particular, they did not want to use any third-party application that contacted their social graphs or in any way publicised formal team interactions via News Feed broadcasts (recall that Facebook's News Feed is a constantly updated list of status announcements from registered friends and groups). Thus, the first trial of *CommonGround* avoided all but the most trivial of profile integration and news publication techniques.

However, as post-trial interview feedback showed in the previous chapter, students were not at all averse to receiving application updates via their own News Feed; most actually appreciated the salient advantages of daily team updates delivered in this manner. Hence, the second release of *CommonGround* saw the addition of a daily News Feed Digest post (Figure 7.17), which summarised company wide application activities and team-mate achievements. Once again, the design rationale underpinning this approach was simple: by embedding a concise team activity announcement within a participant's private News Feed – the landing point and primary source of interest for users of Facebook – students would be better able to monitor the activities of their team mates (during the study mobile access to Facebook increased in popularity considerably and so digest messages provided an additional channel through which to expose *CommonGround* activity data). It is also true that updates pertaining to colleague achievements and level progression were intended to prompt frequent visits to the application and encourage an increase in contribution levels.

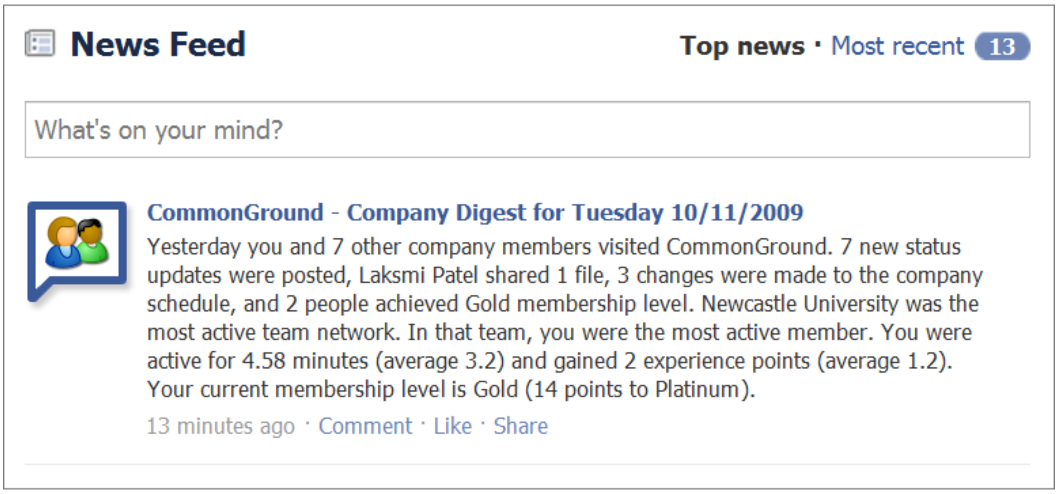

Figure 7.17: Facebook's News Stream Featuring CommonGround's Activity Digest Post

By default, a message containing the same activity digest information was also sent to each participant's primary e-mail address (which could be stopped via *CommonGround's* Settings and User Management console). Furthermore, *private* RSS digests of the Company Feed were also provided via the local server, bypassing Facebook, for use in students' content aggregators (RSS readers). However, experience suggested that authentication features were limited in many RSS readers and so I made the feed publicly available via a sufficiently complex twelve character URI path segment (offering basic "security through obscurity").

7.5.8 Logging Systems

As in the first trial of *CommonGround*, the second release of the application recorded all user interactions via the local hosting server. For each activity event, experience point achievement or message syndicated to other users via the LCCS service, copies were again time stamped and saved to the system's supporting MySQL database. In particular, the following interactivity actions were logged:

- Application access dates and durations
- Profile explorations (initiated via *CommonGround*)
- Direct and indirect friending of team mates
- Chat utterances and whiteboard shape edits
- File uploads
- Schedule additions and updates
- Status additions and updates
- Status comments and "I like this" tags made/received

These logs formed the basis of the chat, schedule and status update history logs that students could access via the application. Recall also that the LCCS's collaborative data capture and logging mechanisms also recorded a great deal of user-interaction and bandwidth consumption details. Together, these data logs provided the basis for some of the network analysis discussed in Chapter 8. The recording of this data was again authorised by users of the application as part of the agreed terms and conditions of its use, in addition to signing a written consent agreement at the outset of the study.

7.6 Achieving a Better CommonGround

To illustrate the features of the second release of *CommonGround*, a full run-time screen capture is provided at the end of this chapter. As discussed earlier, each logical group of features was categorised into four distinct areas: Company Connect, Company Chat, Company Schedule, and finally the new Company Feed. The first three groups featured multiple component views which could be individually activated using toolbar toggle buttons (each could also be resized, expanded or collapsed with a single click to increase or decrease a feature's available viewing space). As in the earlier trial version of *CommonGround*, view changes were saved automatically and restored on future visits and a simple status message on each groups' title toolbar drew participant attention to recent updates. Again, as I will discuss and examine in the next chapter, students found that my approach of presenting all user interface elements in one single comprehensive view worked well in practice.

As shown in Figure 7.18 at the end of this chapter, eight students were logged on to the application at the time of the screen capture (in this instance 4 were from Newcastle University and 4 were from the Aarhus Engineering College in Denmark). Notice that the Virtual Meeting Room is currently active in the Company Connect group, which displays each active user's Facebook profile image and their network affiliations. A snapshot of the Chat Channel, Company Schedule panel and the new Company Feed feature can also be seen. Methods to manage application preferences and user groups were also made accessible via links on the application's title bar. And as with the previous version of *CommonGround*, discussion boards and connections to Newcastle University's e-learning system (NESS) were available via Facebook tabs outside of the main Flex application.

7.7 Concluding Remarks

This chapter presented the second evolutionary release of *CommonGround*, a rich internet application designed to run on – and exploit the ubiquity and features of – the social networking site Facebook. Developed as part of my study to support students participating in distributed group activities, the initial proof-of-concept trial version of the application was reworked considerably in response to student feedback and new advances in remote collaboration technologies. More specifically, a number of the features present in the first trial release were expanded upon and a host of new components implemented (such as a shared whiteboard and file exchange utility). The rationale underpinning the design of each feature – namely the Company Connect, Company Chat, Company Schedule and Company Feed facilities – has been discussed in detail in this chapter. Ultimately, I envisaged that these new affordances would allow me to better foster and analyse the creation of social capital and group awareness in distributed, collaborative learning situations – the primary goal of this study.

Going forward, the new Company Feed feature represented an area of particular interest; it provided students with a far more robust means to disseminate and consume status information during the project. As status update facilities have been shown to greatly contribute to the "stickiness" and success of social networking sites, I reasonably anticipated that this new feature would similarly facilitate an increase in network engagement and repeat use of the *CommonGround* application. Of course, by mirroring the identity, behaviour and functionality of Facebook's pervasive News Feed features (including comments and "I like this" tags), I also aimed to minimise the overheads associated with learning to use new technologies and, in turn, reduce barriers to student interaction. Similarly, to help foster the on-going narrative of group conversation, I expected the new persistent Company Chat features to allow participants to access and review previous team interactions and, in turn, communicate asynchronous social presence and group awareness. As participants would rarely find their entire team online at any given time, this simple addition would also allow absent members to "catch-up" with the recent activities of team mates.

Another area of considerable interest to this author was the introduction of a basic incentive metric. As discussed in detail in this chapter, this simple feature automatically rewarded *CommonGround* users with "experience points" for participatory actions within the application. By quantitatively ranking and elucidating contribution levels at run-time (via in-tool data visualisations), it was my intention to elicit a little healthy competition between team mates and thus motivate participation and repeat visits to the application. Indeed, as my work in this chapter contends, these two factors can greatly influence achievement, ties and satisfaction levels on-project. A detailed discussion of the metric's calculation, and the various "levels" that students could achieve, has been provided.

In addition to redeveloping *CommonGround's* Flex-based application interface, considerable changes were also made to the back-end server support systems to address a number of run-time performance and scalability issues. Firstly, to allow the application to handle high levels of network traffic, it was migrated to a more robust and suitable Apache HTTP web server (and supported by PHP and MySQL scripting and database technologies). Secondly, the application was extended to make it easier for teams to independently administer group membership and account settings. Finally, updates were made to the tool to accommodate Adobe's cloud-based LCCS service which removed many of the message syndication overheads of the application's previous implementation (recall that the LCCS represents a simple and ready-to-use platform upon which to rapidly build and implement data-intensive collaborative applications). Using the Facebook API, the application was again made available to users via the standard Facebook web-interface and thus appeared as if it was an extension of the site.

The effectiveness and combined impact of the new *CommonGround* features on the CETL-ALiC group programming activity will be analysed and discussed in detail in the next chapter.

7.8 Summary

In this chapter I presented a more robust and flexible version of the *CommonGround* tool. Redesigned to better achieve the goals of my study, this updated release resolved issues identified during previous trials and implemented a number of significant improvements (driven by student recommendations and advances in technology). The rationale and methodology directing the tool's redesign has been described in detail, including how the tool interfaced with the powerful LCCS messaging platform. A new sociability incentive metric was also introduced that quantitatively ranked each student's contribution levels during the study in order to encourage increased interaction with the tool. Together, these refinements represented an important step in the tool's evolution from proof-of-concept to fully-featured social app.

In the next chapter I will investigate and analyse a second experimental trial of the *CommonGround* application conducted during the 2009/10 academic year. Chapter 9 will then review the findings of my study in general and conclude this thesis.

Figure 7.18 CommonGround – Real-time Screen Capture

Chapter 8

Trial 2: Pilot Study

8.1 Introduction

The previous chapter introduced a more robust, flexible and refined version of *CommonGround*, the proof-of-concept RIA developed to support stage two students participating in the CETL-ALiC group programming activity. Redesigned in response to run-time performance issues and critical post-trial feedback, the tool once again coupled the inherent communication and social networking features of the Facebook platform with basic collaboration, group awareness, information sharing and project planning facilities. Moreover, this second release represented an important step in the tool's evolution from proof-of-concept to fully-featured social "app". Despite a number of significant revisions and upgrades, however, the primary motivation behind the application's development remained unchanged: to create a "sound social space" capable of filling the communication void that often arose between formal team interactions and, in doing so, help strengthen weak ties, encourage group interaction, and enhance the inclusion and participation of peripheral team members.

Replicating the approach and structure of Chapter 6, I now introduce and discuss the second of two experimental trials of the revised and upgraded *CommonGround* application. Described in detail in 8.2, a field-study was again performed to assess the collaborative capacity of the tool and to expose any further weaknesses in the concept's design or implementation. Following a summary of this chapter's research questions and selected instrumentation in 8.3, 8.4 goes on to again investigate the sociability of *CommonGround* and its ability to foster social presence on-project (based on data collected from participant surveys). In 8.5 I go on to study how *CommonGround* again influenced group cohesion, trust and awareness on-task, followed in 8.6 by an analysis of real-time application usage statistics and learner performance outcomes. A brief discussion of my findings is given in 8.7, before an overview of participant feedback gathered from post-trial surveys and interviews in 8.8. Of potential interest to future work, a recent trial of the application in an industrial setting is also discussed in 8.9.

8.2 Overview of 2009/10 Trial

To support and build upon the positive findings of the earlier proof-of-concept study (as discussed in Chapter 6), a second field-trial of *CommonGround* was performed during the 2009/10 academic year. Unfortunately, the partnership between Newcastle and Durham universities concluded prematurely at the end of 2009 and so the second trial was conducted primarily with local Newcastle University students. However, to provide a satisfactory emulation of GSD, the 2009/10 project mandate was developed in such a way that two distinct internal sub-teams were required in each company – an interface team and a database team. Although not as realistic as a true cross-site collaboration, this artificial split nevertheless went some way towards simulating the demands of a genuine distributed software development project (and, in practice, worked rather well). A smaller cohort of 4 students also participated in an international cross-site assignment with 4 students from Aarhus Engineering College in Denmark. However, for the purposes of this study, their results will be considered together with those of the single-site teams.

A total of 14 Newcastle University companies (out of 22) were randomly selected to join a study group and use the *CommonGround* application throughout the entire project (approximately 33 weeks; 24 contact, 9 non-contact). However, unlike the previous trial, companies were simply introduced to *CommonGround* – and its potential benefits – as part of their initial introduction to the CMC and collaborative tools available to them on-project. Only nine companies committed to using the application (including the international cross-site team), comprising a total of 49 representative stage 2 students; 45 from Newcastle University[11] and 4 from Aarhus Engineering College (44 male, 5 female; mean average age of 19.98, standard deviation 1.38). Of the 9 companies which chose to use *CommonGround*, all student members unanimously agreed to adopt the tool and participate in surveys and feedback sessions (usually conducted during formal team meetings).

For comparison purposes, 6 further companies were invited to join a control group (all of which agreed to do so). Only applicable to this study from 8.5 onwards, this cohort of students comprised a total of 34 Newcastle University students[12] (30 males, 4 females; mean average age of 20.18, standard deviation 1.19). Aside from participating in surveys and feedback sessions, control-group participants were again free to use any CMC technologies of their choice (but were not allowed to use the *CommonGround* application).

[11] 49 students originally started in Newcastle University's study group but 4 left the course during the activity and have thus been omitted.
[12] 37 students originally started in Newcastle University's control group but 3 left the course during the activity and have again been omitted.

8.3 Study Detail

Predicated upon and largely replicating the approach and structure of Chapter 6, I now investigate how the second deployment of *CommonGround* was able to significantly improve social interaction and group awareness during the 2009/10 trial. To do this, I again explore how the tool was able to provide a consistent, centralised space in which students could interact and explore the personal profiles and work-rhythms of their team mates. Similarly, I investigate how the tool influenced perceived levels of social interaction, social presence, mutual understanding, trust, self-disclosure, social cohesiveness and community building on-project; important determinants to critical information exchange, cognitive performance and the successful generation of social capital in collaborative contexts (i.e. the information, knowledge, resources and opportunities perceived to be available through one's network of team members [96]). As this chapter employs the same research methodologies as those described in Chapter 6, I will omit detailed discussion of the measures and investigative techniques used.

8.3.1 Research Questions

Repeating the exploratory investigation conducted in Chapter 6, the following research questions will again be considered:

RQ1. Is the revised *CommonGround* tool capable of encouraging and supporting critical interpersonal processes such as affiliation, team interaction, impression formation, social presence, and positive feelings of team-member connectedness?

RQ2. Extending RQ1, does the revised *CommonGround* tool help to create group awareness and sustain a low-risk environment in which effective, trusting, and cohesive working relationships can be established?

RQ3. Does usage of the revised *CommonGround* environment positively influence an individual's performance and achievement on-project?

The successful outcome of the first trial of *CommonGround* led me to believe that the tool would again be able to establish a "sound" collaborative space on-project. Capable of positively affecting and facilitating social interaction, group awareness, community building, impression-formation, team-member inclusion and individual cognitive performance, I expected that the tool would continue to help reduce the geographic and temporal barriers to interaction (and thus foster the generation of social capital).

8.3.2 Social Instruments

To answer the research questions proposed above, I again employed the closely related measures developed by Kreijns et al. to analyse and determine the social potential of computer-supported collaborative environments; namely the Sociability Scale [188], Social Presence Scale [189], and Social Space Scale [104]. I draw on the first two of these instruments in 8.4 to explore the quality of interaction and social presence afforded to users of the *CommonGround* tool; I then draw on the third scale in 8.5 to investigate and compare the collaborative potential which exists in and between both the study and control groups. Complementing this third measure, I also use the simple Group Awareness Scale developed by Daassi & Favier [116] to explore the ability of *CommonGround* to establish and maintain an effective degree of social, action and activity awareness on-project (i.e. knowledge of co-member roles, activities and work-rhythms). Once again, I do not attempt to examine the individual sociability factors of *CommonGround* and the Facebook application-platform separately, but rather the combination of the two.

8.4 Sociability & Social Presence

Following the approach of the first trial, this section again seeks to address RQ1 by exploring *CommonGround's* social communication affordances and their relevance to the needs and interests of students. Firstly, the sociability of the tool will be investigated (i.e. its capacity to support social interaction, build strong working relationships, and enhance positive feelings of team member connectedness, community and belonging). Following this, the ability of the tool to enable a satisfactory degree of social presence will be investigated (i.e. its capacity to permit online interlocutors to relate to team mates as "real people", to project their identities, and to connect with their larger online networks both synchronously and asynchronously).

8.4.1 Procedure

A self-report survey was again administered to trial-participants at both sites to solicit opinions on a range of sociability and social presence factors. At Newcastle University, a *CommonGround* questionnaire (see Appendix B) was distributed to all members of the study group in their penultimate formal team meeting during week 11 of semester 2 (reworked slightly where cross-site company structure did not apply). An 86.7% response rate was observed (with all questions answered). At the same time, an equivalent electronic questionnaire was administered at Aarhus

Engineering College to all participating cross-site students; a 100% response rate was achieved (with all questions answered).

8.4.2 Sociability

8.4.2.1 Instrument Detail

The *Sociability Scale* [188] is a one-dimensional measure featuring 10 five-point Likert-scale items. To briefly reiterate the scale's description (as discussed in detail in Chapter 6), each item is designed to assess a student's opinions of the social potential of a CMC tool – *CommonGround* in this case – and how well said tool could be used to interact with others in a learning group. The reliability of the instrument achieved a Cronbach's coefficient α of .92 in the original report and .84 in this study, continuing to suggest that the scale is able to measure the sociability construct well.

8.4.2.2 Results

Results from the sociability aspect of the survey (i.e. responses to questions derived from the Sociability Scale only) are provided in Table 8.1 below. As I again only intend to investigate the sociability of *CommonGround* as an isolated construct in this study, I simply use descriptive statistics to summarise the basic characteristics of the data collected. Furthermore, due to the small numbers of participants involved in the international cross-site project, student feedback from both institutions has been combined with data from the single-site teams.

Sociability Scale *(n=43)*		$\bar{x}$	s
Q1	CommonGround enables me to easily contact my team mates.	3.5	1.1
Q2	I do not feel lonely in the CommonGround environment.	3.1	1.1
Q3	The CommonGround environment enables me to get a good impression of my team mates.	4.0	0.8
Q4	The CommonGround environment allows spontaneous informal conversations.	3.4	0.9
Q5	The CommonGround environment enables us to develop into a well performing team.	3.8	0.9
Q6	The CommonGround environment enables me to develop good work relationships with my team mates.	3.4	1.0
Q7	The CommonGround environment enables me to identify myself with the team.	4.0	1.0

Q8	I feel comfortable with the CommonGround environment.	3.7	0.9
Q9	The CommonGround environment allows for non-task-related conversations.	3.8	1.0
Q10	The CommonGround environment enables me to make close friendships with my team mates.	3.4	1.1

Table 8.1: Sociability Scale, Summary Statistics (2009/10)

The results show that students rated the *CommonGround* tool moderate to high on the Sociability Scale. Likert-item scores were largely positive and consistent across the scale producing a mean average of 3.61 (as illustrated in Figure 8.1). In comparison to the previous trial, a notable mean increase in average Likert-item scores of 0.50 is observed, suggesting that students felt more comfortable using the application to interact with colleagues on-project. Similarly, the results indicate that the tool enabled students to easily get in touch with their team mates both formally and informally, thus facilitating valuable chance encounters.

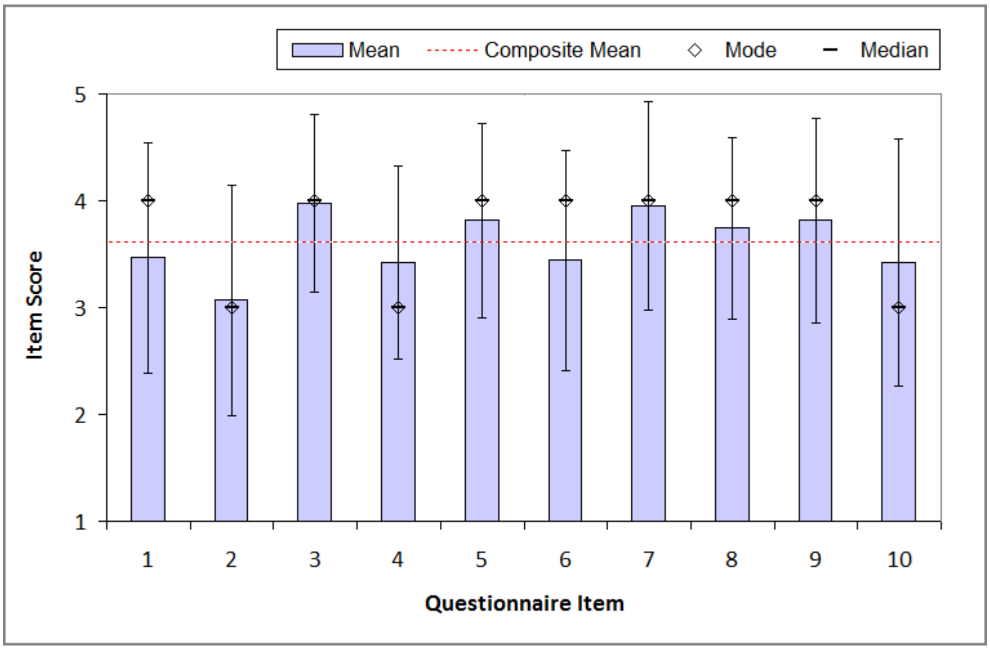

Figure 8.1: Sociability Scale, Average Responses (2009/10)

Confirming the previous trial's findings, students were again able to establish sound working relationships with their colleagues in the *CommonGround* environment, with impression formation and self-disclosure leading to the development of a well-performing, inclusive team. Thus, in reply to

RQ1, the results obtained continue to suggest that *CommonGround* is capable of creating and sustaining team interaction, information exchange, group cohesion and positive feelings of community on-project. Feedback from students obtained during post-trial group interviews also served to confirm these findings, as I will return to later.

8.4.3 Social Presence

8.4.3.1 Instrument Detail

The *Social Presence Scale* [189] is a one-dimensional measure featuring 5 five-point Likert-scale items. As described in detail in Chapter 6, each item is designed to assess the perceived degree of social presence afforded by a CMC tool. The reliability of the instrument achieved a Cronbach's coefficient α of .81 in the original report and .84 in this study.

8.4.3.2 Results

Results from the social presence aspect of the survey (i.e. responses to questions derived from the Social Presence Scale only) are provided in Table 8.2 below. Again, student feedback from both institutions has been combined and descriptive statistics used to summarise the data.

Social Presence Scale *(n=43)*		$\bar{x}$	*s*
Q1	When I have real-time conversations in CommonGround, I have my team mate(s) in my mind's eye.	3.4	0.9
Q2	When I have asynchronous conversations in CommonGround, I have my team mate(s) in my mind's eye.	2.8	1.2
Q3	When I have real-time conversations in CommonGround, I feel that I deal with very real persons and not with abstract anonymous persons.	3.8	1.0
Q4	When I have asynchronous conversations in CommonGround, I feel that I deal with very real persons and not with abstract anonymous persons.	3.3	1.0
Q5	Real-time conversations in *CommonGround* can hardly be distinguished from face-to-face conversations.	2.6	1.0

Table 8.2: Social Presence Scale, Summary Statistics (2009/10)

The results show that students again rated *CommonGround* moderately on the Social Presence Scale, producing a mean average Likert-item score of 3.17 (as illustrated in Figure 8.2 overleaf).

Initially similar to the results of the previous trial, a mean increase in average Likert-item scores of 0.3 is observed, suggesting that the revised application was *slightly* better able to establish a sense of social presence during online communications. Although students rated *CommonGround* well in terms of its ability to articulate both synchronous and asynchronous encounters, of particular note here is the comparatively moderate judgements received for the tool's capacity to facilitate conversations that were "indistinguishable" from face-to-face dialogue (an increase in average Likert-item scores of 0.94 over the previous trial is observed). Considering how poorly this aspect of *CommonGround* scored in the previous trial, this result indicates a noteworthy improvement.

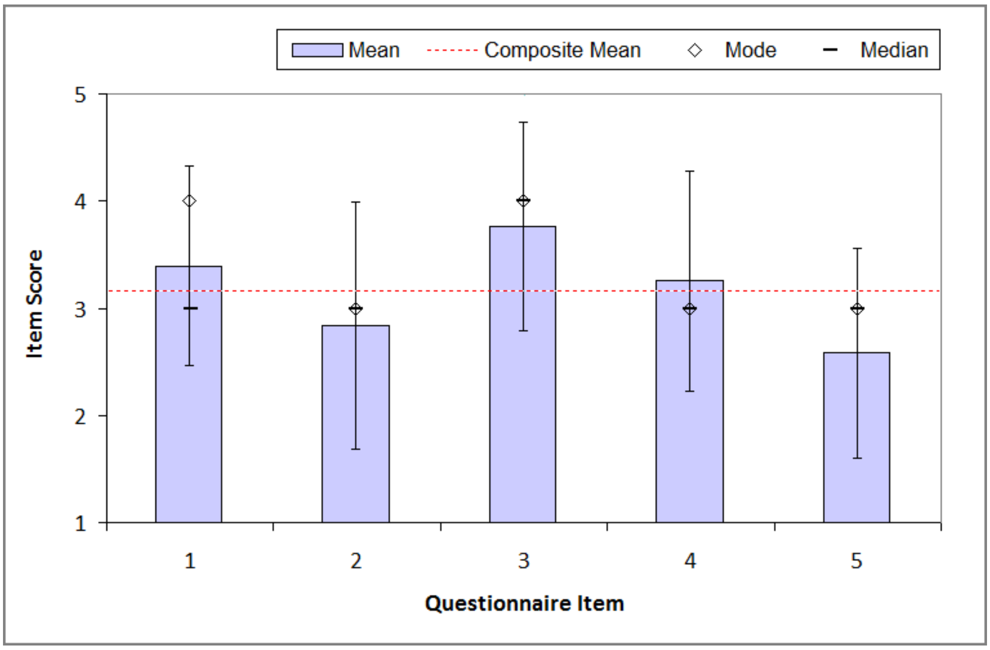

Figure 8.2: Social Presence Scale, Average Responses (2009/10)

Confirming the first trial's findings, the results discussed here once again suggest that *CommonGround*, in the opinion of its users, was capable of creating and sustaining a degree of social-presence on-project, thus complementing the Sociability Scale's positive outcome to RQ1.

8.5 Social Space & Group Awareness

This section seeks to address RQ2 by again exploring *CommonGround's* potential to establish and sustain social collaboration and group awareness on-project. Firstly, the social climate that is present in the study and control groups will be investigated (i.e. the non-latent group dynamics that underlie student collaboration and support the creation of effective, trusting and cohesive working relationships). Following this, the ability of the tool to enable a satisfactory degree of basic group awareness on-project will be investigated (i.e. up-to-the-minute knowledge of what one's team members have done so far, what they are doing now, and what they will do next).

8.5.1 Procedure

A simple paper-and-pencil self-report *Teamwork* questionnaire (see Appendix B) was administered to members of both the study and control groups in week 12 of semester 2. A 93.3% study group and 88.2% control group response rate was observed at Newcastle. However, due to listwise deletion of incomplete responses on the group awareness scale, study group and control group responses were reduced to 86.7% and 82.4% respectively for that construct. An identical electronic questionnaire was also administered at Aarhus Engineering College to all participating cross-site students; a 100% response rate was achieved (with all questions answered).

8.5.2 Social Space

8.5.2.1 Instrument Detail

The *Social Space Scale* [104] is a two-dimensional measure featuring 20 five-point Likert-items designed to assess a student's opinion of both their own and their group's collaborative behaviour. As described in Chapter 6, each item is designed to gauge the quality of a collaborative space and the social potential that exists within it. The reliability of the instrument achieved a Cronbach's coefficient α of .81 in the original report and .89 (study) and .84 (control) in this study.

8.5.2.2 Results

Results from the social space survey (i.e. responses to questions derived from the Social Space Scale) are provided in Table 8.3. Judgements from both institutions have been combined where applicable.

Social Space Scale		*Study (n=42)*		*Control (n=30)*	
Positive Group Behaviour		$\bar{x}$	*s*	$\bar{x}$	*s*
Q1	Company members felt free to criticise the ideas, statements, and/or opinions of others.	3.4	1.1	3.5	1.1

Q2	We reached a good understanding on how we had to function as a team.	3.3	0.9	2.9	1.1
Q3	Company members ensured that we kept in touch with each other.	3.0	1.1	3.0	1.3
Q4	Company members worked hard on the project assignment.	3.5	1.3	3.2	1.1
Q5	I maintained contact with all other company members.	3.7	1.1	3.1	1.1
Q6	Company members gave personal information about themselves.	3.2	0.9	2.5	1.1
Q7	The company conducted open and lively conversations and/or discussions.	3.9	1.0	3.4	1.3
Q8	Company members took the initiative to get in touch with others.	3.7	0.9	2.9	1.2
Q9	Company members spontaneously started conversations with others.	3.6	1.0	3.1	1.4
Q10	Company members asked others how the work was going.	3.7	1.1	3.6	1.0
Negative Group Behaviour[13]					
Q11	Company members felt attacked personally when their ideas/statements/opinions were criticised.	2.1	1.0	3.4	1.1
Q12	Company members were suspicious of others.	1.9	0.8	2.6	1.0
Q13	Company members grew to dislike others.	2.8	1.1	3.3	1.4
Q14	I did the lion's share of the work.	1.9	0.9	2.6	1.0
Q15	Company members obstructed the progress of the work.	2.6	1.1	3.2	1.1
Q16	Company members were unreasonable.	3.2	1.0	3.5	1.0
Q17	Company members disagreed amongst each other.	3.3	1.1	3.7	1.0
Q18	The team had conflicts.	3.4	1.0	3.8	1.3
Q19	Company members gossiped about each other.	1.9	1.2	3.1	1.2
Q20	Company members did not take others seriously.	3.0	1.0	2.9	1.1

Table 8.3: Social Space Scale, Summary Statistics (2009/10)

[13] Negative group behaviour scores (Q11-Q20) were reverse-coded for analysis.

Table 8.3 shows that students in the study group again rated their perceived degree of social space moderate to high. Results are encouraging and largely consistent across the scale, producing a mean average Likert-item score of 3.4 with negative items reversed (as illustrated in Figure 8.3).

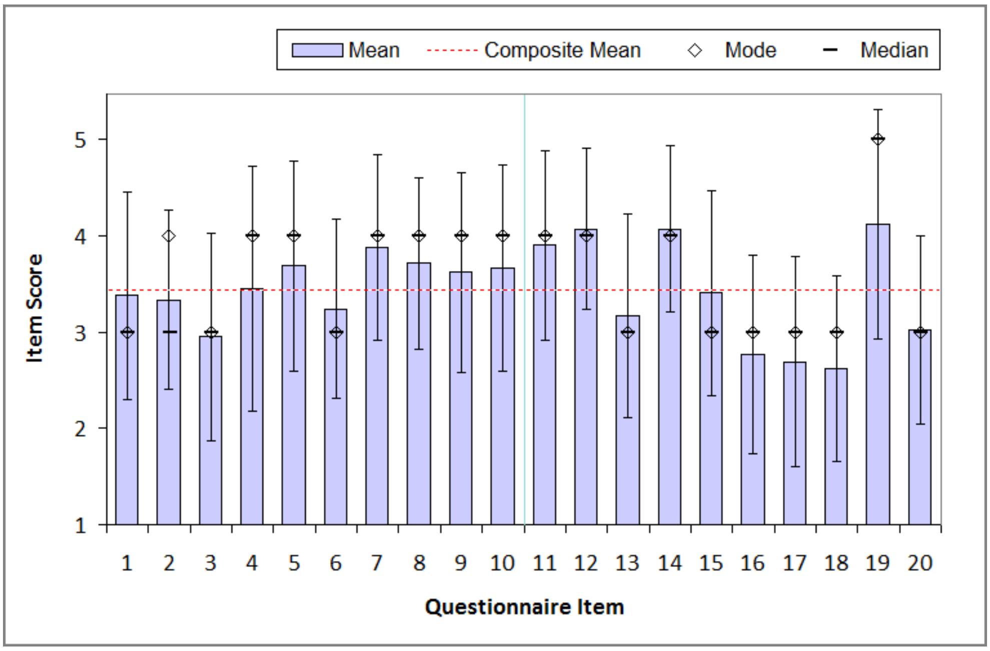

Figure 8.3: Social Space Scale, Average Responses (Study Group, 2009/10)

When compared to the previous trial (local usage only), a small decrease in average Likert-item scores of 0.3 is observed. However, these largely consistent results again suggest that students in the control group perceived their social space to be a predominately positive, lively and low-risk environment. Repeating the earlier trial's findings, students indicated moderately strong levels of community and group cohesion on-project (and, in turn, strong levels of respect, commitment and trust). And although team member disagreements were again fairly high, conflicts continued to have little apparent effect on the students' ability to function as a team. Paradoxically, respondents rated Q3: "Company members ensured that we kept in touch with each other" markedly lower than the previous trial (a 1.1 mean decrease in Likert-item scores). However, in post-trial interviews, students commented that this was due to a lack of any formal, concentrated effort to stay in contact with team mates, and agreed that *CommonGround* made interaction more transparent; an extremely positive outcome.

To allow me to better gauge the specific role of *CommonGround* in the establishment of this social space, student feedback from non-participating teams must again be considered. As the results provided in Table 8.3 show, students in the control group (i.e. non-users of *CommonGround*) reported a poorer social climate than that of the study group, rating their perceived degree of social space with a moderate Likert-item average score of 3.0 (with negative items reversed, as illustrated in Figure 8.4). Again, the majority of scale items scored more negatively when compared to study group results, although the gap is clearly far narrower than in the previous trial. A decrease of 0.5 for average Likert-item scores is observed between groups, indicating reduced team interaction, reduced self-disclosure, and heightened team conflict.

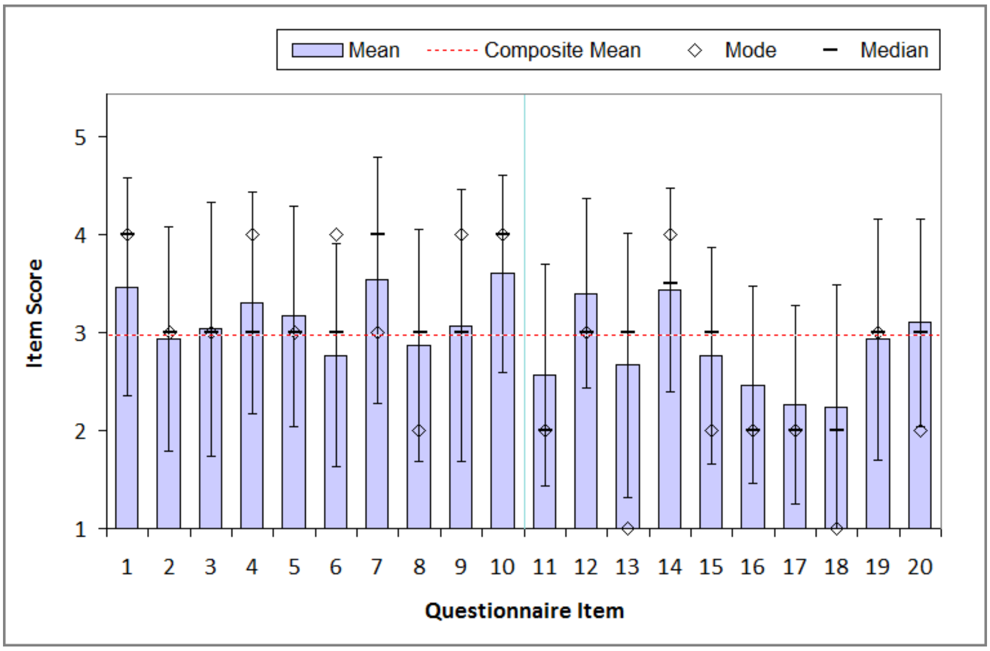

Figure 8.4: Social Space Scale, Average Responses (Control Group, 2009/10)

To compare results between the two trial conditions in more detail, I again performed a two-tailed independent sample t-test, T_1. The null hypothesis (H_0) was *local study group score = local control group score*; the alternative hypothesis (H_1) was *local study group score ≠ local control group score* (with study/control group membership as the independent variable and the summated Social Space Likert-scale as the dependent variable). Results, as provided in Table 8.4 overleaf, reveal a significant statistical difference (with medium effect size, *d*, as per Cohen [190]) between the mean summated scores of students in the study group and the control group. I therefore reject H_0 and accept H_1.

The results summarised above (and illustrated in Figure 8.5 overleaf; negative questions reverse coded) once more indicate a positive outcome to RQ2 and continue to suggest that the *CommonGround* environment is capable of establishing a sound social space on-project. Student interaction was demonstrably improved in teams that employed and embraced the tool, driven by greater social interaction (whether on-task or not), self-disclosure, positive feelings of community, and lower levels of conflict and mistrust.

	Group Statistics			*Significance*		
	n	$\overline{x}$	*s*	*t (df)*	*p*	*d*
T_1 Study Group	42	68.76	11.80	3.31	.001	0.79
T_1 Control Group	30	59.56	11.32	(70)		

Table 8.4: Differences Between Study and Control Group Social Space Scores (2009/10)

To reiterate a key point discussed in Chapter 6, the Social Space Scale indicates that the team structures and group dynamics created in this environment give rise to the generation of social capital and the creation of effective, trusting and cohesive/inclusive working relationships where knowledge-construction, competency acquisition, and commitment to shared goals and mutual understanding is achievable. Once again, the findings discussed here correspond with and support feedback from students obtained during post-trial group interviews.

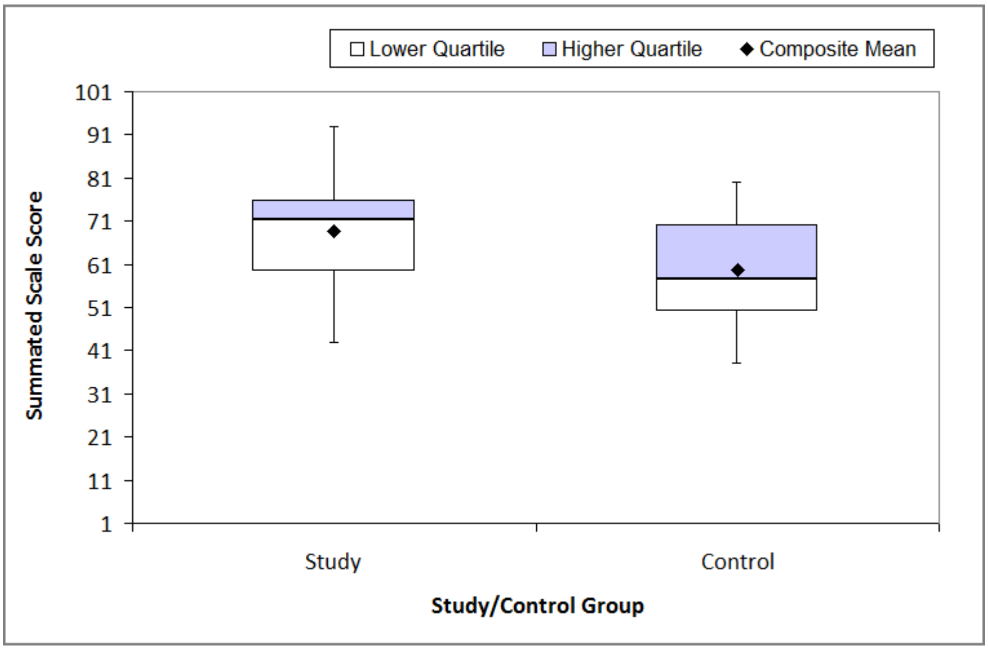

Figure 8.5: Social Space Scale, Summated Scores (2009/10)

8.5.3 Group Awareness

8.5.3.1 Instrument Detail

As described in detail in Chapter 6, the *Group Awareness Scale* [116] is a one-dimensional measure featuring 5 seven-point Likert-scale items designed to gauge a student's cognisance of team-mate activity, progress, availability, and willingness to communicate. The reliability of the instrument achieved a Cronbach's coefficient α of between .84 and .87 in the original report and .76 (study) and .80 (control) in this study.

8.5.3.2 Results

Results from the team awareness survey (i.e. responses to questions derived from the Group Awareness Scale) are provided in Table 8.5 below. Again, each institution's scores were combined where applicable.

Group Awareness Scale		*Study (n=39)*		*Control (n=28)*	
		$\bar{x}$	s	$\bar{x}$	s
Q1	I am usually aware of the progress of our project.	5.6	0.8	5.0	0.9
Q2	I am usually aware of the activities of my team mates.	5.4	1.2	3.7	1.2
Q3	I am usually aware of my team mates' availability.	4.7	1.2	3.7	1.3
Q4	I am usually aware of how willing my team mates are to communicate.	4.5	1.0	3.0	1.3
Q5	I am usually informed of what occurs in our company or shared workspace.	5.7	1.1	5.5	0.9

Table 8.5: Group Awareness Scale, Summary Statistics (Study Group, 2009/10)

The results reveal that students in the study group again scored their perceived degree of group awareness moderate to high. Responses were positive and largely consistent across the scale, producing a mean average Likert-item score of 5.2 (as illustrated in Figure 8.6 overleaf). When compared to the previous trial (local usage only), results are surprisingly comparable, with only a very small mean decrease in Likert-item scores of 0.2 observed. These results again suggest that study group students were able to maintain critical awareness of overall project progress and up-to-date knowledge of the day-to-day activities and availability (i.e. work rhythms) of their team mates. However, to help determine the degree to which *CommonGround* was able to help in this regard, control group feedback must again be considered.

The results provided in Table 8.5 show that control group students consistently scored their perceived degree of group awareness lower than that of the study group, producing a mean average Likert-item score of 4.2 (Figure 8.7 overleaf). Similar to the previous trial's outcomes, a noticeable drop in activity and availability awareness is observed, with students reporting difficulties monitoring the actions, progress and work rhythms of their team mates. In post-trial interviews, students again lamented the duplication of work, increased frustration, reduced team morale, and occasional isolation of team members that occurred as a direct consequence of this breakdown in communications. When compared to the study group, a notable decrease in average Likert-item scores of 1.0 (-19.5%) is observed.

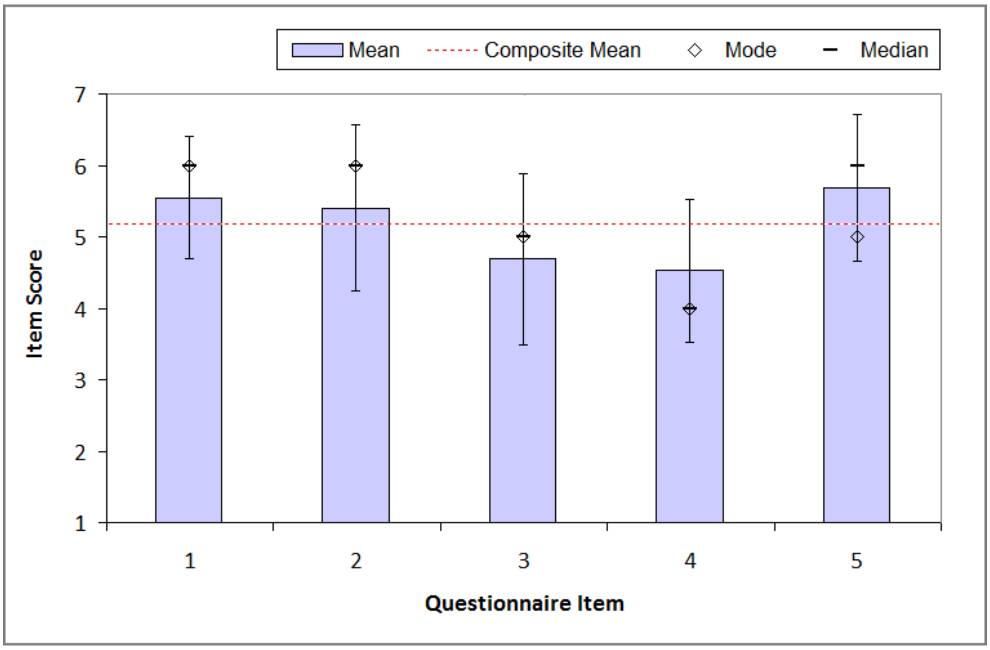

Figure 8.6: Group Awareness Scale, Average Responses (Study Group, 2009/10)

To compare results between the two trial conditions in more detail, I again performed a two-tailed independent sample t-test, T_1. Once again, the null hypothesis (H_0) was *local study group score = local control group score*; the alternative hypothesis (H_1) was *local study group score* $\neq$ *local control group score* (with study/control group membership as the independent variable and the summated group awareness Likert-scale as the dependent variable). The results, as provided in Table 8.6 (and illustrated in Figure 8.8 overleaf), reveal a statistically reliable difference (with large effect size *d*) between the mean summated scores of students in the study group and those in the control group (as one would expect given the clear differential in average summated scores). I am therefore able to again reject H_0 and accept H_1 for both T_1 and T_2.

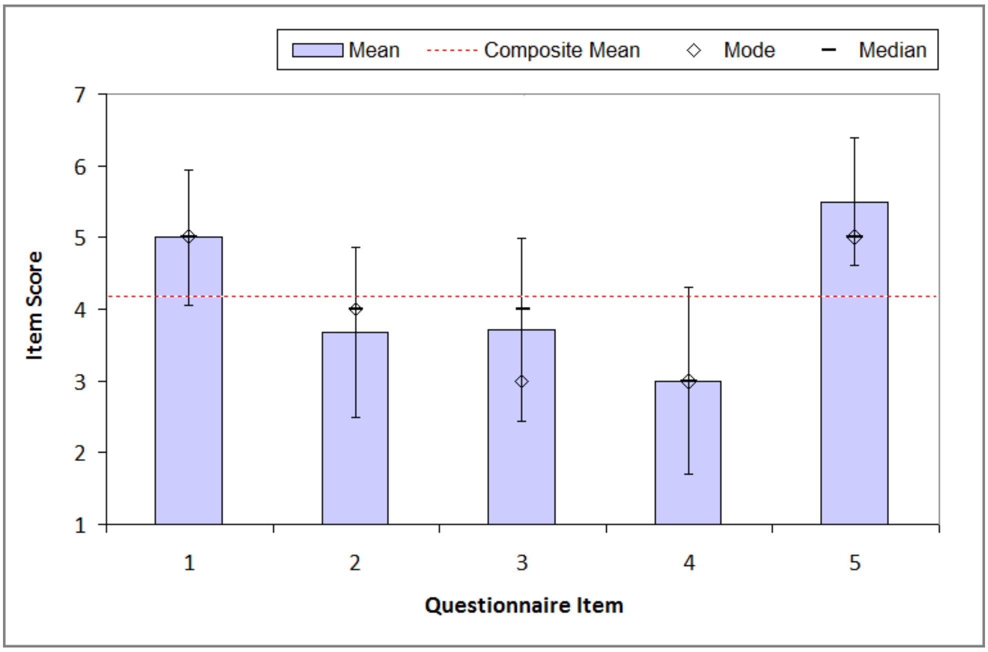

Figure 8.7: Group Awareness Scale, Average Responses (Control Group, 2009/10)

The results summarised and discussed in this section once again indicate a positive outcome to RQ2 and continue to suggest that the *CommonGround* environment positively contributes towards the establishment of action, activity and social group awareness on-project.

	Group Statistics			*Significance*		
Local Scores	*n*	$\overline{x}$	*s*	*t (df)*	*p*	*d*
T_1 Study Group	39	25.97	3.85	4.50	<.001	1.24
T_1 Control Group	28	20.96	4.31	(65)		

Table 8.6: Differences Between Study and Control Group Awareness Scores (2009/10)

To briefly reiterate a key point made during my discussion of similar findings in Chapter 6, the results presented suggest that the social and status affordances of *CommonGround* are able to positively affect the dissemination of critical awareness information on project. In turn, students are better able to keep track of the actions, roles and beliefs of their colleagues, facilitating the interaction, inclusion, and the creation of shared understanding around a common goal.

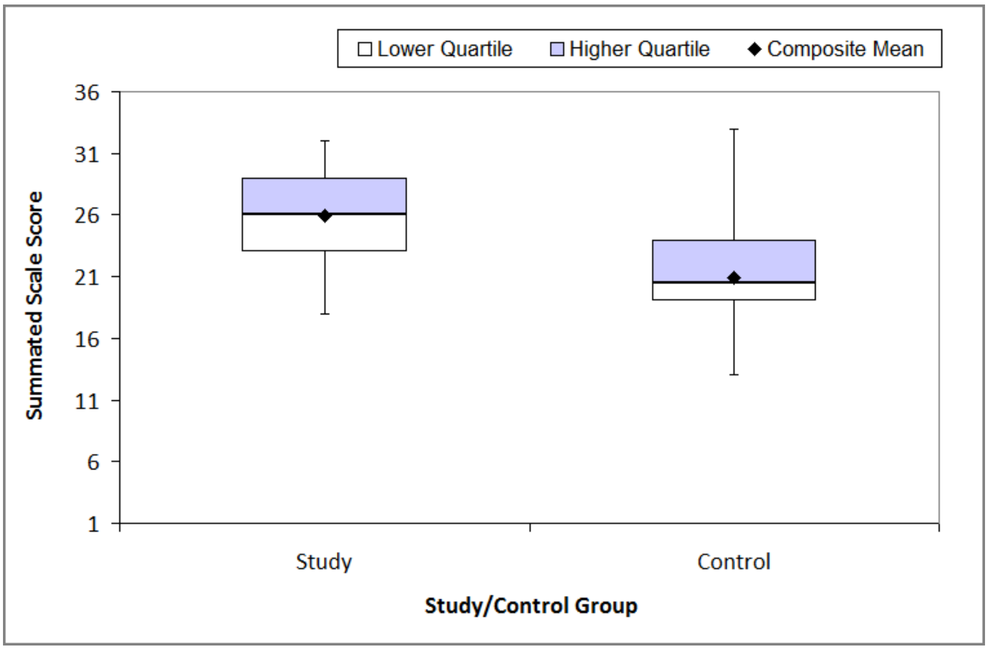

Figure 8.8: Group Awareness Scale, Summated Scores (2009/10)

8.6 Usage Statistics & Cognitive Performance

This section seeks to address RQ3 by once again exploring *CommonGround's* real-time feature-usage statistics (as automatically recorded and logged by the local hosting server during the 2009/10 trial). Following a summary of the academic achievements of both study and control group participants (as measured by final awarded grade), an investigation will be performed to ascertain the relationship – if any – between use of the tool and individual performance on-project.

8.6.1 Data Log Discussion

Following the 2008/09 trial, data logs again indicated positive, heavy use of *CommonGround*, as summarised in Table 8.7 overleaf and later illustrated in Figures 8.9 and 8.10. The user activity described was taken from *two* combined windows of activity; the first extended 91 days between weeks 3 to 12 in semester 1 (i.e. after all team members had accepted invitations to join the application and ending on the final day of term, including a 3 week vacation), and the second extended 112 days between weeks 1 to 11 in semester 2 (i.e. starting after the semester 1 assessment period and ending on the day of the final team deliverable, including a 4 week vacation).

Average Weekly User Interactions *(n=49)*	*Semester 1*		*Semester 2*	
Activity Event	$\overline{x}$	*s*	$\overline{x}$	*s*
Impressions (i.e. application loads)	12.17	2.41	17.22	4.32
Chat utterances	23.62	7.91	21.08	5.17
Status updates	5.68	1.53	6.38	1.96
Status comments/likes	15.45	4.06	24.08	6.62
Schedule additions/updates	2.40	0.71	2.17	0.64
Whiteboard shape edits	29.21	8.77	15.04	4.33
File uploads	0.90	0.28	1.38	0.35
Chance encounters	18.59	5.77	25.24	6.84
(of which led to a chat conversation)	3.67	1.25	5.05	1.99
Profile explorations (initiated via app)	5.00	1.24	1.80	0.54
Application visit duration (minutes per visit)	4.35	1.23	2.85	0.84
Average Final Friend Connections[14]				
Team member friend requests	3.10	1.76	1.45	1.00
Total team member friends	3.84	1.75	2.00	1.19
Average Sociability Score				
Average Total Experience Points	46.46	8.15	59.38	8.31

Table 8.7: Average CommonGround Interactivity Statistics (2009/10)

In the first semester of the 2009/10 trial, students accessed the *CommonGround* application approximately 1.74 times each day and remained connected for a surprisingly long average of 4.35 minutes (in post-trial interviews, one student commented that this was largely due to “leaving the app running in the background when [they] did other things”). In semester 2, connection duration fell to 2.85 minutes as impressions increased to a daily average of 2.46, suggesting that students once again starting “dipping in and out” of the application as and when they visited Facebook. Overall, mean

[14] Average Newcastle team size = 6.

impressions peaked at a little under 5 daily views (4.73) by week 10 of semester 2. Naturally, as impressions increased, so too did chance encounters and, in turn, valuable social interactions. In the first semester of the trial, for example, students connected with approximately 3 members of their team each day in the *CommonGround* environment (2.66 daily average), of which 19.7% resulted in a chat conversation. In semester 2, chance encounters increased to almost 4 per day (3.61 daily average), of which a further 20.0% led to in-tool real-time chat. Asynchronously, status updates occurred approximately 0.81 times each day in semester 1, rising to 0.91 in semester 2. Comments on those statuses (including "likes") were encouragingly high, with approximately 2.21 daily interactions in semester 1 and 3.44 in semester 2; an extremely positive finding. Again, in post-trial interviews, students commented that this feature was the primary motivation for frequent return visits to the application (both to publish and consume informal and on-task updates).

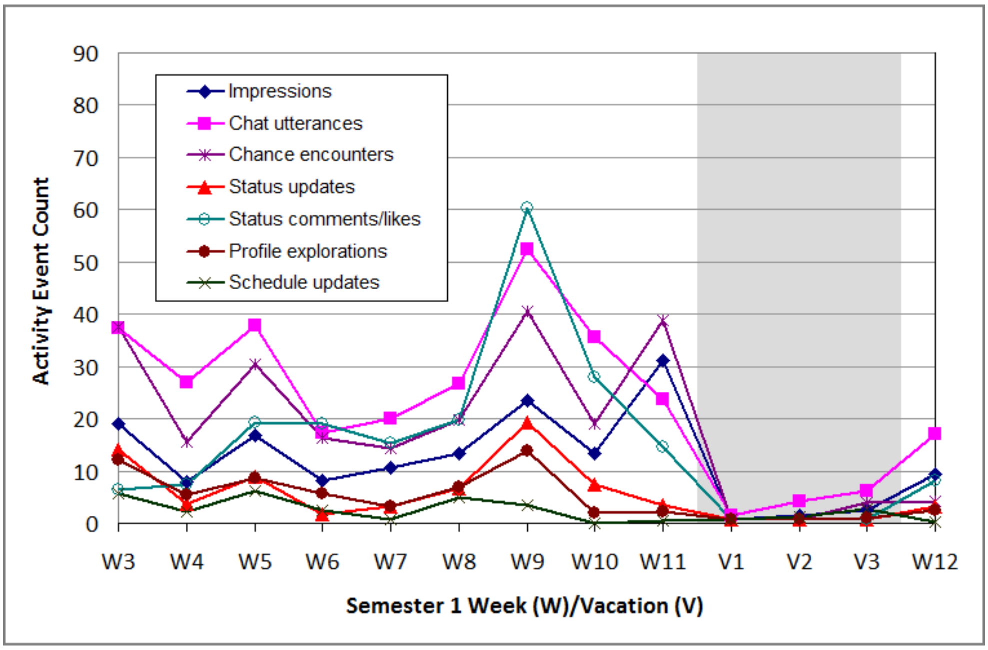

Figure 8.9: Weekly CommonGround Interaction Trends (Semester 1, 2009/10)[15]

Occurring less frequently, files were uploaded to *CommonGround* an average of 0.90 times per week in semester 1, increasing to 1.38 times per week in semester 2. However, certain "front-loaded"

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[15] Interactions are also plotted individually by type in Appendix A. These help to better demonstrate weekly trends for low frequency series (e.g. status updates, schedule updates and profile explorations).

feature interactions tended to reverse the general trend towards increased usage of the tool over the course of the trial. For example, average schedule updates occurred approximately 2.40 times per week in semester 1 – as a result of students populating the team schedule – *dropping* to 2.17 per week in semester 2. Similarly, average whiteboard interactions – used primarily during project design phases – occurred 29.21 times per week in semester 1 before dropping to 15.04 per week in semester 2. Perhaps more expectedly, exploration of team member profile information occurred on average 5.00 times per week during semester 1 – as students got to know one another – and again dropped to 1.80 interactions per week in semester 2.

By the end of semester 1, students had also added a little under 4 team members (average 3.84) as friends on the Facebook service (3.10 of which were requested via the *CommonGround* tool), thus enabling full exploration of their profile. By week 11 of semester 2, this number had grown by 2.00 to an average of 5.84 (4.55 of which were requested in-tool), representing an extremely encouraging result (average team size was 6 in 2009/10).

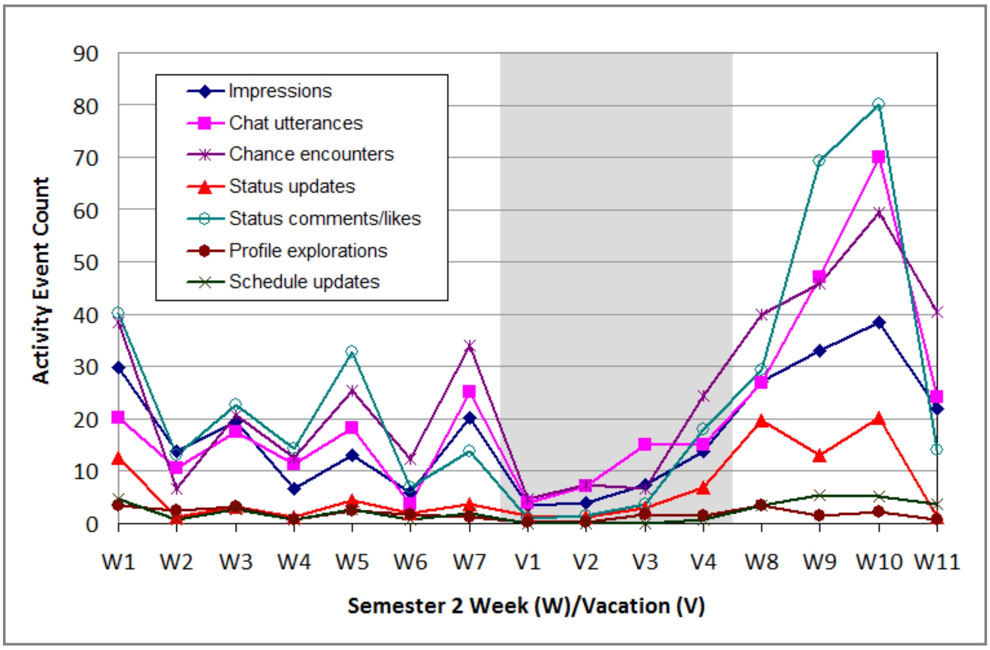

Figure 8.10: Weekly CommonGround Interaction Trends (Semester 2, 2009/10)[15]

Finally, in terms of sociability score (recall that a new sociability incentive metric was introduced to *CommonGround* to quantitatively rank contribution levels during the study), students on average achieved 46.09 experience points by the end of semester 1 (equating to a gold sociability level; see Table 7.3 in Chapter 7). By the end of semester 2, experience points had reached an average of 59.25

(equating to a platinum sociability level; scores were rounded down by the application). 22 of the 49 participants also attained the highest level available: diamond. Perhaps more encouragingly, no students remained in the bronze or silver levels by the end of the project, with the remaining participants achieving either gold (8) or platinum (19).

8.6.2 Data Log Trends

The *CommonGround* feature-usage statistics summarised in Figure 8.9 demonstrate that – similar to the first trial – semester 1 usage started with an initial peak of interest (when participants experimented with the tool and first populated schedule/status information). Interactions dropped slightly thereafter, but tended to increase and decrease in line with team deliverable deadlines in weeks 5, 8, 9 and 11 (as detailed in Table 3.2 in Chapter 3). For instance, interactions peaked in weeks 9 and 11 as those team deliverables – a team report and final project specification – placed the most demand on students to work together as a coherent unit. Once again, however, interaction levels fell significantly during the three week vacation period (indicated by the shaded area in Figure 8.9). However, data does show that student communication continued during this time; again a significant finding considering students typically did not interact during vacation periods.

Semester 2's feature-usage statistics, as summarised in Figure 8.10, follow a roughly similar pattern to the first trial. Interaction levels again started well, attributable mainly to students reorienting themselves with the project's progress and their colleagues' statuses. Following this, usage repeats the first semester's pattern of increasing and decreasing in line with team deliverable deadlines (occurring in weeks 3, 5, 7 and 10). Again, a significant drop-off in usage occurred during the first few weeks of a four week vacation period (indicated by the shaded area in Figure 8.10), but interaction continued and even reached approximate term-time levels by the final week (an extremely positive finding). Usage levels then grew steadily until, in week 10 – when final system demonstrations were due – interaction once again peaked.

8.6.3 Student Performance

To answer RQ3, I again investigate the relationship between usage of *CommonGround* and student achievement on-project. As in Chapter 6, learning performance will be measured by Newcastle University students' final grades (calculated through a combination of individual/team deliverables and assessor/peer assessments). Table 8.8 overleaf thus provides a summary of average 2009/10 student marks across both study and control groups.

Final Average/Min/Max Student Marks				
Study Group (n=45)	$\bar{x}$	*s*	*Min*	*Max*
Study Team 1	65.80	13.12	46	80
Study Team 2	81.50	4.93	75	88
Study Team 3	74.40	5.18	67	81
Study Team 4	66.33	7.69	59	79
Study Team 5	69.75	2.22	67	72
Study Team 6	69.83	8.89	56	83
Study Team 7	61.83	5.91	52	69
Study Team 8	71.67	3.06	69	75
Study Team 9	77.75	2.75	75	81
Total	70.73	8.95		
Control Group (n=34)	$\bar{x}$	*s*	*Min*	*Max*
Control Team 1	54.83	12.67	42	72
Control Team 2	64.00	16.08	36	76
Control Team 3	64.00	16.34	47	83
Control Team 4	73.33	8.76	60	82
Control Team 5	61.33	11.94	39	73
Control Team 6	60.17	10.57	42	72
Total	62.88	13.11		

Table 8.8: Study/Control Group Team Performance, Summary Statistics (2009/10)

The results shown reveal that teams in the study group again achieved higher average combined grades than the control group, with a total mean difference between groups of 7.85 (representing a slightly smaller gap than that observed in the previous trial). To compare individual final grades between the two trial conditions in more detail, I performed a two-tailed independent sample t-test to compare results between the two trial conditions. The null hypothesis, H_0, was *local study group grades = local control group grades*; the alternative hypothesis, H_1, was *local study group grades ≠ local control group grades* (with study/control group membership as the independent variable and individual final grades as the dependent variable). As one would perhaps again expect, a significant difference was found in grades between study group participants (*M* = 70.73, *SD* = 8.95) and control group participants (*M* = 62.89, *SD* = 13.11; *t* (55.18) = 3.002, *p* = 0.004) with a medium to large effect size (Cohen's d = 0.80). I therefore reject H_0 and accept H_1. Of course, these results still do not indicate a causal relationship; however, they do indicate a strong connection between use of *CommonGround* and higher learning performance on-project, again suggesting a positive outcome to RQ3.

8.6.4 Feature-Performance Correlations

To conclude this chapter's analysis of *CommonGround*, I now once again briefly investigate the specific features of the application and how their use influenced student performance on-project. To do this, Pearson bivariate correlation coefficients were calculated to explore the linear relationship between each primary social-affordance of *CommonGround* (as measured and described earlier in Table 8.7) and final Newcastle student grades. As well as providing a valuable insight into which application features are best able to affect student performance on-project, I again intended to use these findings to inform possible future development efforts going forward.

CommonGround Feature *(n=45)*	*r*	*p*
Impressions (i.e. application loads)	.348*	.019
Chat utterances	.372*	.012
Status updates	.356*	.016
Status comments/likes	.300*	.045
Schedule additions/updates	.365*	.014
Whiteboard shape edits	.251	.097
File uploads	.360*	.015
Chance encounters	.405**	.006
Profile explorations (initiated via *CommonGround*)	.381**	.010
Application visit duration	.370*	.012
Team member friends	.357*	.016

Table 8.9: Pearson Correlations Between Feature Measures and Final Grade (2009/10)

Although I still cannot establish causality between the factors considered and final student grades, Table 8.9 nevertheless indicates a statistically significant and positive correlation between the two.

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

The consistency of the results presented, although initially surprising, indicate that interactivity occurs as a direct consequence of application impressions; that is, as impressions increase, so too do most other application interactions. Reflecting the previous trial's findings, chance encounters appear to again correlate best with overall performance on-project, producing a medium correlation (as per Cohen [190]) between the two variables, closely followed by all but one of the other interaction types: whiteboard shape edits, which achieved a poorer, small correlation. Of interest, unlike the previous trial, total team member friends also appear to have produced a medium correlation with final grade. However, I believe increased friending of team mates is more a product of participation and community spirit rather than a direct predictor of individual performance.

8.7 Discussion

This chapter has described the second deployment of *CommonGround* and investigated its ability to support social interaction and student/team awareness during the 2009/10 CETL-ALiC group-programming activity. Following a field test of the revised application, the Sociability, Social Presence and Social Space scales were once again used to measure the collaborative potential of the tool and its ability to establish and sustain a "sound social space" on-project. My results, as summarised and discussed in this chapter, indicate a positive outcome to that investigation, confirming the earlier determination that *CommonGround* (running on the Facebook platform) is an effective, low-risk environment capable of facilitating social interaction and team-member connectedness.

More specifically, the slightly higher scores achieved on the Sociability and Social Presence Scales indicate that the upgraded *CommonGround* application – in comparison to the 2008/09 trial – was better able to help students maintain effective interpersonal relationships on-project (confirming that the tool's upgrades were a step in the right direction). Similarly, the high scores achieved on the Social Space Scale suggest that *CommonGround* was again able to reduce barriers to interaction, thus helping to strengthen team ties and generate positive feelings of community, belonging, trust, respect and course satisfaction. A repeat of the earlier group awareness investigation, coupled with an exploration of application usage statistics, also continues to suggest that *CommonGround* represents a viable group-collaboration tool capable of encouraging student cooperation, coordination and the inclusion of peripheral team members. By elucidating team member roles, group norms and values (via chat, status updates, profile explorations and chance encounters), I contend that *CommonGround* allows students to "get to know one another" and assess and the skills, work rhythms and needs of their colleagues – both online and off – within a pre-existing and convenient environment. Perhaps more importantly, the social connections formed within that environment indicate increased access to peer expertise, resources and knowledge (i.e. social capital), as positively demonstrated by the observed impact on individual final grades.

I therefore assert that the revised and updated version of the *CommonGround* tool is of significant benefit to collaborative student teams (whether co-located or distributed). To support this outcome, post-trial group interviews were again conducted to gather general feedback from users of *CommonGround* regarding the various positive and negative aspects of the tool's functionality, quality and usability. The main findings from those sessions will now be briefly discussed.

8.8 Student Feedback

For a second time, I conducted post-trial surveys and group interviews to gather quality and usability feedback from members of the study group.

8.8.1 Post Project Interviews

As this was the final year of the CETL-ALiC initiative, no interviews to assess the wider outcomes of the group programming project were conducted. However, to gather qualitative feedback from users of *CommonGround* regarding the tool's functionality, quality and usability, an hour-long unstructured group interview was conducted at Newcastle University in week 12 of the 2009/10 academic year (chaired by this author). All study group participants were invited to attend, 67% of which took up the offer (n=30). As described in detail in 6.8.1, questions were kept intentionally open-ended to encourage two-way communication and allow students to express their opinions freely on whichever topics they felt mattered most. The feedback gathered again served to elucidate how students used *CommonGround* on-project, as I will now discuss.

8.8.2 Remarks and Criticism

The majority of students who were questioned commented positively on the professional design of *CommonGround* and its ease of use; the new features implemented for this version (in response to the criticism discussed in Chapter 6) were very well received and no reliability issues were reported. In particular, students stated that the redesigned Company Feed feature was again the primary driver behind frequent and repeat visits to the application, with real-time status and event announcements (and weekly digest e-mails and News Feed posts) allowing them to keep track of the activities of their team mates. Feedback also indicated that the ability to "like" and comment on status updates created a powerful and genuinely useful asynchronous, threaded, topic-based discussion board for important on-task conversations (students reported that informal off-task interaction was once again confined largely to the chat feature). Significantly, for this iteration of the application, no students lamented a lack of data persistence between sessions. In fact, where students moved teams or joined the project late, the history and data persistence features introduced to *CommonGround* reportedly allowed them to "catch-up" with the recent activities of their new team mates.

Replicating the previous trial's findings, students also rated the Virtual Meeting Room feature (now an integrated part of the Company Connect feature) very highly, suggesting that it again helped to initiate and situate interaction and greatly improved feelings of online presence and community. Similarly, where chance encounters were concerned, students agreed that the meeting room metaphor helped to encourage the exploration of personal profiles and the "friending" of team mates. However, beyond simple experimentation, very few students found the whiteboard feature particularly useful (somewhat contradicting the moderate usage statistics observed). However, the international cross-site team did report that this feature was very useful during the design and specification stages, suggesting it is more helpful in true cross-site contexts where no face-to-face meetings can occur. Moving on to the file repository feature, all teams reported that the file storage and exchange facilities worked very well in practice, especially the mechanism to access previous versions of a document. However, a number of team members did comment that alternative facilities (such as the widely used and highly regarded file sharing tool *Dropbox* [200]) had been used instead.

In terms of the incentive metrics introduced to encourage interaction with *CommonGround* (namely experience points, sociability levels and star awards), students do seem to have reacted positively to their presence. Aside from posting, viewing and commenting upon status updates, many students reported that the acquisition of experience points significantly incentivised frequent return visits to the application. However, a smaller cohort of students indicated that they felt socially obliged to maintain an artificially high level of contributions in order to "keep up" with the perceived achievements of their more competitive, extrovert colleagues. Many students agreed that this was a good thing; others were not so sure. From my own perspective, I believe any increase in interaction – even if regarded as somewhat superfluous in nature – is likely to be a good thing.

One final note of significance with regards to future versions of *CommonGround*: should the tool ever be released into the public domain, the location of the application and its supporting server systems on a non-dedicated desktop computer will likely present scalability and security concerns. Thus, for future developments, a sufficiently robust cloud-based solution should be sought.

8.9 Industrial Experience

As a somewhat anecdotal extension to the second deployment of *CommonGround*, a 12 month industrial trial of the application was conducted in collaboration with a leading north-east UK e-learning and educational resource publisher. Although outside the primary scope of this thesis, 17 employees were invited to use the system during the second quarter of 2010, 4 of whom were based at the company's head office. The remaining 13 employees and freelance content developers telecommuted on a full- or part-time basis from locations throughout the UK and neighbouring European countries. VPN connections to the business network provided access to shared resources, but formal team interactions were largely confined to short one-to-one telephone calls and e-mail conversations. Once again, however, all employees were active Facebook users; proficient in its use and keen to try popular third-party applications. Moreover, all participants were aware of the unexploited collaborative potential of Facebook for professional interaction and recognised the usefulness of a tool such as *CommonGround* (despite initial reservations from management regarding the perceived "time wasting" nature of Facebook). Although I have not performed an in-depth analysis of team interaction, usage logs do suggest that participants fully embraced and made considerable use of the tool. Mirroring my academic findings, feedback from participants also indicated that the numerous synchronous and asynchronous communication facilities provided by Facebook and *CommonGround* served to strengthen existing social ties (by encouraging users to interact with and explore the personal profiles, statuses and work rhythms of their colleagues). More importantly, by reducing the barriers to interaction and community formation, participants felt the tool significantly enhanced their vocational community and returned strong payoffs in terms of support and access to expertise and knowledge.

8.10 Concluding Remarks

Expanding on the preliminary investigation discussed in Chapter 6, this chapter presented the second of two experimental trials of *CommonGround*, a Web 2.0 RIA created as part of my study to support students participating in the CETL-ALiC group programming activity. Conducted during the 2009/10 academic year, this field-trial replicated the general approach, procedures and methodologies established during the previous year's proof-of-concept study in order to corroborate those findings and reassess the updated application's social affordances. Thus, the following three research questions were again investigated:

RQ1. Is the revised *CommonGround* tool capable of encouraging and supporting critical interpersonal processes such as affiliation, team interaction, impression formation, social presence, and positive feelings of team-member connectedness?

RQ2. Extending RQ1, does the revised *CommonGround* tool help to create group awareness and sustain a low-risk environment in which effective, trusting, and cohesive working relationships can be established?

RQ3. Does usage of the revised *CommonGround* environment positively influence an individual's performance and achievement on-project?

The Sociability Scale [188], Social Presence Scale [189], Social Space Scale [104], and Group Awareness Scale [116] were again used to examine student participation during the trial. Results from this exploratory study, as summarised and discussed in 8.7, confirmed that *CommonGround* was indeed able to establish a "sound" collaborative space on-project capable of facilitating social interaction, group awareness, community building, impression-formation, team-member inclusion and individual cognitive performance. Confirming and expanding my earlier findings, these results once again allow me to conclude with a positive outcome to RQ1, RQ2 and RQ3.

8.11 Summary

In this chapter I presented the second of two experimental field-trials of *CommonGround*. Following an overview of the trial and the research questions posed, I once again provided a detailed discussion of the selected instrumentation used in this study. Replicating the approach of the first trial, I then went on to analyse the sociability of *CommonGround* and its capacity to foster social presence and group awareness on-project. An analysis of real-time application usage statistics and learner performance outcomes was again provided, together with a detailed discussion of participant feedback gathered from post-trial surveys and focus group interviews. A recent trial of the application in an industrial setting was also discussed that indicated positive results (and may be of interest to future research in this area).

In the next chapter I will go on to conclude this thesis, summarising the outcomes of the work presented and making recommendations for further studies in this area.

Chapter 9

Conclusion and Further Work

9.1 Thesis Summary

Chapters 1 and 2 provided an introduction to this study and a review of relevant background literature. In Chapter 3 I presented the *Active Learning in Computing* (ALiC) initiative, a five year HEFCE-funded partnership between a consortium of North East UK universities. Established in 2005, the project's primary objectives sought to enhance the student learning experience by placing a far greater emphasis on both industry-relevant group work and independent problem solving. As part of this initiative, Newcastle and Durham University partners extended their traditional team-based software engineering programmes to address the emerging commercial adoption of global software development (a practice whereby virtual teams of distributed domain experts use ICT-mediated systems to work collaboratively across spatial, temporal and organisational boundaries). Running over the course of an entire academic year, participating undergraduate students were placed into virtual companies and encouraged to collaborate both locally and cross-site to create a variety of complex software solutions for real-world industrial clients. Supported by considerable investment in ICT infrastructure, this approach sought to generate active interaction between team members and foster the development of both interpersonal and vocational skills significant to the requirements of employers.

In Chapter 4 I turned to the CMC technologies adopted by teams collaborating on-project. Unfortunately, my investigation showed that students continually reported substantial difficulties interacting and communicating with their peers both locally and cross-site (despite considerable investment by the CETL-ALiC partnership in top-of-the-range IT infrastructure). As described, students were often reluctant to adopt and embrace unfamiliar technologies and, when frustrated by unreliability issues or an "overload" of CMC tools, invariably adopted the services and platforms most familiar to them. In particular, my work has shown that they made significant use of popular and freely available social networking services such as Facebook (but were averse to declaring this in formal reports due to the informal nature and recreational expectations of the technology). Representing the main contribution of this study, a new stream of research was therefore established at Newcastle University to investigate the emergence of social media in team communication strategies and, if possible, harness its collaborative potential for professional, formal use on-project.

As part of this work, I proposed the creation of a web-based application called *CommonGround* capable of combining the inherent communication and group awareness features of the Facebook platform (e.g. profile creation, synchronous and asynchronous chat, status updates, etc.) with project-related status, meeting, scheduling and planning facilities. The design, development and evolution of this application was described in detail in Chapters 5 and 7, with the impact of each iteration on the group project – and on the generation of *social capital* as a whole – described in Chapters 6 and 8.

9.2 Conclusion

The CETL-ALiC group programming activity described in this thesis has generated a great deal of positive feedback from participating undergraduates. On the whole, students commented that they liked and enjoyed the project and found the challenge of meeting and working with others without structured supervision to be particularly fulfilling. Many students also expressed that they felt more confident about their abilities and transferable soft skills post-project, and in some cases were now capable of taking on roles which they would never have ordinarily considered [143]. These sentiments can be summarised by the following excerpt from a team's end-of-project report:

> *"We feel the project was very worthwhile. Our various accomplishments and failures now seem unimportant compared to the knowledge and experience gained. We have not only learned a lot of programming and technical skills, but have also gained some great life experiences in team working and project management which we will carry with us into any future work."*

The group programming project also provided the CETL-ALiC partnership with significant insights into distributed teamwork and the areas that cause the most concern to students. Some of those areas, such as assessment and the evaluation of individual contributions, were able to improve year-on-year. However, both local and cross-site team communication issues presented much more of a challenge. This study has explored those issues in detail and investigated new, innovative and cost-effective ways to mitigate the problems experienced. I will now summarise the general methodology and findings of this work and outline its primary contributions to pedagogic research and the field of computer-supported collaborative learning (CSCL). The lessons learned during this study can also be abstracted to help inform similar studies beyond the scope of the CETL-ALiC remit.

9.2.1 Facilitating Student Interaction

The survey results, group interviews and feedback analyses presented in this thesis have shown that, beyond face-to-face encounters, the computer-mediated communication channels established by students to maintain interaction during collaborative projects often break down. Although partially due to time and resource pressures, many of these problems stem from poor local and cross-site communication strategies and an over-reliance on asynchronous technologies such as e-mail (which fail to provide the collaborative depth and social affordances needed to significantly influence the acquisition, building and exchange of knowledge). In addition, experiences to-date also indicate that a variety of unfamiliar systems actually undermine student communication strategies. Thus, without broad training and experience in professional CMC technologies and their collaborative potential, students will invariably find themselves overwhelmed by the sheer number of tools available (and the ensuing "information overload" that their use generates). To make matters worse, many professional tools simply ignore the instrumental role that social interaction plays in increasing computer-mediated group performance and student motivation, assuming it will occur simply because the environment makes it possible.

If left unchecked, communication breakdowns invariably lead to duplication of work, reduced team morale, and increased student frustration and interpersonal conflict. In turn, a lack of community spirit can decrease student motivation and isolate peripheral team members. Attempts to encourage interaction by mandating communication technologies such as video-conferencing tools and virtual learning environments may help, but it is doubtful whether their introduction justifies the additional complexity and expense incurred. Students may even resist these new technologies simply because of the time and mental effort required to learn and use them.

As is often the case in such matters, however, it is best to let the communities of practice concerned lead the way and adopt the technologies that work best for them. During the CETL-ALiC project described in this thesis, for example, students began to autonomously incorporate social networking services into their team communication strategies, thus satisfying their own group collaboration needs and mitigating the shortcomings of other, less reliable technologies. Facebook in particular emerged as one of the primary collaborative tools for both informal and on-task interaction; its simplicity, availability, convenience and familiarity made it an ideal platform to build community around a common goal. By simplifying the dynamics of relationship building, the service encouraged the facilitation of trust, team cohesion, common understanding and an orientation towards cooperation via productive chance encounters, profile explorations and informal “water cooler” conversation. The online interactions facilitated in this context thus allowed team roles to be learned and values understood, with students able to co-create knowledge and strategically monitor the activities, tasks and responsibilities of their group. And as learning and team work are inherently social processes, this technology was able to play an instrumental role in enhancing computer-mediated group performance and team member motivation. Social media technologies therefore represent an innovative and cost-effective way to generate and maintain team member interaction across all aspects of student-group activities (with potential technological, educational and commercial implications extending beyond the scope of the CETL-ALiC initiative, as a recent industrial trial discussed in Chapter 8 attests to).

Consequently, this thesis contends that CSCL educators and businesses alike must acknowledge, embrace and encourage social media use as a practical and relevant form of team interaction (as I have shown, more and more professional organisations are now recognising the power of social networking services for distributed group communication). However, this work does not suggest that team interaction and community building can be ignored simply because collaborative groups have access to and frequently use social networking services. Facebook and social media sites like it are predominantly personal, private and recreational services in which users mirror their offline relationships online; it is unrealistic to assume that users will naturally employ these platforms for professional, on-task collaboration. In fact, as this study has shown, students will strongly resist *any* requirement to open their social networks to new colleagues (especially if they have never met face-to-face or will only work together for a short amount of time). Fortunately, the use of third-party Facebook “apps” – such as the *CommonGround* tool described in this thesis – can complement and enhance a group’s collaborative potential without directly impacting upon its members’ social graphs or routine, day-to-day use of the service.

9.2.2 Study Outcomes

Advancing the field of CSCL, the *CommonGround* tool described in this study was conceived of as a means to couple the familiar social communication features of Facebook with formal group-collaboration, meeting, scheduling and task allocation facilities. More specifically, the application was designed to harness and extend the built-in collaborative affordances of the Facebook platform in order to create an accessible, convenient channel through which team members could meet and interact online. Thus, by filling the communication void that often arises between formal team interactions (and in turn reduce the geographic and temporal barriers to participation), the application would stimulate greater team member cooperation, trust and self-disclosure by facilitating informal chance encounters, group awareness and profile exploration. To evaluate the extent to which *CommonGround* was able to realise these objectives, various research instruments were employed. In particular, the closely related measures developed by Kreijns et al. (namely the Sociability Scale [188], Social Presence Scale [189] and Social Space Scale [104]) were used to determine the social potential of *CommonGround*. Similarly, a simple group awareness scale developed by Daassi & Favier [116] was used to explore the ability of *CommonGround* to establish and maintain an effective degree of social, action and activity awareness (i.e. knowledge of co-member roles, activities and work-rhythms).

As the positive results presented in this thesis have shown, the *CommonGround* application is indeed able to create effective collaborative relationships capable of sustaining and supporting group cohesiveness, task awareness, shared understanding, trust, empathy, respect and course satisfaction. My investigation into group awareness (supported by high levels of application usage statistics) also confirmed that *CommonGround* is an environment which builds community and encourages student cooperation, coordination and cohesion. The mutual dependencies created in this setting thus encourage team roles to be learned and group values understood, returning strong payoffs in terms of social support and access to expertise, resources and knowledge (i.e. social capital). In particular, status updates and chance encounters allow students to get to know one another and exchange information that directly influences impression formation and affiliation (i.e. the propensity for students to keep in touch with each other). Perhaps more importantly, the informal connections formed also serve to strengthen team ties and encourage the inclusion of peripheral, passive team members. Finally, although my focus has been on social interaction rather than educational performance (measuring the acquisition of declarative knowledge is outside the scope of this thesis), the results of this investigation do indicate that increased use of the *CommonGround* application results in higher overall achievement in collaborative group contexts.

9.2.3 Creating a CommonGround

The proposal, design, implementation and deployment of the *CommonGround* application have all been discussed in detail in this thesis. However, the motivations underpinning its creation can be abstracted to help inform the development of future groupware tools for alternative social platforms. Firstly, for a social app to be successful in a collaborative context there must be no requirement for users to add team mates as "friends" on the service (the app must create and manage group connections outside of a person's private social network). Secondly, interaction with the tool must be initiated directly by the participant (i.e. there should be no unsolicited or invasive prompts to visit the app). Thirdly, the tool must not publicise its use to a participant's social network (i.e. by posting events to a user's profile page). And finally, the tool must include custom collaboration affordances and not expect – or presume the use of – any platform-specific communication channels (which are generally designed to be used with a user's private social network). Of course, any tool created should also respect the privacy of participants and avoid soliciting or disseminating detailed personal information to other participants. Given user attitudes towards third-party social applications, the tool should also be stable and reliable (experiences suggest that any inherent difficulties accessing an app will quickly put users off).

The lessons learned during the design and implementation of *CommonGround's* rich and varied feature set can also be used to inform future efforts in social media development. Firstly, a platform's API should be used to create an app that looks and works as though it is a natural extension of the site (to minimise the overheads associated with learning to use a new technology). A real-time roster of online team mates is also a basic requirement of any social tool, and to enable a small degree of online social presence and group awareness, it is recommended that a connected user's Facebook profile picture is used – a simple yet effective technique to individualise members and stimulate informal interaction via productive chance encounters. In addition, a congruent visual metaphor analogous to a real-world meeting environment (e.g. an illustrated reproduction of a traditional face-to-face meeting room) can also help to situate interaction and instantly communicate a tool's purpose. Via a combination of these two affordances, it is also advantageous to visually communicate each user's network affiliations and team roles so that online interlocutors can tell at a glance which colleagues are online, where they are from and what skills they posses. A simple means to access and explore the personal profiles of team mates – if privacy settings permit – is also highly recommended.

The ability to "microblog" is an extremely useful feature of any social tool. As this thesis has demonstrated, simple "status update" affordances allow users to disseminate information about themselves and track the actions, beliefs and interests of those in their network. Moreover, they contribute greatly to the "stickiness" of a social tool and thus represent a potent means to facilitate network engagement and repeat use. To complement this feature, a basic text-based synchronous chat affordance is all that is needed to enable real-time one-to-one and one-to-many social interaction. However, as this study has shown, *persistent* chat text should be used to support team awareness and help foster the on-going narrative of group conversation. Finally, basic scheduling tools can also help team members see at a glance the tasks assigned to them, their submission dates and the progress that others are making on their allotted duties. As these tasks can be readily viewed and discussed by all active users with roles and timescales collaboratively decided upon, they represent an attractive means to foster group, task and activity awareness.

Needless to say, added extras such as file exchange features and interactive whiteboards can be of some use, but their inclusion should not distract from the provision of important information dissemination, profile exploration and group awareness features (such as those described above). From a design perspective, it is also recommended that a social tool's interface is presented in a single, comprehensive view (vertical scrolling appears to be favoured over more traditional menu or tab driven interfaces – perhaps because data views requiring vertical scrolling is an accepted design form on Facebook). In addition, a basic contribution metric – such as the one presented in this study – can also incentivise regular use of a tool. By quantitatively ranking and elucidating contribution levels at run-time, one can elicit a little healthy competition between team mates and thus motivate participation and continued interaction (which, as discussed in this thesis, can lead directly to increases in achievement, ties and satisfaction levels). Importantly, however, a metric need only provide a basic indicator of interactivity; a detailed analysis and reporting of the threaded nature, content or reciprocity of a message is not strictly necessary.

One final note on technology provision: while it is not yet advisable to assume or mandate the exclusive use of student-owned computing equipment in collaborative educational contexts, this work does suggest that such an approach offers significant advantages and departmental IT cost-reductions.

9.3 Take Home Message

Worldwide adoption of information and communication technologies has transformed the industrial society of yesterday into the knowledge-driven economy that we live in today. In the global communities and labour markets that have arisen from that transformation, UK graduates are faced with a variety of challenges posed by the ever-increasing over-supply of highly skilled, low cost workers from developing economies (in addition, of course, to a recessive economic climate and shortage of jobs closer to home). This is particularly true in ICT-based sectors where the internationalisation of business now requires graduates that can embrace the technological and cultural demands of 21st century commerce. Multi-cultural and cross-domain team-working skills and an ability to manage complex interpersonal relationships are the most basic of the "global competencies" students must possess if they are to operate successfully in their chosen fields. It is therefore the responsibility of educators to react to the global demand for knowledge workers and thus prepare students for the realities of working in this highly competitive environment.

The CETL-ALiC group programming activity described in this thesis has gone some way towards responding to those challenges by providing students with a genuine insight into cross-site software development. By placing an emphasis on both industry-relevant group work and independent problem solving, the project encouraged active dialogue and the development of strong, real-world problem solving skills significant to the needs of employers. More specifically, however, it is through the innovative uses of popular social media that this study has responded to the evolving role of ICT in the world and the skill demands of a rapidly changing software engineering industry. In particular, the inherent communication and "group awareness" affordances of social networking services such as Facebook have been shown to demonstrably reduce the geographic and temporal barriers to team interaction, allowing distributed team members to become increasingly aware of each others skills, personalities, work rhythms and needs within a convenient, persistent and familiar infrastructure. And unlike many of the typical CMC technologies that institutions might mandate to encourage team collaboration, social networking services are already established in the everyday lives of students.

Thus, by embracing social media technologies as part of a holistic view of modern teaching and learning (that correlates well with recognised modern constructivist thinking), the work conducted in this thesis has helped to expose the latent collaborative potential of the social web and, in turn, transformed how we think of and use social media to stimulate, maintain and support group interaction in higher education and beyond.

9.4 Further Work

With regards to the research objectives of this specific study, the scope for future extensions and avenues of further enquiry are considerable.

Firstly, initial results and feedback from students who have used the *CommonGround* application on-project have proven extremely encouraging. However, although specific to team-working projects in computing science, it is intended that this work can be generalised for other subjects. To obtain more comprehensive results applicable to a wider educational context, it would therefore be interesting to expand the use of *CommonGround* to other subject domains and larger populations of users. Before one considers a third, full-scale deployment, however, issues of scalability and security must first be considered (as touched upon in Chapter 8). Looking beyond these basic improvements, it would also be greatly beneficial to submit the application to the Facebook directory and thus make it available to the general public. I would recommend, however, that the application's back-end server implementation support a local instance of Adobe's LCCS system (rather than the current

Adobe-hosted cloud-based solution). Although still suitable for most use-cases, for large-scale deployments the expensive usage charges incurred may become a limiting factor.

Of particular interest to future work is the provision of access to *CommonGround's* network via mobile devices. At the time of writing, Facebook's various mobile interfaces do not support third party applications and many of the more popular Apple devices do not support Flash/Flex. However, mobile technologies are expected to play a growing part in the development of social networking services in the future (in December 2011, Facebook reported that almost 88% of users accessed the service via a mobile device [148]). Hence, the development of a app – or HTML5 front-end – for mobile platforms capable of bridging popular social networking technologies and the *CommonGround* service presents an intriguing research proposition.

Focussing on the analytical aspects of this study, it would be an interesting extension to explore the longitudinal evolution of group awareness during trials of *CommonGround* (group awareness has been shown to change significantly over time [116]). In addition, it would be beneficial to perform a full content analysis of student/team interactions across all relevant features of the tool (much of the groundwork was laid for this in the 2008/09 and 2009/10 trials but were omitted due to time limitations and the focus on sociability, social presence and group awareness factors). More work in this area and on the selection/development of an adequate coding scheme would certainly allow better conclusions to be drawn on the relationship between on/off-task interaction and the negotiation of common ground. Going forward, it would also be very interesting to ascertain how the competencies acquired on-project translate to success in industry.

Finally, as an extension to the second deployment of *CommonGround*, the 12 month industrial trial of the application touched upon in Chapter 8 continues to represent an area of particular interest. Although largely outside the primary scope of this thesis (and therefore not described in detail), employees who made use of the tool felt that it significantly enhanced team-member connectedness, group awareness and self-disclosure – both online and off. Again, by reducing the barriers to interaction and community formation, participants reported that continued use of the tool returned strong payoffs in terms of trust, support and access to business expertise and knowledge. Thus, for researchers focussing on CMC tools to create, maintain and strengthen professional online communities of practice, the work I have started here suggests another interesting and potentially valuable avenue of study.

References

[1] T. Charlton, M. Devlin, and S. Drummond, “Using Facebook to improve communication in undergraduate software development teams,” *Computer Science Education*, vol. 19, no. 4, pp. 273-292, 2009.

[2] T. Charlton, M. Devlin, L. Marshall, and S. Drummond, “Encouraging interaction and status awareness in undergraduate software engineering projects: The role of social networking services,” *IEEE EDUCON 2010 Conference*, pp. 179-184, 2010.

[3] T. Charlton, L. Marshall, and M. Devlin, “Evaluating the extent to which sociability and social presence affects learning performance,” *ACM SIGCSE Bulletin*, vol. 40, no. 3, p. 342, 2008.

[4] T. Charlton, L. Marshall, and M. Devlin, “Creating Reusable Learning Objects For First Year Programming,” in *10th Annual Conference of the Subject Centre for Information and Computer Sciences*, 2009, p. 80.

[5] A. Gorra, J. Finlay, M. Devlin, J. Lavery, R. Neagle, J. Sheridan-Ross, T. Charlton, R. Boyle, and J. Sheridan, “Learning With Technology: What do Students Want?,” in *Proceeding of the 5th International Conference on e-Learning: Universiti Sains Malaysia, Penang, Malaysia, 12-13 July 2010*, 2010, p. 126.

[6] B. Wellman, A. Q. Haase, J. Witte, and K. Hampton, “Does the Internet increase, decrease, or supplement social capital?,” *American Behavioral Scientist*, vol. 45, no. 3, pp. 436-455, 2001.

[7] K. Guruz, *Higher education and international student mobility in the global knowledge economy*, vol. 36, no. 1. SUNY Press, 2008, pp. 60-62.

[8] P. Brown, D. Ashton, H. Lauder, and G. Tholen, “Towards a high-skilled, low-waged workforce? A review of global trends in education, employment and the labour market,” *SKOPE Monograph No*, vol. 10, no. 10, 2008.

[9] ITU. ICT Data and Statistics [Online]. Accessed July 19, 2011. Available: http://www.itu.int/ITU-D/ict/statistics

[10] R. Freeman, “The Great Doubling: The Challenge of the New Global Labor Market,” *Ending Poverty in America How to Restore the American Dream*, pp. 55–65, 2007.

[11] J. Diamond, A., Walkley, L., Forbes, P., Hughes, T. and Sheen, “Global Graduates into Global Leaders,” 2011. [Online]. Accessed November 22, 2011. Available: http://www.cfe.org.uk/uploaded/files/Global Graduates Full Report.pdf

[12] A. J. Hesketh and P. Brown, *The Mismanagement of Talent: Employability and the Competition for Jobs in the Knowledge Economy.*, vol. 59, no. 2. Oxford University Press, p. 670, 2004.

[13] E. Ferguson, C. Kussmaul, D. D. McCracken, and M. A. Robbert, "Offshore outsourcing: current conditions & diagnosis," *ACM SIGCSE Bulletin*, vol. 36, no. 1, pp. 330-331, 2004.

[14] A. M. Townsend, S. M. Demarie, and A. R. Hendrickson, "Virtual teams: Technology and virtual the workplace of the future," *The Academy of Management Executive*, vol. 12, no. 3, pp. 17-29, 2010.

[15] K. Fryer and M. Gothe, "Global software development and delivery: Trends and challenges," 2008. [Online]. Accessed March 2, 2010. Available: http://www.ibm.com/developerworks/rational/library/edge/08/jan08/fryer_gothe/index.html

[16] B. S. Bell and S. W. J. Kozlowski, "A typology of virtual teams," *Groups and Organizational Management*, vol. 27, no. 1, pp. 14-49, 2002.

[17] M. Z. Last, "Understanding the group development process in global software teams," *Frontiers in Education*, vol. 3, pp. S1F-20-5 vol.3, 2003.

[18] R. Kommeren and P. Parviainen, "Philips experiences in global distributed software development," *Empirical Software Engineering*, vol. 12, no. 6, pp. 647-660, 2007.

[19] R. B. Barr and J. Tagg, "From teaching to learning: A new paradigm for undergraduate education," *Change*, vol. 27, no. 6, pp. 13-25, 1995.

[20] G. Roberts, "SET for Success - The supply of people with science, technology, engineering and mathematics skills," *Review Literature And Arts Of The Americas*, April, 2002.

[21] D. Jonassen, M. Davidson, M. Collins, J. Campbell, and B. B. Haag, "Constructivism and computer-mediated communication in distance education," *American Journal of Distance Education*, vol. 9, no. 2, pp. 7-26, 1995.

[22] J. Piaget and B. Inhelder, *The psychology of the child*, vol. 5001. Basic Books, 1969.

[23] L. S. Vygotsky, *Mind in Society*, Harvard University Press, pp. 381-381, 1978.

[24] A. Woolfolk, "Teachers, teaching, and educational psychology," in *Educational Psychology*, Pearson/Allyn & Bacon, pp. 1-19, 2007.

[25] L. Wang, "Sociocultural Learning Theories and Information Literacy Teaching Activities in higher Education," *Reference User Services Quarterly*, vol. 47, no. 2, pp. 149-158, 2007.

[26] A. E. Guskin, "Reducing Student Costs & Enhancing Student Learning Part II: Restructuring the Role of Faculty," *Change*, vol. 26, no. 5, pp. 16-25, 1994.

[27] B. Tangney, A. FitzGibbon, T. Savage, S. Mehan, and B. Holmes, "Communal constructivism: students constructing learning for as well as with others," in *Proceedings of*

Society for Information Technology Teacher Education International Conference 2001, no. 2006-08-06, pp. 1-7, 2001.

[28] S. Kerka, “Constructivism, Workplace Learning, and Vocational Education,” *ERIC Digest*, no. 181, ERIC Clearinghouse on Adult, Career, and Vocational Education, 1997.

[29] K. Kreijns, “Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research,” *Computers in Human Behavior*, vol. 19, no. 3, pp. 335-353, 2003.

[30] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*, vol. 95, no. 2. Cambridge University Press, p. 138, 1991.

[31] E. Wenger, “Communities of practice,” *Communities*, vol. 22, p. 57, 2009.

[32] M. S. Granovetter, “The Strength of Weak Ties,” *American Journal of Sociology*, vol. 78, no. 6, pp. 1360-1380, 1973.

[33] J. W. Collins and N. P. O’Brien, *The Greenwood dictionary of education*. Greenwood, 2011.

[34] G. Stahl, “Group cognition in computer-assisted collaborative learning,” *Journal of Computer Assisted Learning*, vol. 21, no. 2, pp. 79-90, 2005.

[35] H. H. Clark and S. E. Brennan, “Grounding in communication. Perspectives on socially shared cognition,” in *Perspectives on socially shared cognition*, L. B. Resnick, J. M. Levine, and S. D. Teasley, Eds., pp. 127-149, 1991.

[36] L. Alpay, A. Giboin, and R. Dieng, “Accidentology: an example of problem solving by multiple agents with multiple representations,” in *Learning with multiple representations*, Elsevier, pp. 152-174, 1998.

[37] M. Devlin, C. Phillips, and L. Marshall, “Organised Chaos - Learning Outcomes from trialling Active Learning Methods in Computing Science,” in *International Conference in Engineering Education New Challenges in Engineering Education and Research in the 21st Century*, pp. 1-11, 2008.

[38] B. S. Bloom, *Taxonomy of Educational Objectives: The Classification of Educational Goals*, vol. 2, no. 2. Longman Group, 1956.

[39] F. Marton, D. Hounsell, and N. Entwistle, *The Experience of learning*, Scottish Academic Press, pp. 1-12, 1984.

[40] H. Gardner, *The Unschooled Mind: How children think and how schools should teach*, Basic Books, 1991.

[41] M. Prensky, “Listen to the Natives,” *Educational Leadership*, vol. 63, no. 4, pp. 8-13, 2006.

[42] N. Selwyn, “An investigation of differences in undergraduates’ academic use of the internet,” *Active Learning in Higher Education*, vol. 9, no. 1, pp. 11-22, 2008.

[43] J. Palfrey and U. Gasser, *Born Digital: Understanding the First Generation of Digital Natives*, vol. 11, no. 1. Basic Books, p. 375, 2008.

[44] F. Pedro, "New Millennium Learners in Higher Education: Evidence and Policy Implications," in *International conference on 21st century competencies*, pp. 21-23, 2009.

[45] B. Sparrow, J. Liu, and D. M. Wegner, "Google Effects on Memory : Information at Our Fingertips," *Computer*, August, pp. 776-778, 2011.

[46] D. Oblinger, "Boomers, Gen-Xers & Millennials," *Educause Review*, vol. 38, no. 4, pp. 36-45, 2003.

[47] M. Prensky, "How to teach with technology: keeping both teachers and students comfortable in an era of exponential change," *Learning*, vol. 2. BECTA, pp. 40-46, 2007.

[48] N. Jones and U. of Glamorgan, *From here to E-ternity: A learning journey*. *Professorial Inaugural Lecture*, March, University of Glamorgan, 2003.

[49] Z. King, "New or traditional careers? A study of UK graduates' preferences," *Human Resource Management*, vol. 13, no. 1, pp. 5-26, 2003.

[50] D. Kember and D. Leung, "The influence of active learning experiences on the development of graduate capabilities," *Studies in Higher Education*, vol. 30, no. 2, pp. 155-170, 2005.

[51] S. L. Sullivan and F. Wayne, "A Software Project Management Course Role-Play Team-Project Approach Emphasizing Written and Oral Communication," *ACM SIGCSE Bulletin*, vol. 25, no. 1, pp. 283-287, 1993.

[52] A. Pears and M. Daniels, "Developing global teamwork skills: The Runestone project," in *Education Engineering EDUCON 2010 IEEE*, pp. 1051-1056, 2010.

[53] H. Hakimzadeh, R. Adaikkalavan, and R. Batzinger, "Successful implementation of an active learning laboratory in computer science," in *Proceeding of the 39th ACM annual conference on SIGUCCS*, pp. 83-86, 2011.

[54] A. Rovai, "Sense of community, perceived cognitive learning, and persistence in asynchronous learning networks," *The Internet and Higher Education*, vol. 5, no. 4, pp. 319-332, 2002.

[55] T. O'Reilly, "What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software," *Design*, vol. 65, no. 65, pp. 17-37, 2007.

[56] D. Murphy, R. Walker, and G. Webb, "Online learning and teaching with technology: Case studies, experience, and practice," *Studies in Higher Education*, vol. 27, no. 3, pp. 357-358, 2002.

[57] R. Eynon, "The use of the internet in higher education: academics' experiences of using ICTs for teaching and learning," *ASLIB Proceedings*, vol. 57, no. 2, pp. 168-180, 2005.

[58] D. E. Baird and M. Fisher, "Neomillennial User Experience Design Strategies: Utilizing Social Networking Media To Support 'Always on' Learning Styles," *Journal of Educational Technology Systems*, vol. 34, no. 1, pp. 5-32, 2005.

[59] T. Franklin and M. Harmelen, "Web 2.0 for Content for Learning and Teaching in Higher Education," *Teaching in Higher Education*, vol. 2008, May, pp. 1-29, 2007.

[60] A. Meneely and L. Williams, "On preparing students for distributed software development with a synchronous, collaborative development platform," *SIGCSE 09 Proceedings of the 40th ACM technical symposium on Computer science education*, vol. 41, no. 1. ACM, pp. 529–533, 2009.

[61] D. Damian, A. Hadwin, and B. Al-Ani, "Instructional design and assessment strategies for teaching global software development: a framework," *Proceedings of the 28th international conference on Software engineering*, vol. 2006, pp. 685-690, 2006.

[62] D. Petkovic, G. Thompson, and R. Todtenhoefer, "Teaching practical software engineering and global software engineering: evaluation and comparison," in *ITiCSE06 Proceedings of the 11th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education*, vol. 2006, no. 3, pp. 294-298, 2006.

[63] M. Purvis, M. Purvis, and S. Cranefield, "Educational experiences from a Global Software Engineering (GSE) project," *Reproduction*, vol. 30, pp. 269-275, 2004.

[64] C. Deiters, C. Herrmann, R. Hildebrandt, E. Knauss, M. Kuhrmann, A. Rausch, B. Rumpe, K. Schneider, "GloSE-Lab: Teaching Global Software Engineering," in *Proceedings of 6th International Conference on Global Software Engineering ICGSE11*, pp. 156-160, 2011.

[65] A. Nevgi, P. Virtanen, and H. Niemi, "Supporting students to develop collaborative learning skills in technology-based environments," *British Journal of Educational Technology*, vol. 37, no. 6, pp. 937-947, 2006.

[66] R. Sharpe, G. Benfield, G. Roberts, and R. Francis, *The undergraduate experience of blended e-learning: a review of UK literature and practice*, The Higher Education Academy, 2006.

[67] S. Bandinelli, E. Di Nitto, and A. Fuggetta, "Supporting cooperation in the SPADE-1 environment," *IEEE Transactions on Software Engineering*, vol. 22, no. 12, pp. 841-865, 1996.

[68] K. Bielaczyc, "Designing social infrastructure: The challenge of building computer-supported learning communities," in *The Journal of the Learning Sciences*, vol. 15, no. 3, pp. 106–114, 2001.

[69] H. Cho, M. Stefanone, and G. Gay, "Social information sharing in a CSCL community," *Proceedings of the Conference on Computer Support for Collaborative Learning Foundations for a CSCL Community CSCL 02*, vol. 28, no. 7, p. 43, 2002.

[70] K. Kreijns and P. A. Kirschner, "The Sociability of Computer-Supported Collaborative Learning Environments," *Educational Technology & Society*, vol. 5, no. 1, pp. 8-22, 2002.

[71] H. So and T. Brush, “Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors,” *Computers & Education*, vol. 51, no. 1, pp. 318-336, 2008.

[72] C. N. Gunawardena, “Social Presence Theory and Implications for Interaction and Collaborative Learning in Computer Conferences,” *International Journal of Educational Telecommunications*, vol. 1, no. 2/3, pp. 147-166, 1995.

[73] P. T. Northrup, “A framework for designing interactivity into web-based instruction,” *Educational Technology*, vol. 41, no. 2, pp. 31-39, 2001.

[74] G. Corfield, S. Green, and E. Pearson, “Could PLEs be the future, from institutional to student control,” in *Proceedings of 9th Annual Conference of the Subject Centre for Information and Computer Sciences*, pp. 140-146, 2008.

[75] C. Madge, J. Meek, J. Wellens, and T. Hooley, “Facebook, social integration and informal learning at university: ‘It is more for socialising and talking to friends about work than for actually doing work’,” *Learning Media And Technology*, vol. 34, no. 2, pp. 141-155, 2009.

[76] comScore. Press Release: Facebook Ranks as Top Social Networking Site in the Majority of European Countries [Online]. Accessed April 20, 2009. Available: http://www.comscore.com/press/release.asp?press=2774

[77] J. Donath and D. Boyd, “Public Displays of Connection,” *BT Technology Journal*, vol. 22, no. 4, pp. 71-82, 2004.

[78] J. Golbeck, “The Dynamics of Web-based Social Networks: Membership, Relationships, and Change,” *First Monday*, vol. 12, no. 11, pp. 1-18, 2007.

[79] C. Haythornthwaite, “Strong, Weak, and Latent Ties and the Impact of New Media,” *The Information Society*, vol. 18, no. 5, pp. 385-401, 2002.

[80] S. R. Hiltz, *The Virtual Classroom: Learning without Limits via Computer Networks*. Ablex Pub. Corp., 1994.

[81] D. Boyd and N. B. Ellison, “Social Network Sites: Definition, History, Scholarship,” *Journal of Computer-Mediated Communication*, vol. 13, no. 1, pp. 1-19, 2007.

[82] R. Wegerif, “The Social Dimension of Asynchronous Learning Networks,” *Journal of Asynchronous Learning Networks*, vol. 2, no. 1, pp. 34-49, 1998.

[83] A. M. M. Alemán and K. L. Wartman, *Online social networking on campus: Understanding what matters in student culture*. Taylor & Francis, 2009.

[84] N. Selwyn, “Web 2.0 applications as alternative environments for informal learning - a critical review,” *Paper for OCEDKERIS expert meeting Session*, vol. 2007, no. 22, pp. 1-10, 2007.

[85] C. Lampe, N. Ellison, and C. Steinfield, “A familiar face(book): profile elements as signals in an online social network,” in *Technology*, vol. 59, no. 1, pp. 435-444, 2007.

[86] N. B. Ellison, C. Steinfield, and C. Lampe, “The Benefits of Facebook ‘Friends:’ Social Capital and College Students’ Use of Online Social Network Sites,” *Journal of Computer-Mediated Communication*, vol. 12, no. 4, pp. 1143-1168, 2007.

[87] W. Orlikowski, “Learning from notes: Organizational issues in groupware implementation,” *The Information Society*, vol. 9, no. 3, pp. 237-250, 1993.

[88] P. Layzell, O. P. Brereton, and A. French, “Supporting collaboration in distributed software engineering teams,” in *Software Engineering Conference 2000 APSEC 2000 Proceedings Seventh AsiaPacific*, pp. 38-45, 2000.

[89] L. Barkhuus and J. Tashiro, “Student socialization in the age of Facebook,” *Proceedings of the 28th international conference on Human factors in computing systems CHI 10*, vol. 96, no. 2, p. 133, 2010.

[90] L. Johnston and L. Miles, “Assessing contributions to group assignments,” *Assessment & Evaluation in Higher Education*, vol. 29, no. 6, pp. 768, 751, 2004.

[91] C. O’Hanlon, “If you can’t beat 'em, join 'em,” *THE Journal*, vol. 34, no. 8, pp. 39-40, 2007.

[92] J. P. Mazer, R. E. Murphy, and C. J. Simonds, “I’ll See You On ‘Facebook’: The Effects of Computer-Mediated Teacher Self-Disclosure on Student Motivation, Affective Learning, and Classroom Climate,” *Communication Education*, vol. 56, no. 1, pp. 1-17, 2007.

[93] P. Ractham and D. Firpo, “Using Social Networking Technology to Enhance Learning in Higher Education: A Case Study Using Facebook,” *Communities*, pp. 1-10, 2011.

[94] J. DiMicco, D. R. Millen, W. Geyer, C. Dugan, B. Brownholtz, and M. Muller, “Motivations for social networking at work,” *Proceedings of the ACM 2008 conference on Computer supported cooperative work CSCW 08*, no. 3, p. 711, 2008.

[95] N. Ford, M. Bowden, and J. Beard, “Learning together: using social media to foster collaboration in higher education,” in *Cutting Edge Technologies in Higher Education*, vol. 2, Emerald, pp. 105-126, 2010.

[96] J. S. Coleman, “Social Capital in the Creation of Human Capital,” *American Journal of Sociology*, vol. 94, no. 1, p. S95-S120, 1988.

[97] C. Steinfield, J. M. Dimicco, N. B. Ellison, and C. Lampe, “Bowling Online: Social Networking and Social Capital within the Organization,” in *Proceedings of the fourth international conference on Communities and technologies*, pp. 245–254, 2009.

[98] S. Valenzuela, N. Park, and K. F. Kee, “Is There Social Capital in a Social Network Site?: Facebook Use and College Students’ Life Satisfaction, Trust, and Participation,” *Journal of Computer-Mediated Communication*, vol. 14, no. 4, pp. 875-901, 2009.

[99] R. D. Putnam, *Bowling alone: The collapse and revival of American community*. Simon and Schuster, 2001.

[100] N. Lin, "Building a Network Theory of Social Capital," *Connections*, vol. 22, no. 1, pp. 28-51, 1999.

[101] T. Kobayashi, K. Ikeda, and K. Miyata, "Social capital online: Collective use of the Internet and reciprocity as lubricants of democracy," *Information Communication Society*, vol. 9, no. 5, pp. 582-611, 2006.

[102] J. Preece, "Sociability and usability in online communities: determining and measuring success," *Behaviour Information Technology*, vol. 20, no. 5, pp. 347-356, 2001.

[103] K. Kreijns, *Sociable CSCL environments: Social Affordances, Sociability, and Social Presence*, 2004.

[104] K. Kreijns, P. A. Kirschner, W. Jochems, and H. Van Buuren, "Measuring perceived quality of social space in distributed learning groups," *Computers in Human Behavior*, vol. 20, no. 5, pp. 607-632, 2004.

[105] L. Rourke and T. Anderson, "Exploring Social Communication in Computer Conferencing," *Journal Of Interactive Learning Research*, vol. 13, no. 3, pp. 259-275, 2002.

[106] P. R. Lowenthal, "The evolution and influence of social presence theory on online learning," *Online*, no. 303, pp. 1-30, 2010.

[107] J. Short, E. Williams, and B. Christie, *The social psychology of telecommunications*, vol. 7, no. 1. Wiley, p. 32, 1976.

[108] B. Kehrwald, "Understanding social presence in text-based online learning environments," *Distance Education*, vol. 29, no. 1, pp. 89-106, 2008.

[109] C. N. Gunawardena and F. J. Zittle, "Social presence as a predictor of satisfaction within a computer-mediated conferencing environment," *American Journal of Distance Education*, vol. 11, no. 3, pp. 8-26, 1997.

[110] R. E. Rice, "Media Appropriateness: Using Social Presence Theory to Compare Traditional and New Organizational Media," *Human Communication Research*, vol. 19, no. 4, pp. 451-484, 1993.

[111] J. Fulk, J. Schmitz, and C. W. Steinfield, "A social influence model of technology use," in *Organizations and Communication Technology*, J. Fulk and C. Steinfield, Eds. Sage, pp. 117-140, 1990.

[112] L. Rourke, T. Anderson, D. R. Garrison, and W. Archer, "Assessing social presence in asynchronous text-based computer conferencing," *Journal of Distance Education*, vol. 14, no. 2, pp. 50-71, 1999.

[113] C. Tu, "On-line learning migration: from social learning theory to social presence theory in a CMC environment," *Journal of Network and Computer Applications*, vol. 23, no. 1, pp. 27-37, 2000.

[114] C. Gutwin, G. Stark, and S. Greenberg, "Support for workspace awareness in educational groupware," in *The first international conference on Computer support for collaborative learning CSCL 95*, pp. 147-156, 1995.

[115] P. Reyes and P. Tchounikine, "Mining learning groups' activities in forum-type tools," in *CSCL 05 Proceedings of the 2005 conference on Computer support for collaborative learning learning 2005 the next 10 years*, no. 1, pp. 509-513, 2005.

[116] M. Daassi and M. Favier, "An Exploratory Investigation of Group Awareness in Virtual Project Teams," in *EMISA'04*, 2004, pp. 141-150.

[117] J. M. Carroll, D. C. Neale, P. L. Isenhour, M. B. Rosson, and D. S. McCrickard, "Notification and awareness: synchronizing task-oriented collaborative activity," *International Journal of Human-Computer Studies*, vol. 58, no. 5, pp. 605-632, 2003.

[118] K. Kreijns, P. A. Kirschner, W. Jochems, and H. Van Buuren, "Determining sociability, social space, and social presence in (a)synchronous collaborative groups.," *Cyberpsychology and Behavior*, vol. 7, no. 2, pp. 155-172, 2004.

[119] C. Gutwin, R. Penner, and K. Schneider, "Group awareness in distributed software development," *Proceedings of the 2004 ACM conference on Computer supported cooperative work CSCW 04*, pp. 72-81, 2004.

[120] S. Greenberg, C. Gutwin, and A. Cockburn, "Using distortion-oriented displays to support workspace awareness," in *Displays*, no. April, pp. 1-12, 1996.

[121] J. D. Herbsleb and R. E. Grinter, "Architectures, coordination, and distance: Conway's law and beyond," *IEEE Software*, vol. 16, no. 5, pp. 63-70, 1999.

[122] S. R. Hiltz, "Collaborative Learning in Asynchronous Learning Networks: Building Learning Communities," *New Jersey Institute of Technology*, vol. 2002, no. October. New Jersey Institute of Technology, p. 8, 1998.

[123] J. Conway, *Educational Technology's Effect on Models of Instruction*. 1997, pp. 5-11.

[124] S. Brown and P. Race, *Assess your own teaching quality*. Routledge, 1995.

[125] A. H. Miller, B. W. Imrie, and K. Cox, "Student assessment in higher education: a handbook for assessing performance," *Studies in Higher Education*, vol. 24, no. 3. Kogan Page, pp. 390-392, 1998.

[126] R. Breen, R. Lindsay, A. Jenkins, and P. Smith, "The Role of Information and Communication Technologies in a University Learning Environment," *Studies in Higher Education*, vol. 26, no. 1, pp. 95-114, 2001.

[127] S. Bennett, K. Maton, and L. Kervin, "The 'digital natives' debate: A critical review of the evidence," *British Journal of Educational Technology*, vol. 39, no. 5, pp. 775-786, 2008.

[128] N. Marriott, P. Marriott, and N. Selwyn, “Accounting undergraduates’ changing use of ICT and their views on using the internet in higher education,” *Education*, vol. 13, no. December, pp. 117 - 130, 2004.

[129] D. H. Jonassen, *Computers in the classroom: mindtools for critical thinking*. Prentice Hall, 1996.

[130] G. Heiberger and R. Harper, “Have You Facebooked Astin Lately? Using Technology to Increase Student Involvement,” *The New York Times*, vol. 2008, no. 124, pp. 19–35, 2008.

[131] A. Acquisti and R. Gross, “Imagined Communities: Awareness, Information Sharing, and Privacy on the Facebook,” *Privacy Enhancing Technologies*, vol. 4258, pp. 36-58, 2006.

[132] C. Dwyer and S. R. Hiltz, “Trust and Privacy Concern Within Social Networking Sites,” in *Proceedings of the Thirteenth Americas Conference on Information Systems*, vol. 13, 2007.

[133] N. Jones and A. Lau, “E-learning - a change agent for education,” *Research in Higher Education*, vol. 1, no. 1, pp. 40-48, 2009.

[134] H.-T. Hung and S. C.-Y. Yuen, “Educational use of social networking technology in higher education,” *Teaching in Higher Education*, vol. 15, no. 6, pp. 703-714, 2010.

[135] CETL ALiC. Centre for Excellence in Teaching and Learning: Active Learning in Computing [Online]. Available: http://www.dur.ac.uk/alic

[136] Higher Education Funding Council for England (HEFCE) [Online]. Accessed November 2, 2008. Available: http://www.hefce.ac.uk/

[137] B. S. Bell and S. W. J. Kozlowski, “A typology of virtual teams,” *Groups and Organizational Management*, vol. 27, no. 1, pp. 14-49, 2002.

[138] E. Ferguson, C. Kussmaul, D. D. McCracken, and M. A. Robbert, “Offshore outsourcing: current conditions & diagnosis,” *ACM SIGCSE Bulletin*, vol. 36, no. 1, pp. 330-331, 2004.

[139] L. Brodie, H. Zhou, and A. Gibbons, “Steps in developing an advanced software engineering course using problem based learning,” *Engineering Education*, vol. 3, no. 1, pp. 2-12, 2008.

[140] Z. M. Baroudi, “Formative Assessment: Definition, Elements and Role in Instructional Practice,” *Postgraduate Journal of Education Research*, vol. 8, no. 1, pp. 37-48, 2007.

[141] J.-W. Strijbos, R. L. Martens, W. M. G. Jochems, and N. J. Broers, “The effect of functional roles on perceived group efficiency during computer-supported collaborative learning: a matter of triangulation,” *Computers in Human Behavior*, vol. 23, no. 1, pp. 353-380, 2007.

[142] R. M. Belbin, *Team roles at work: A strategy for human resource management*, Oxford: Butterworth--Heinemann, 1993.

[143] M. Devlin, L. Marshall, and C. Phillips, “Active Learning in Computing: Engaging Learners in a Cross-Site Team Project,” *Technical Report Series-University Of Newcastle Upon Tyne Computing Science*, vol. 997, 2007.

[144] L. Johnston and L. Miles, "Assessing contributions to group assignments," *Assessment & Evaluation in Higher Education*, vol. 29, no. 6, pp. 768, 751, 2004.

[145] O.P. Brereton, S. Lees, R. Bedson, C. Boldyreff, D. Drummond, P.J. Layzell, L.A. Macaulay, R. Young, "Student group working across universities: a case study in software engineering," in *Proceedings of 13th Conference on Software Engineering Education & Training*, vol. 43, no. 4, pp. 394-399, 2000.

[146] M. Z. Last, M. Daniels, V. L. Almstrum, C. Erickson, and B. Klein, "An international student/faculty collaboration: the Runestone project," in *ACM SIGCSE Bulletin*, vol. 32, no. 3, pp. 128-131, 2000.

[147] M. Devlin, S. Drummond, C. Phillips, and L. Marshall, "Improving Assessment in Software Engineering Student Team Projects," in *9th Annual Conference of the Subject Centre for Information and Computer Sciences*, p. 133--139, 2008.

[148] M. Devlin, C. Phillips, and L. Marshall, "Assessment in Software Engineering-Towards a new Framework for Group Projects," in *Proceedings of the ICEE & ICEER 2009 Korea International Conference on Engineering Education and Research*, pp. 13-18, 2009.

[149] M. Devlin and C. Phillips, "Assessing competency in undergraduate Software Engineering teams," in *IEEE EDUCON 2010 Conference*, pp. 271-278, 2010.

[150] M. Devlin, S. Drummond, and A. Hatch, "Using collaborative technology in CS education to facilitate cross-site software development," *Journal of Systemics, Cybernetics and Informatics*, vol. 1, 2008.

[151] S. R. Fussell, R. E. Kraut, F. J. Lerch, W. L. Scherlis, M. M. McNally, and J. J. Cadiz, "Coordination, overload and team performance: effects of team communication strategies," in *Proceedings of the 1998 ACM conference on Computer supported cooperative work*, pp. 275–284, 1998.

[152] Access Grid [Online]. Accessed September 20, 2010. Available: http://www.accessgrid.org/

[153] M. Johnson and O. Liber, "The Personal Learning Environment and the human condition: from theory to teaching practice," *Interactive Learning Environments*, vol. 16, no. 1, pp. 3-15, 2008.

[154] B. L. Kirkman, B. Rosen, P. E. Tesluk, and C. B. Gibson, "The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction," *Academy of Management Journal*, vol. 47, no. 2, pp. 175-192, 2004.

[155] T. Postmes, R. Spears, and M. Lea, "Breaching or building social boundaries," *Communication Research*, vol. 25, no. 6, pp. 689-715, 1998.

[156] S. Drummond and M. Devlin, "Software Engineering Students' Cross-site Collaboration: An Experience Report," in *HEA ICS 7th Annual Conference*, 2006.

[157] J. D. Herbsleb, A. Mockus, T. A. Finholt, and R. E. Grinter, “Distance, dependencies, and delay in a global collaboration,” in *Proceedings of the 2000 ACM conference on Computer supported cooperative work*, pp. 319-328, 2000.

[158] Facebook. Press Statistics [Online]. Accessed January 13, 2012. Available: http://www.facebook.com/press/info.php

[159] Social Bakers. UK Facebook Statistics [Online]. Accessed February 13, 2012. Available: http://www.socialbakers.com/facebook-statistics/united-kingdom

[160] A. Keenan and A. Shiri, “Sociability and social interaction on social networking websites,” *Library Review*, vol. 58, no. 6, pp. 438-450, 2009.

[161] L. Grossman, “Why Facebook is the future,” *Time*, pp. 1-2, 2007.

[162] C. Lampe, N. Ellison, and C. Steinfield, “A Face(book) in the Crowd : Social Searching vs Social Browsing,” *Human Factors*, vol. 4, no. 8, pp. 167-170, 2006.

[163] S. Golder, D. M. Wilkinson, and B. A. Huberman, “Rhythms of social interaction: messaging within a massive online network,” *3rd International Conference on Communities and Technologies*, vol. 30, pp. 1-16, 2006.

[164] C. Lampe, N. B. Ellison, and C. Steinfield, “Changes in use and perception of Facebook,” *Proceedings of the ACM 2008 conference on Computer supported cooperative work CSCW 08*, p. 721, 2008.

[165] M. Burke, C. Marlow, and T. Lento, “Feed me: motivating newcomer contribution in social network sites,” in *Proceedings of the 27th international conference on Human factors in computing systems*, pp. 945-954, 2009.

[166] A. N. Joinson, “Looking at, looking up or keeping up with people?: motives and use of Facebook,” in *Proceeding of the twenty sixth annual SIGCHI conference on Human factors in computing systems*, pp. 1027-1036, 2008.

[167] Twitter [Online]. Accessed October 16, 2008. Available: https://twitter.com/

[168] Facebook Developers [Online]. Accessed October 17, 2008. Available: http://developers.facebook.com

[169] D. Boyd and E. Hargittai, “Facebook privacy settings: Who cares?,” *First Monday*, vol. 15, no. 8, pp. 13-20, 2010.

[170] I. Hann, S. Viswanathan, and B. Koh, “The Facebook App Economy,” 2011. [Online]. Accessed November 12, 2011. Available: http://www.rhsmith.umd.edu/digits

[171] A. Hewitt and A. Forte, “Crossing boundaries: Identity management and student/faculty relationships on the Facebook,” *Poster presented at CSCW Banff Alberta*, vol. 1, pp. 1-2, 2006.

[172] J. B. Walther, "Computer mediated communication: Impersonal, interpersonal and hyperpersonal interaction," *Communication Research*, vol. 23, no. 1, pp. 3-43, 1996.

[173] S. Zhao, S. Grasmuck, and J. Martin, "Identity construction on Facebook: Digital empowerment in anchored relationships," *Computers in Human Behavior*, vol. 24, no. 5, pp. 1816-1836, 2008.

[174] R. Kling, "Learning about information technologies and social change: The contribution of social informatics," *The Information Society*, vol. 16, no. 3, pp. 217-232, 2000.

[175] K. Hampton and B. Wellman, "Neighboring in Netville: How the Internet Supports Community and Social Capital in," *City Community*, vol. 2, no. 4, pp. 277–311, 2003.

[176] FriendFeed [Online]. Accessed January 12, 2009. Available: http://friendfeed.com/

[177] Presently/Socialspring [Online]. Accessed January 12, 2009. Available: http://www.socialspring.com

[178] K. J. Burhanna, J. Seeholzer, and J. Salem Jr., "No Natives Here: A Focus Group Study of Student Perceptions of Web 2.0 and the Academic Library," *The Journal of Academic Librarianship*, vol. 35, no. 6, pp. 523-532, 2009.

[179] J. M. Hudson and A. Bruckman, "Go Away": Participant Objections to Being Studied and the Ethics of Chatroom Research," *The Information Society*, vol. 20, no. 2, pp. 127-139, 2004.

[180] B. J. Berg, L. Berquam, J. Berg, and K. Christoph, "Social Networking Technologies: A 'Poke' for Campus Services," *Technology*, vol. 42, no. 2, pp. 32-44, 2007.

[181] Adobe. Flex Software Development Kit [Online]. Accessed October 17, 2008. Available: http://www.adobe.com/products/flex

[182] Adobe. Flash Builder [Online]. Accessed October 17, 2008. Available: http://www.adobe.com/products/flash-builder

[183] Adobe. Flash Player Statistics [Online]. Accessed October 12, 2008. Available: http://www.adobe.com/products/player_census/flashplayer/

[184] The Apache Software Foundation. Apache Tomcat [Online]. Accessed October 14, 2008. Available: http://tomcat.apache.org

[185] The Apache Software Foundation. Apache Derby [Online]. Accessed October 13, 2008. Available: http://db.apache.org/derby/

[186] Adobe Open Source. BlaseDS [Online]. Accessed September 29, 2009. Available: http://labs.adobe.com/technologies/blazeds

[187] R. C. Clark and C. Lyons, *Graphics for learning: Proven guidelines for planning, designing, and evaluating visuals in training materials*. Pfeiffer, 2010.

[188] K. Kreijns, P. A. Kirschner, W. Jochems, and H. Van Buuren, "Measuring perceived sociability of computer-supported collaborative learning environments," *Computers & Education*, vol. 49, no. 2, pp. 176-192, 2007.

[189] K. Kreijns, P. A. Kirschner, W. Jochems, and H. Buuren, "Measuring perceived social presence in distributed learning groups," *Education and Information Technologies*, vol. 16, no. 4, pp. 365-381, 2010.

[190] J. Cohen, *Statistical power analysis for the behavioural sciences*, vol. 2, no. 2. Lawrence Erlbaum Associates, p. 567, 1988.

[191] H. Cho, G. Gay, B. Davidson, and A. Ingraffea, "Social networks, communication styles, and learning performance in a CSCL community," *Computers & Education*, vol. 49, no. 2, pp. 309-329, 2007.

[192] J. Kimmerle and U. Cress, "Group awareness and self-presentation in computer-supported information exchange," *The International Journal of Computer-Supported Collaborative Learning*, vol. 3, no. 1, pp. 85-97, 2007.

[193] D. Fono and R. Baecker, "Structuring and supporting persistent chat conversations," in *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work CSCW 06*, pp. 455-458, 2006.

[194] A. Ribak, M. Jacovi, and V. Soroka, "'Ask before you search': peer support and community building with reachout," in *Proceedings of the 2002 ACM conference on Computer supported cooperative*, pp. 126-135, 2002.

[195] The Apache Software Foundation. Apache HTTP Server Project [Online]. Accessed October 14, 2009. Available: http://httpd.apache.org/

[196] Adobe Open Source. LiveCycle Enterprise Suite [Online]. Accessed October 22, 2009. Available: http://www.adobe.com/products/livecycle/

[197] Adobe. The LCCS Developer Portal [Online]. Accessed October 22, 2009. Available: https://portal.collaboration.adobelivecycle.com/

[198] J. Vassileva, "User Motivation and Persuasion Strategy for Peer-to-Peer Communities," *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, p. 193a-193a, 2005.

[199] T. Erickson, D. N. Smith, W. A. Kellogg, M. Laff, J. T. Richards, and E. Bradner, "Socially Translucent Systems: Social Proxies, Persistent Conversation, and the Design of 'Babble'," in *Design*, May, pp. 72-79, 1999.

[200] Dropbox [Online]. Accessed October 21, 2010. Available: http://www.dropbox.com

Appendix A

A.1 Nomenclature

ALIC	Active Learning in Computing
AMF	Action Message Format; a binary format for passing serialised messages between Flash/Flex applications and a Java-based server's back-end logic
API	Application Programming Interface
CETL	Centre for Excellence in Teaching and Learning
CMC	Computer-Mediated Communication
EULA	End-User Licence Agreement
FBML	Facebook Mark-up Language
Flash/Flex	A multimedia platform capable of supporting rich internet applications (RIAs)
GSD	Global Software Development
GUI	Graphical User Interface
HEFCE	Higher Education Funding Council for England
MXML	Adobe's XML-based GUI markup language
NESS	Newcastle E-Learning Support System; a web-based e-learning environment allowing students to submit project deliverables and receive marks and feedback
RIA	Rich Internet Application
SDK	Software Development Kit
SNS	Social Networking Service
SWF	Shockwave Flash file format; a self-contained binary file which requires the Adobe Flash Player client runtime environment for execution
VLE	Virtual Learning Environment

A.2 CommonGround Usage Statistics (2008/09)

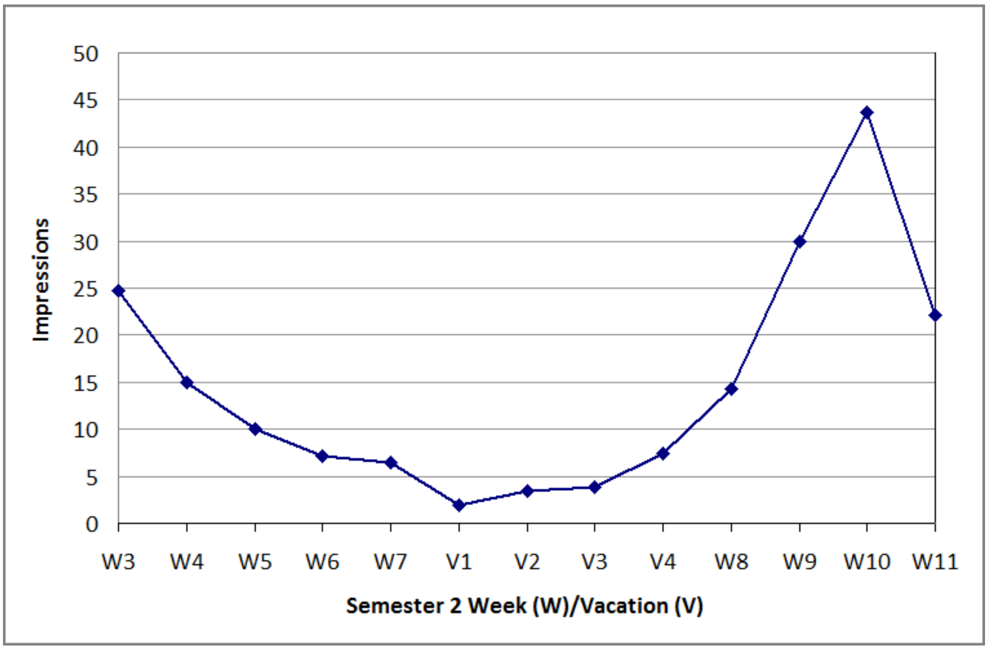

Figure A2.1: CommonGround Activity Events: Impressions (Semester 2, 2008/09)

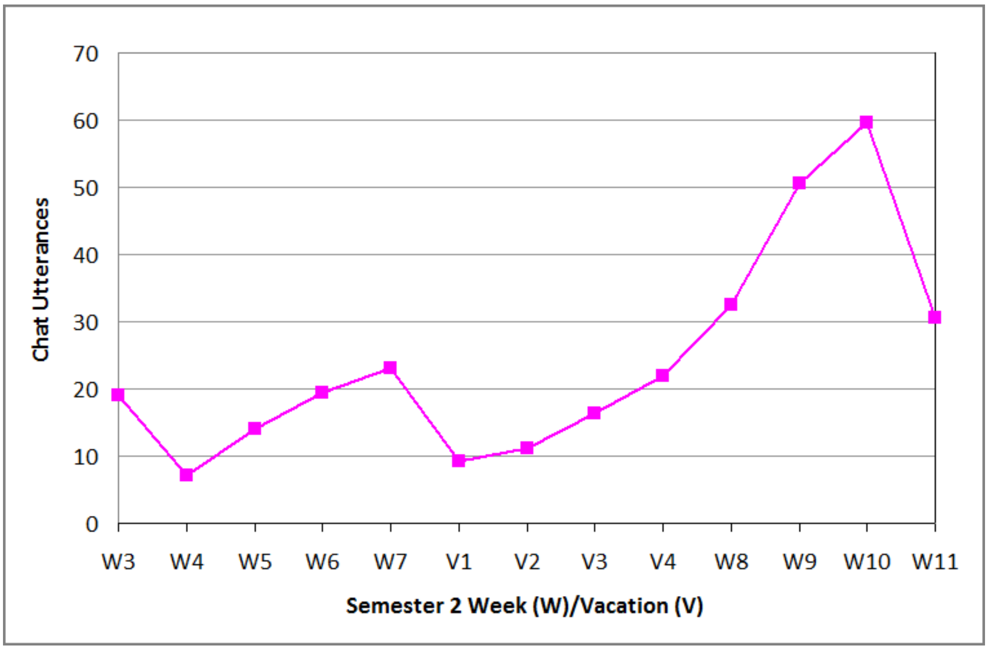

Figure A2.2: CommonGround Activity Events: Chat Utterances (Semester 2, 2008/09)

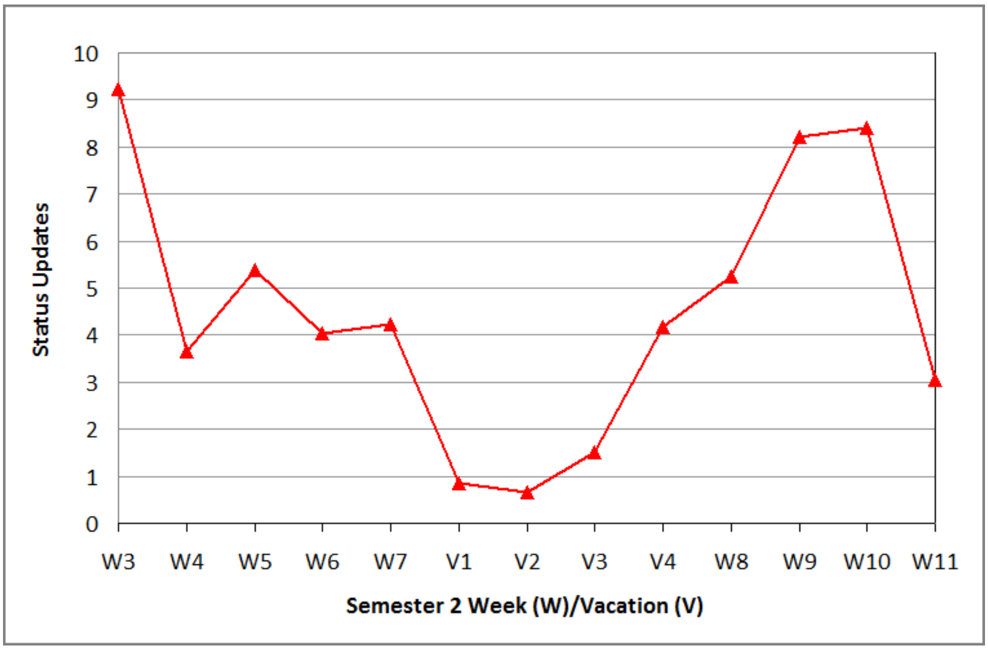

Figure A2.3: CommonGround Activity Events: Status Updates (Semester 2, 2008/09)

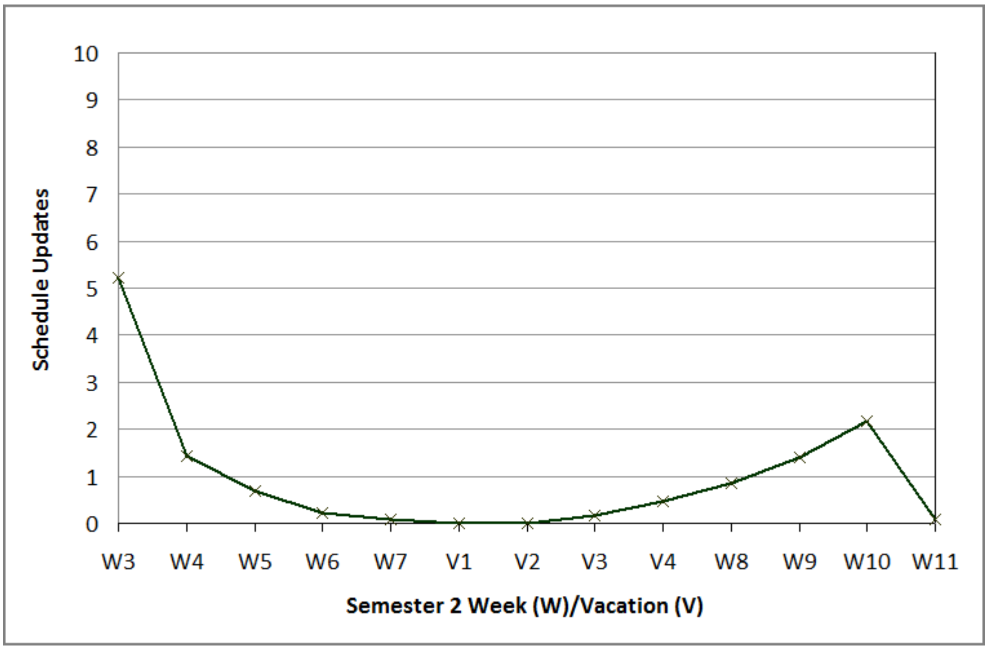

Figure A2.4: CommonGround Activity Events: Schedule Updates (Semester 2, 2008/09)

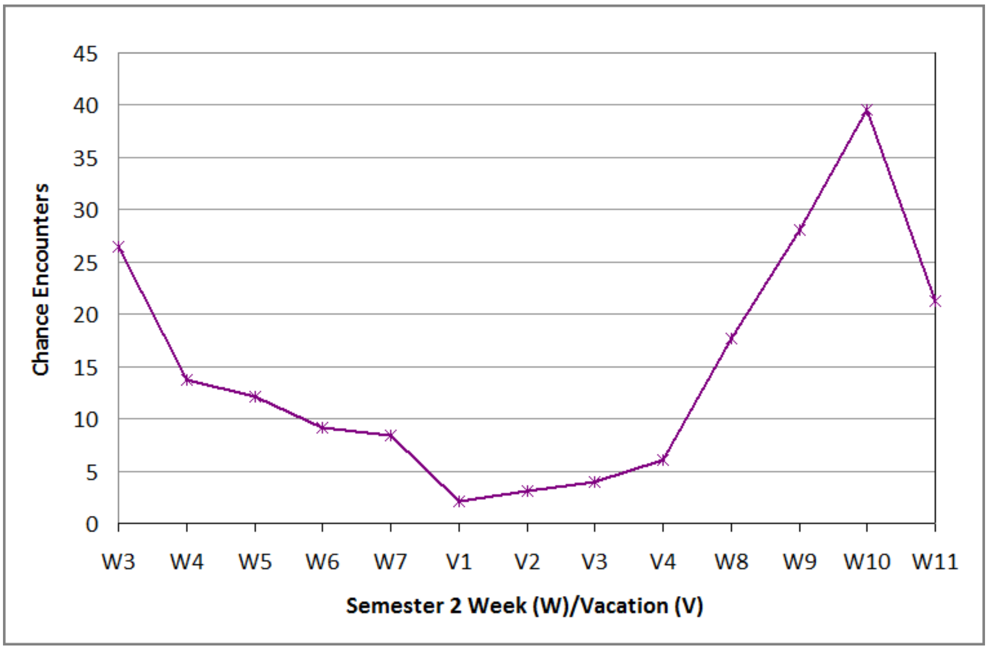

Figure A2.5: CommonGround Activity Events: Chance Encounters (Semester 2, 2008/09)

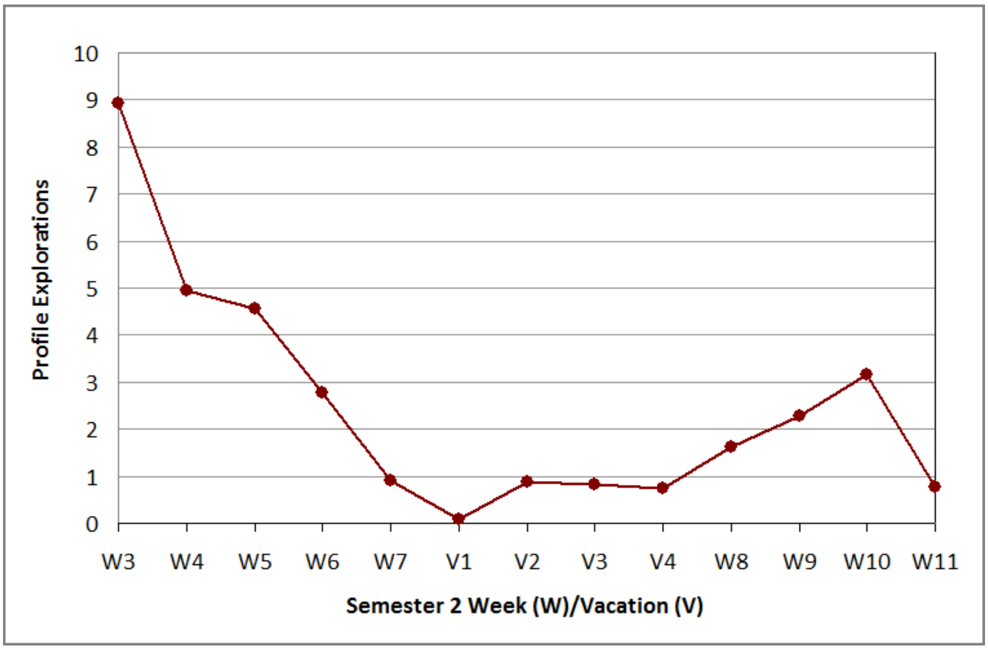

Figure A2.6: CommonGround Activity Events: Profile Explorations (Semester 2, 2008/09)

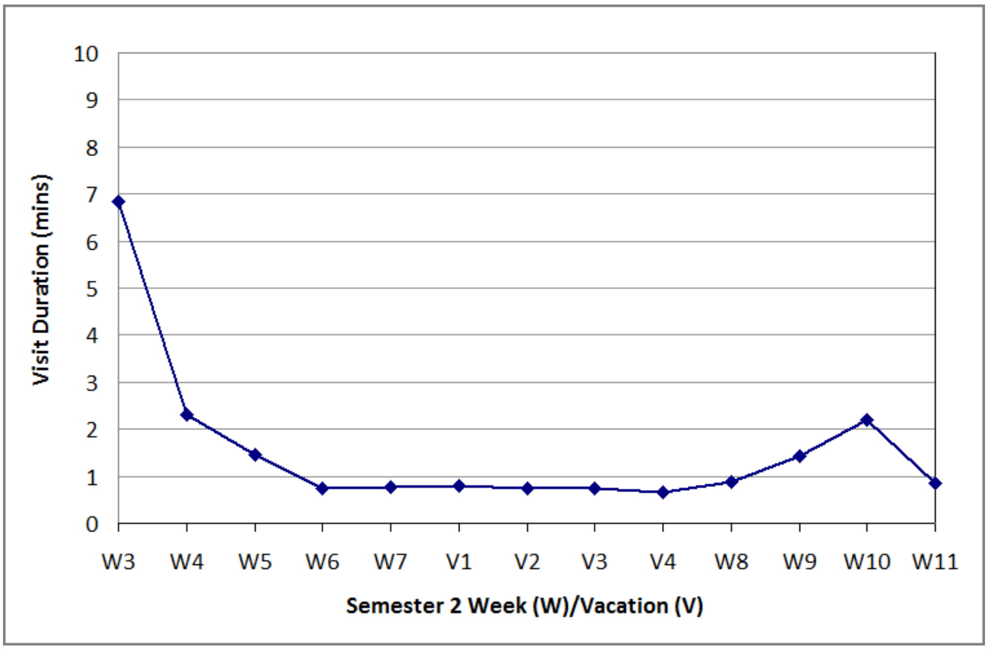

Figure A2.7: CommonGround Activity Events: Visit Duration (Semester 2, 2008/09)

A.3 CommonGround Usage Statistics (2009/10)

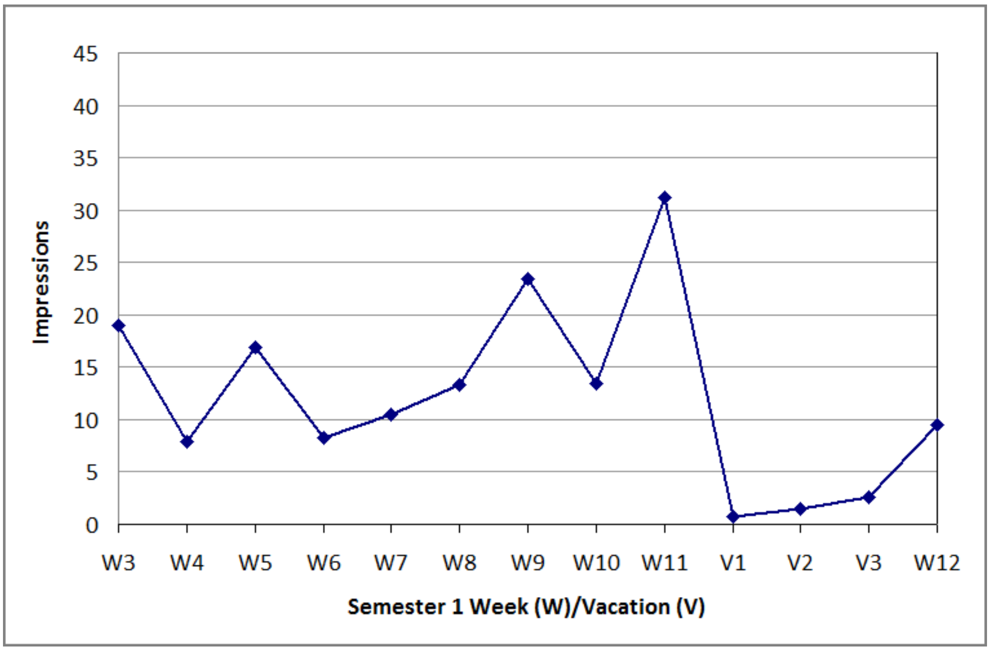

Figure A3.1: CommonGround Activity Events: Impressions (Semester 1, 2009/10)

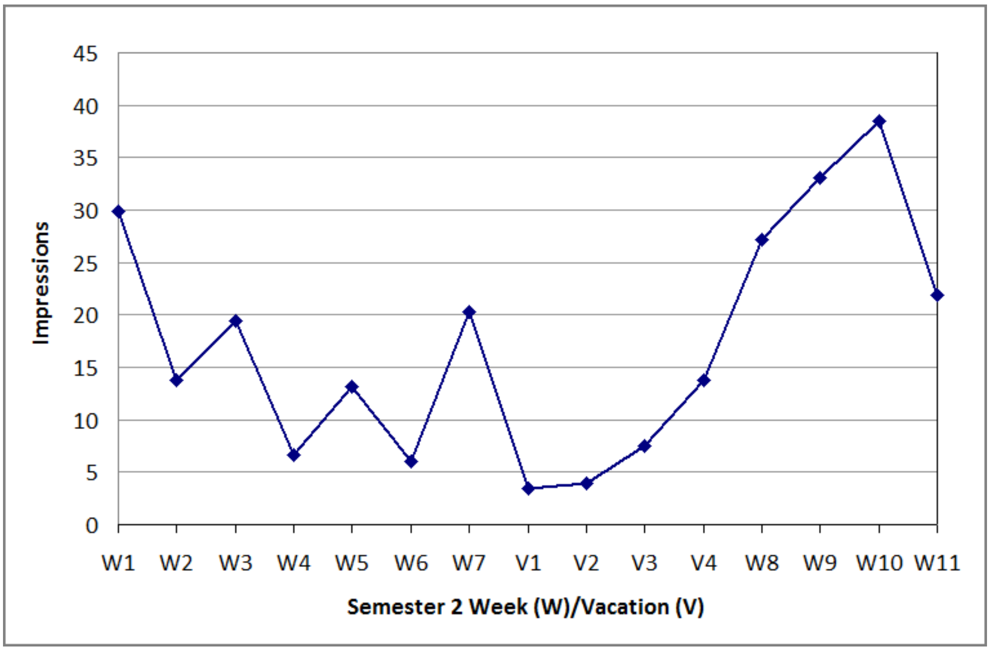

Figure A3.2: CommonGround Activity Events: Impressions (Semester 2, 2009/10)

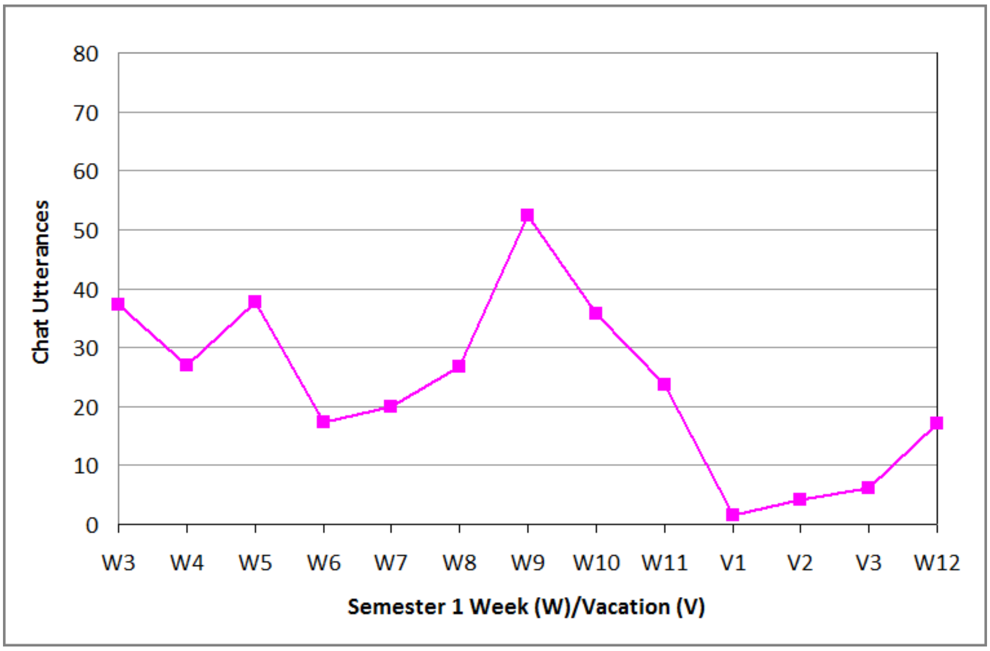

Figure A3.3: CommonGround Activity Events: Chat Utterances (Semester 1, 2009/10)

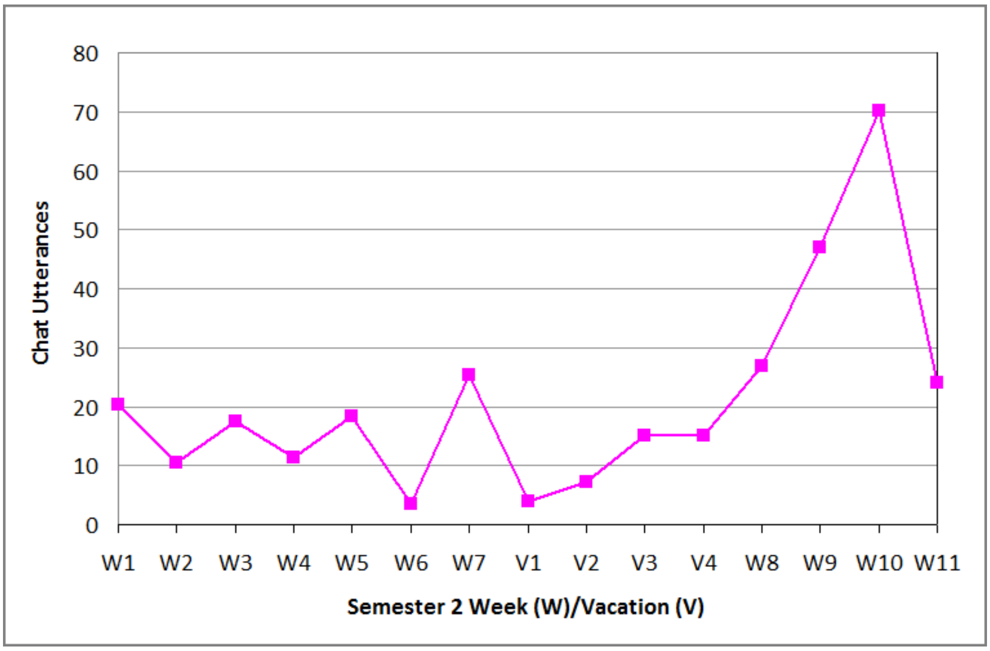

Figure A3.4: CommonGround Activity Events: Chat Utterances (Semester 2, 2009/10)

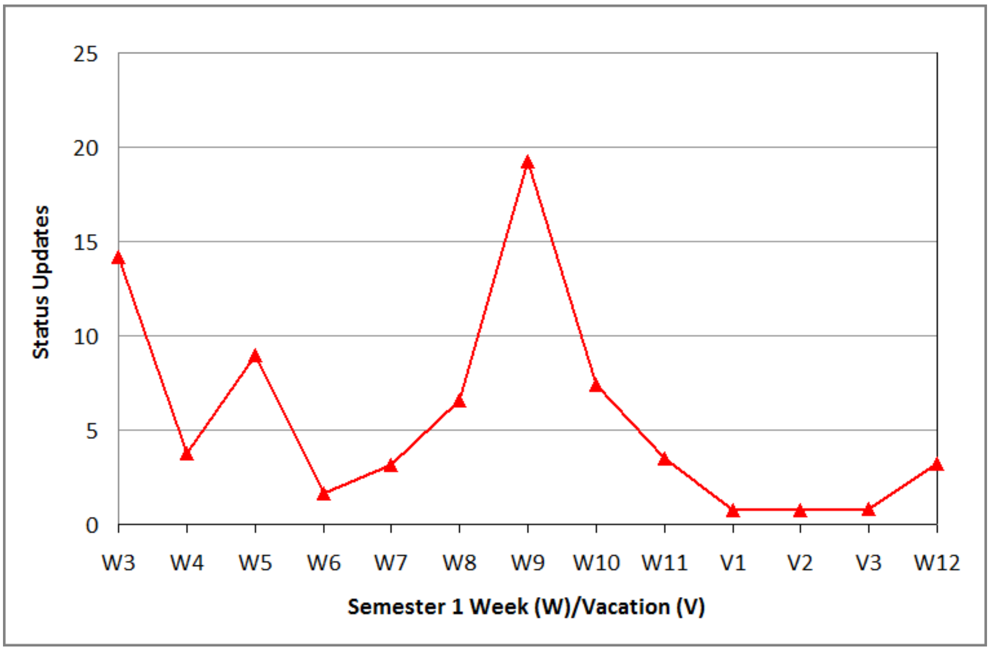

Figure A3.5: CommonGround Activity Events: Status Updates (Semester 1, 2009/10)

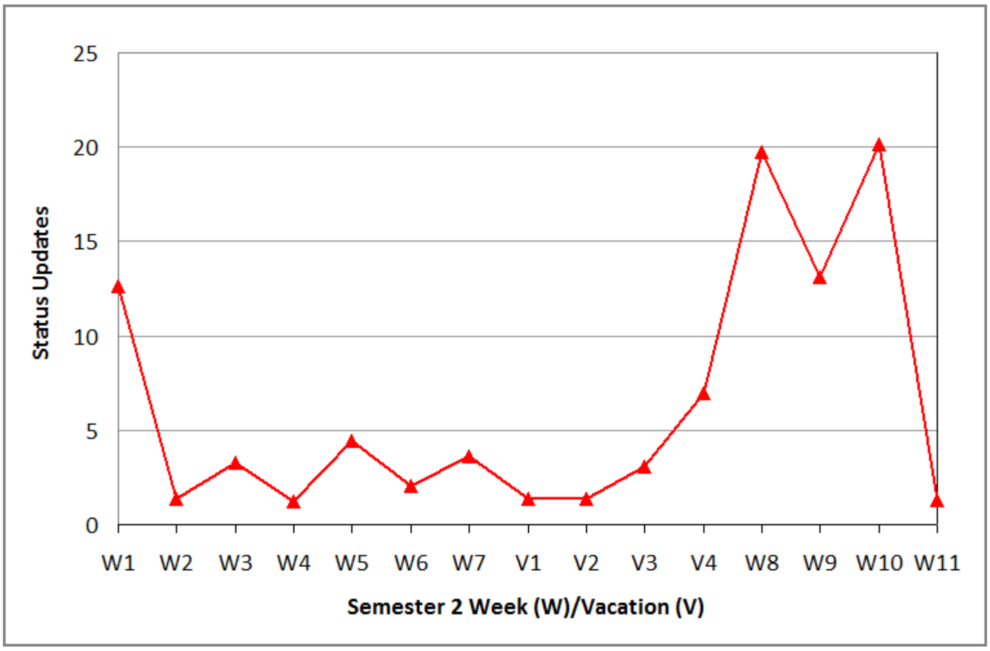

Figure A3.6: CommonGround Activity Events: Status Updates (Semester 2, 2009/10)

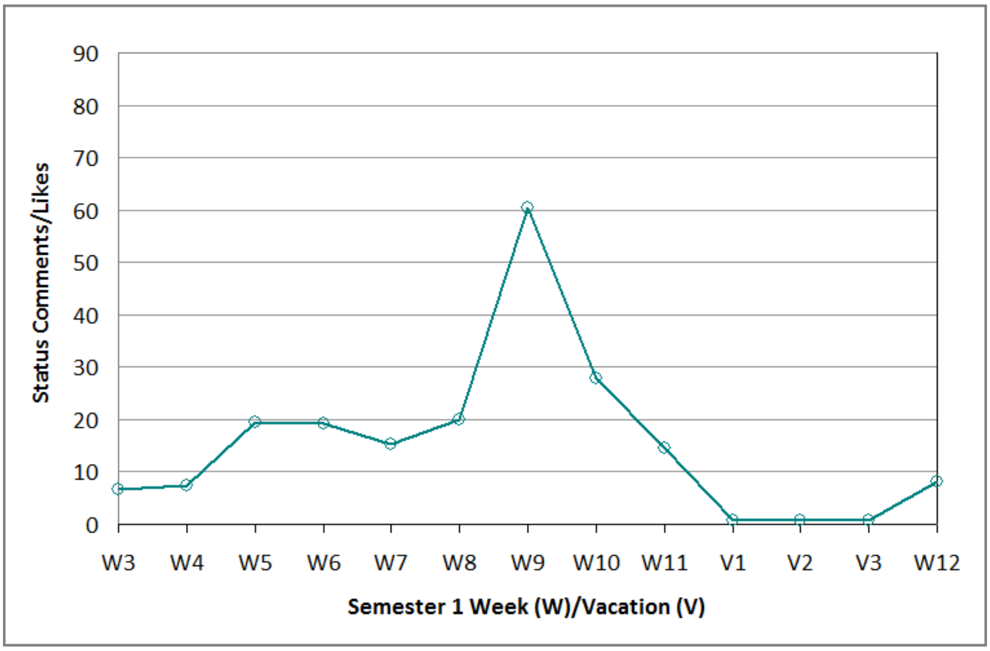

Figure A3.7: CommonGround Activity Events: Status Comments/Likes (Semester 1, 2009/10)

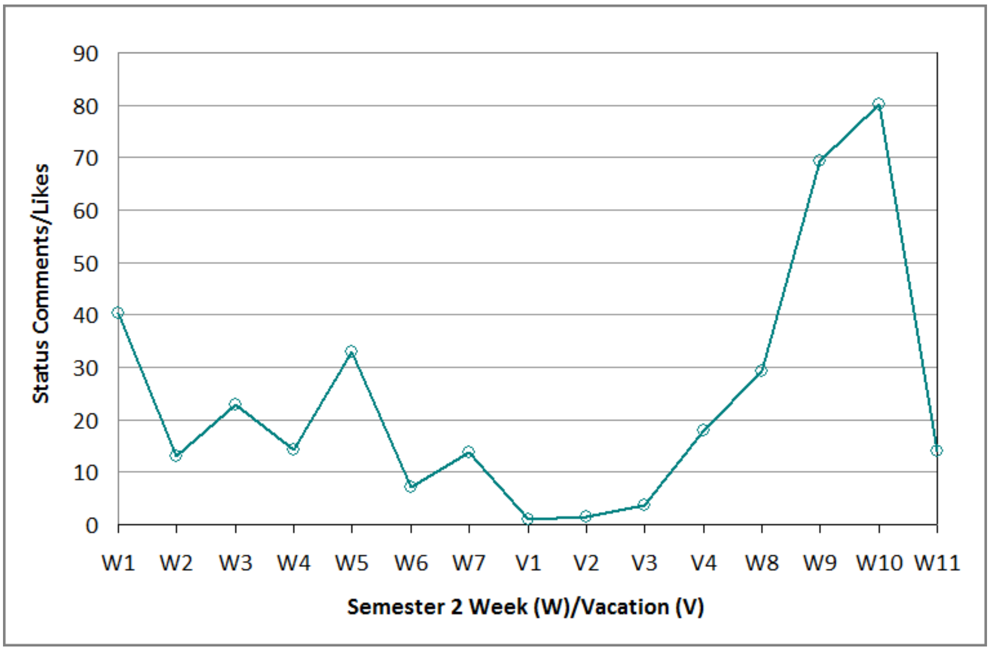

Figure A3.8: CommonGround Activity Events: Status Comments/Likes (Semester 2, 2009/10)

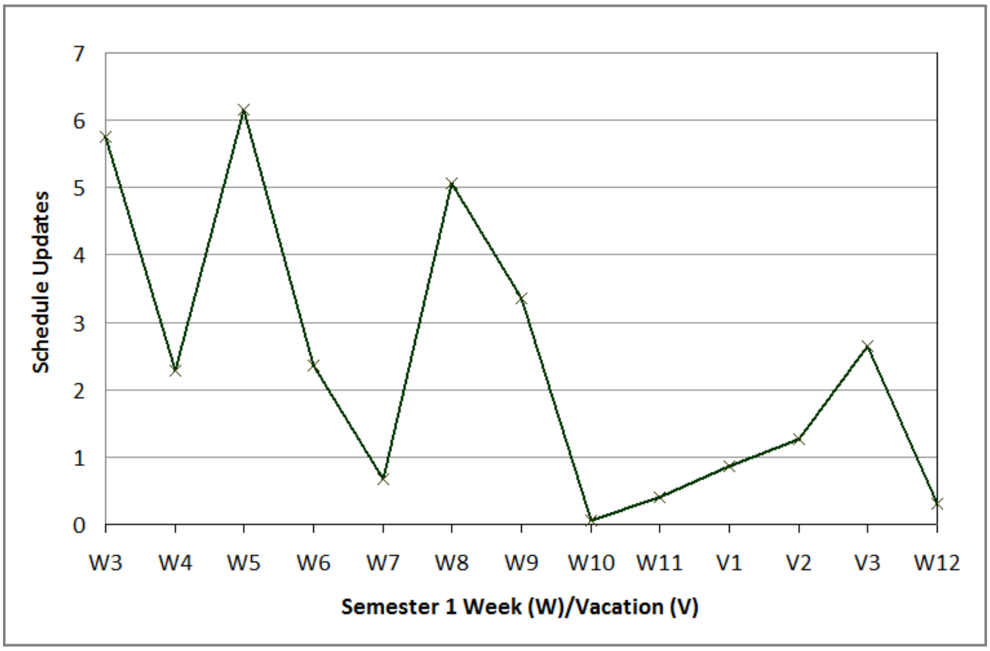

Figure A3.9: CommonGround Activity Events: Schedule Updates (Semester 1, 2009/10)

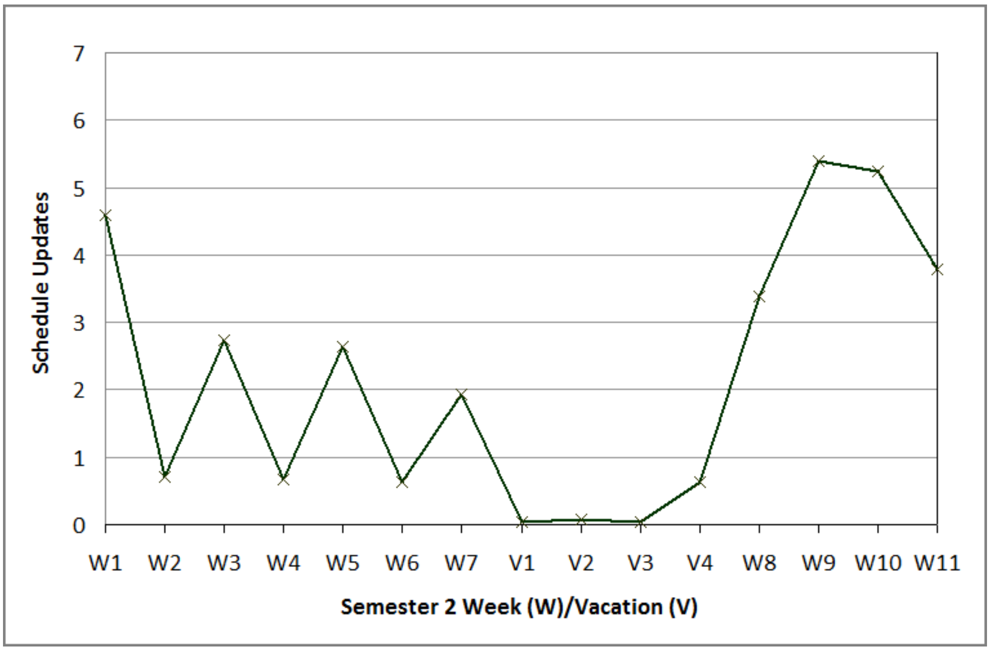

Figure A3.10: CommonGround Activity Events: Schedule Updates (Semester 2, 2009/10)

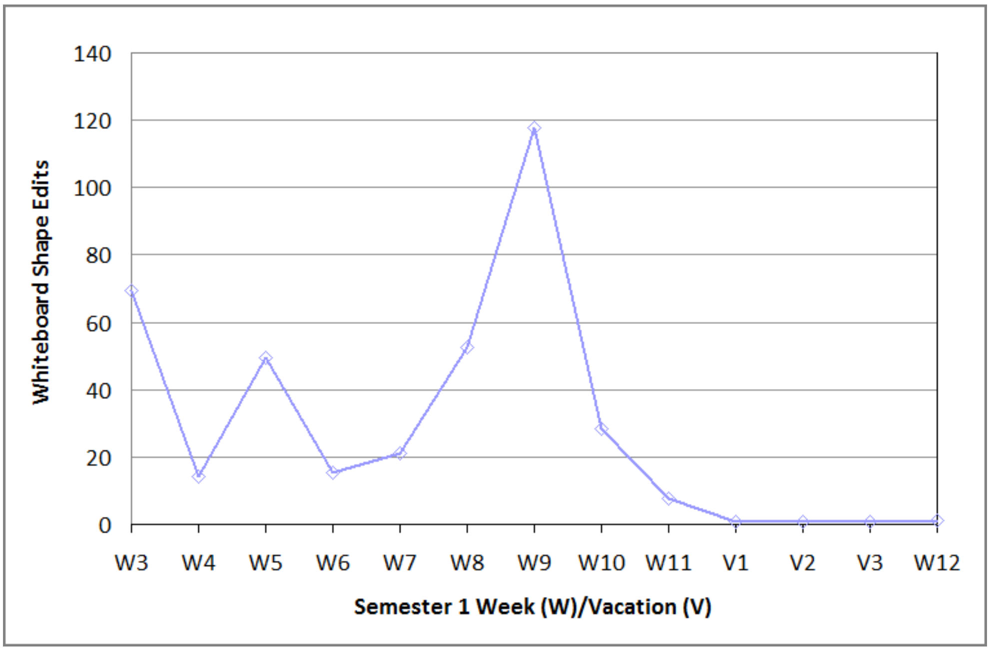

Figure A3.11: CommonGround Activity Events: Whiteboard Edits (Semester 1, 2009/10)

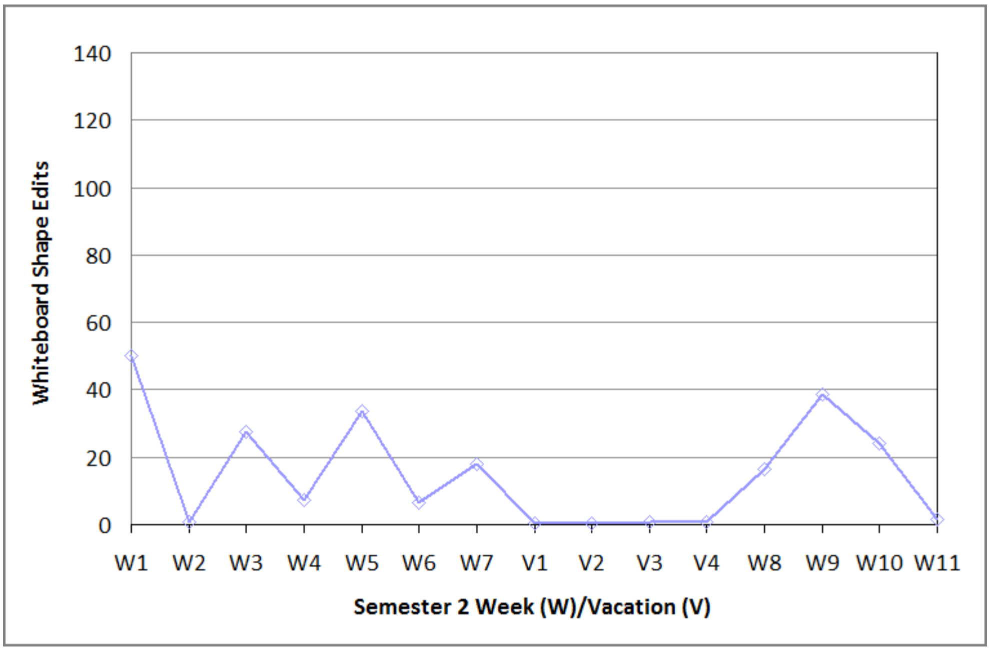

Figure A3.12: CommonGround Activity Events: Whiteboard Edits (Semester 2, 2009/10)

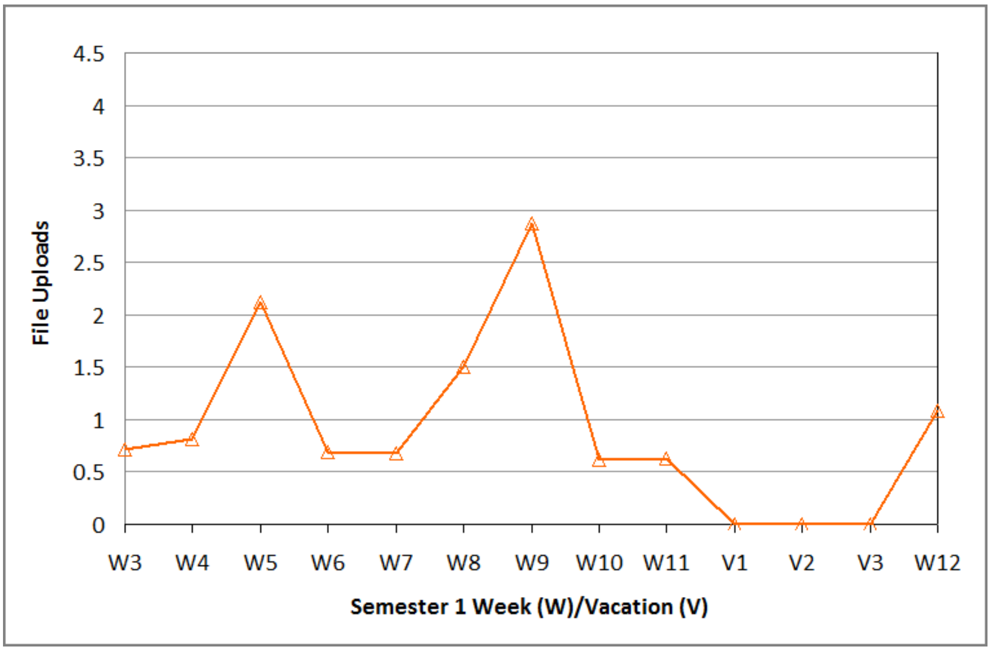

Figure A3.13: CommonGround Activity Events: File Uploads (Semester 1, 2009/10)

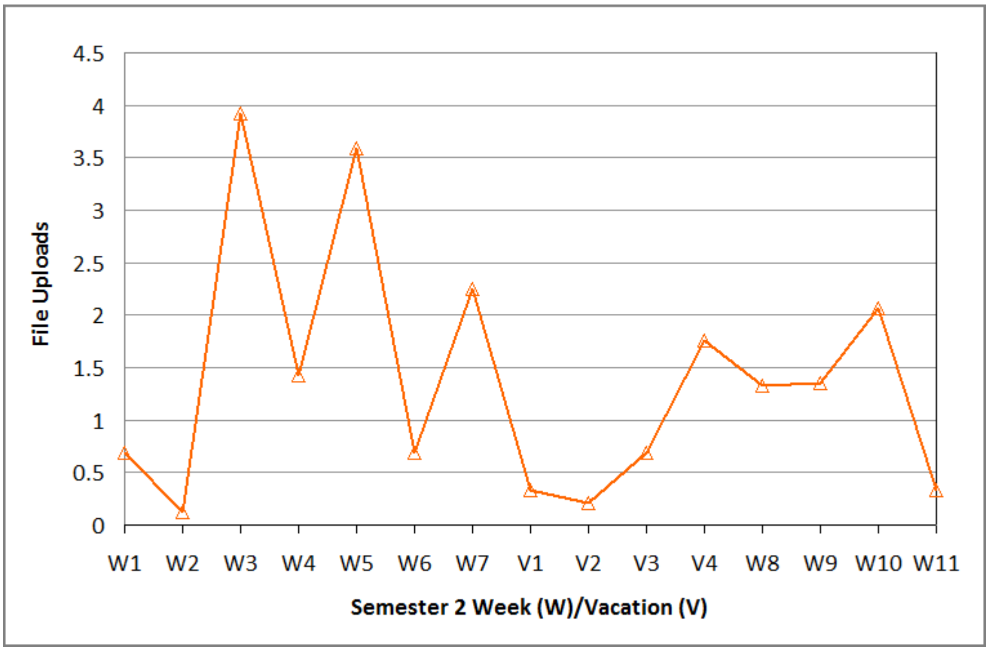

Figure A3.14: CommonGround Activity Events: File Uploads (Semester 2, 2009/10)

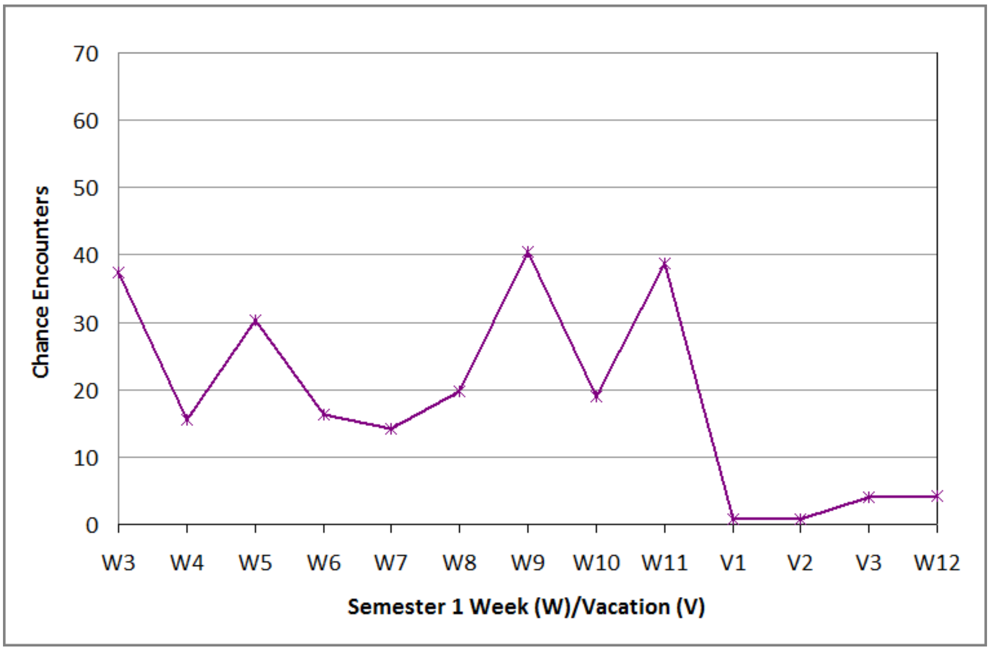

Figure A3.15: CommonGround Activity Events: Chance Encounters (Semester 1, 2009/10)

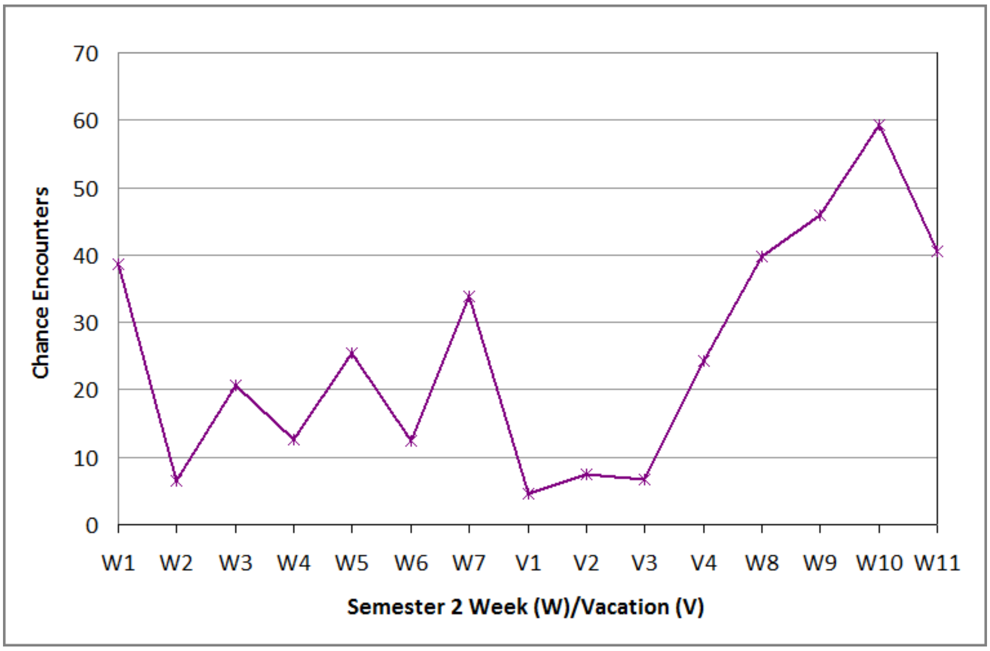

Figure A3.16: CommonGround Activity Events: Chance Encounters (Semester 2, 2009/10)

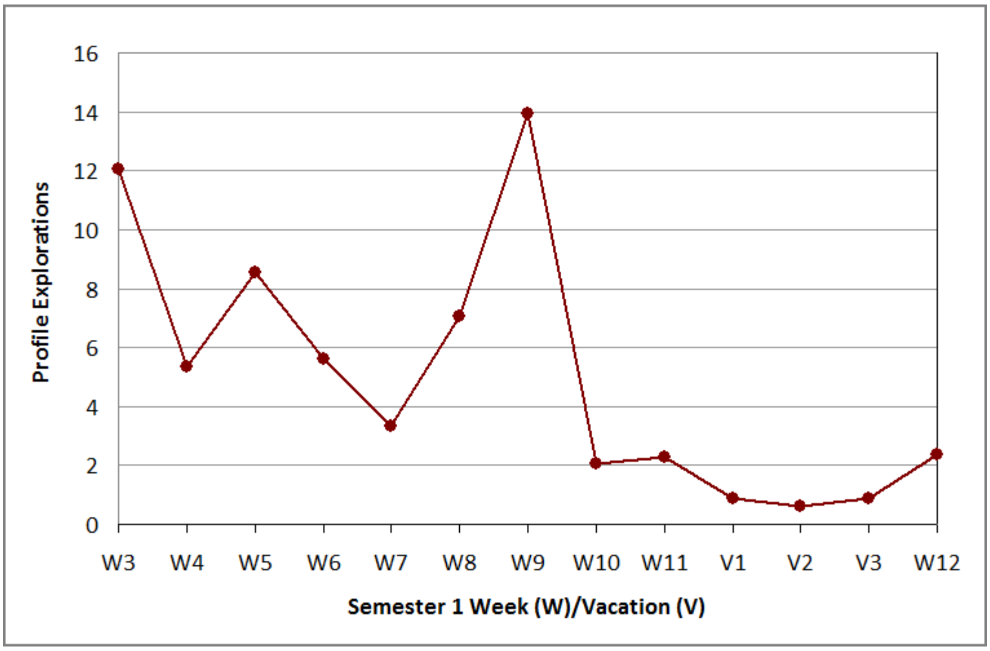

Figure A3.17: CommonGround Activity Events: Profile Explorations (Semester 1, 2009/10)

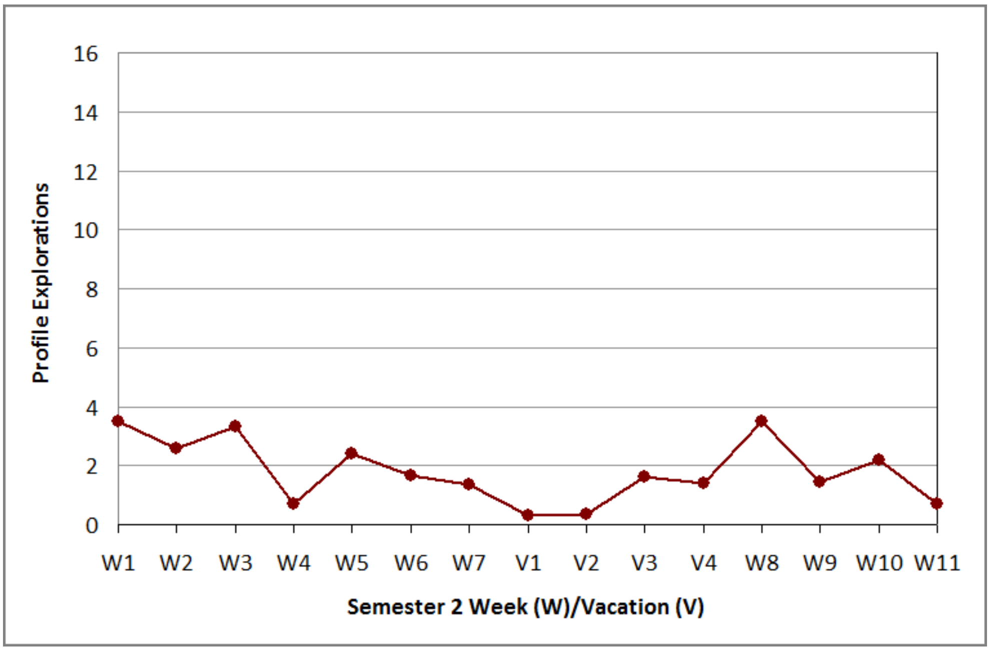

Figure A3.18: CommonGround Activity Events: Profile Explorations (Semester 2, 2009/10)

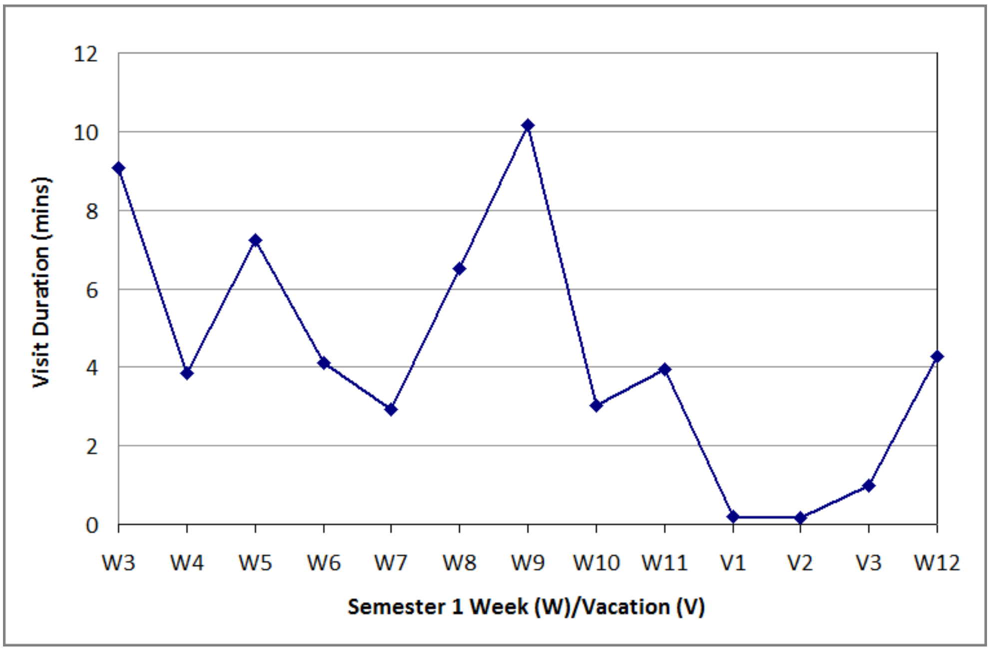

Figure A3.19: CommonGround Activity Events: Visit Duration (Semester 1, 2009/10)

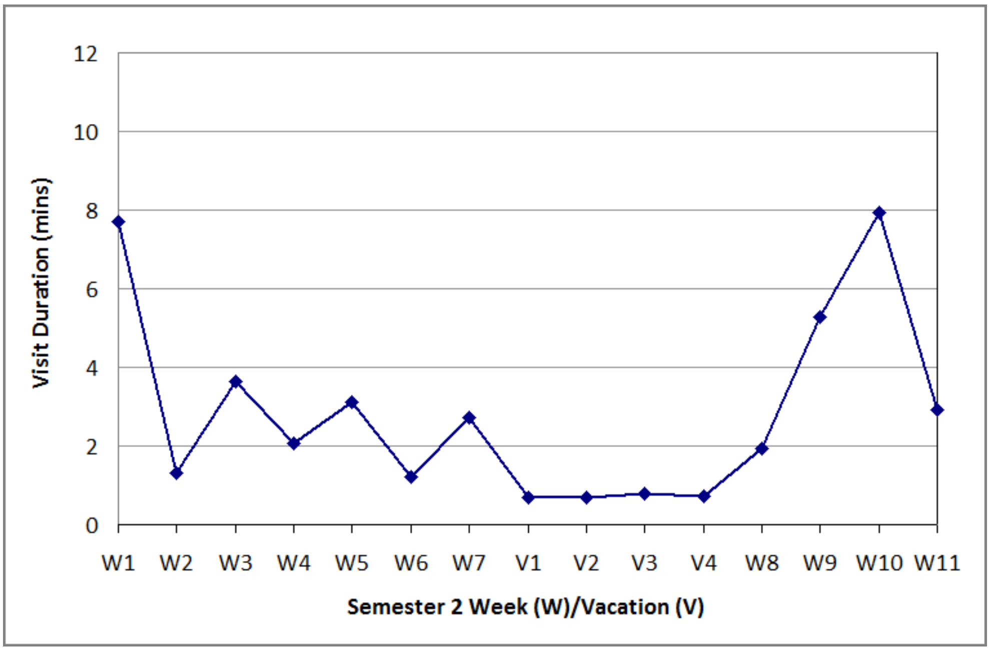

Figure A3.20: CommonGround Activity Events: Visit Duration (Semester 2, 2009/10)

Appendix B

B.1 Survey Questionnaires

For reference, the following closing pages feature a selection of sample questionnaires from the 2008/09 academic year created for and used during this study:

1. Student Technology Survey - 08/09
2. Group Project Survey - 08/09
3. CommonGround Survey - 08/09
4. Teamwork Survey - 08/09

Please return to: **Terry Charlton, Room 818, Daysh Building**

Student Technology Survey - 08/09

Active Learning in Computing CETL @ Newcastle

Revised 14 January 2009

Please take a few minutes to complete this short survey based on your use of computing, mobile and communication technologies. Your responses will be analysed as part of our research into student hardware ownership and social networking participation and will help us to improve the services we offer.

Please note that your participation in this survey is absolutely voluntary. All your responses are anonymous and entirely confidential. No personal information is collected.

ABOUT YOU

1 How old are you? ________________ ☐ Male? ☐ Female?

2 Are you a full-time or part-time student? ☐ Full ☐ Part-time

TECHNOLOGY

3 Do you personally possess any of the following *(please tick all that apply)*

☐ A laptop ☐ A desktop ☐ A games console ☐ Internet access

4 If you regularly carry one or more mobile devices with you, what features do they have?

☐ Telephone/SMS ☐ Music player ☐ Video player ☐ Internet browser

☐ PDA software ☐ Other (please state): ______________________________

5 Do you regularly use a mobile device to do any of the following *(please tick all that apply)*

☐ Make or receive voice calls
☐ Access the internet
☐ Watch video/video podcasts
☐ Send or receive email
☐ Blogging
☐ Send or receive instant messages
☐ Send or receive text messages
☐ Listen to music or audio podcasts
☐ Play games
☐ Post messages to discussion boards
☐ Post updates to Twitter or Facebook
☐ I don't use a mobile device
☐ Other (please state):

6 How many hours would you say you spend on the Internet every day?

☐ Less than 10 minutes
☐ 10–30 minutes
☐ 30–60 minutes
☐ 1–2 hours
☐ 2–4 hours
☐ 5 hours or more

SOCIAL NETWORKING AND SHARING SERVICES

We are interested in the types of social networking and social sharing websites that you use. This helps us to think about the services we can offer you while you study with us.

7 Do you have an account with any of the following social networking services?

❑ Facebook ❑ MySpace ❑ Friends Reunited ❑ Bebo

❑ Friendster ❑ Jaiku ❑ Orkut ❑ Twitter

❑ Others (please state): ______________________________

8 If you do not have an account with any social networking services, why not?

❑ No reason ❑ Don't like them ❑ No home internet ❑ Privacy issues

❑ Other (please state): ______________________________

9 Do you regularly use any of the following services *(please tick all that apply)*

❑ Video sharing (e.g. YouTube, Yahoo Video)
❑ Music sharing/purchasing (e.g. Napster, iTunes)
❑ Photo sharing (e.g. FlickR, Picasa)
❑ Bookmark sharing (e.g. Delicious, Digg)
❑ File sharing (e.g. eMule, BitTorrent)
❑ Blogs, wikis or similar (e.g. Blogger, WordPress)
❑ Gaming communities (e.g. Xbox Live, PlayStation Network)
❑ Discussion boards or forums
❑ Other (please state): ______________________________

10 If applicable, do you use your mobile device(s) to access these services?

❑ Yes ❑ No ❑ Not applicable

11 If applicable, are you concerned about protecting your privacy on these services?

❑ Yes ❑ No ❑ Don't care ❑ Not applicable

12 Would you find it useful for the university to contact you via these services? For example, to remind you about a deadline or to tell you something important.

❑ Yes ❑ No

13 Do you regularly visit any of the following virtual communities *(please tick all that apply)*

❑ Second Life ❑ There.com ❑ Other (please state): ______________

FACEBOOK

Facebook is the most popular social networking website on the Internet, and as such we're interested in how you make use of the service. Please answer the following questions honestly – again, the answers you give are anonymous and will be kept entirely confidential. No personal information is collected.

Note: *If you do not have a Facebook account then you do not need to complete this section.*

14 How often do you access your Facebook account *(please tick only 1)*

- ☐ Once or twice a year
- ☐ Once or twice a month
- ☐ Once or twice a week
- ☐ Once or twice most days
- ☐ Several times a day

15 How long would you say you are connected to the site each visit *(please tick only 1)*

- ☐ 0–2 minutes
- ☐ 2–5 minutes
- ☐ 5–10 minutes
- ☐ 10–30 minutes
- ☐ 30 minutes – 1 hour
- ☐ 1 hour or longer

16 What are the primary reasons that you use Facebook *(please tick all that apply)*

- ☐ To keep in contact with *current* friends and family
- ☐ To find and reconnect with *old* friends and family with whom you've lost touch
- ☐ To find and make *new* friends
- ☐ To organise and participate in events or groups
- ☐ To play games (including recreational applications/quizzes)
- ☐ Other (please state): ____________________

17 How often do you add or update the following information about yourself on Facebook?

	Rarely	*Sometimes*	*Often*
Your status	☐	☐	☐
Your profile	☐	☐	☐
Pictures or videos of yourself or friends	☐	☐	☐
Events you are organising/participating in	☐	☐	☐
Application content (e.g. places you've visited)	☐	☐	☐

18 Have you ever used Facebook to ask a colleague for help, or been part of a group organised to solve a problem?

- ☐ Yes (please describe): ____________________
- ☐ No
- ☐ Don't know

FACEBOOK - continued

19 Which features of Facebook do you engage with most *(please tick all that apply)*

- ☐ Posting status updates or viewing/commenting on others
- ☐ Browsing my friends' profiles and learning more about them
- ☐ Viewing and commenting on my friends' photos and videos
- ☐ Playing games
- ☐ Organising or participating in events
- ☐ Chatting with friends
- ☐ Creating or participating in online groups or discussion boards
- ☐ Browsing and/or purchasing items on the Marketplace
- ☐ Using applications/quizzes
- ☐ Other (please state): ____________________

20 Do you regularly install and/or use applications on Facebook?

☐ Yes ☐ No ☐ Don't know

21 If known, please state which applications you use the most and why. If you do not use any applications, please state why not

22 Approximately how many *friends* do you have on Facebook? ____________

23 How many of your Facebook *friends* would you say…

	All	*A lot*	*Some*	*Few*	*None*
You've never met in real life	☐	☐	☐	☐	☐
Are close friends or family	☐	☐	☐	☐	☐
Are distant friends or family	☐	☐	☐	☐	☐
Are colleagues at work or university	☐	☐	☐	☐	☐
You don't really know at all	☐	☐	☐	☐	☐

24 Would you say that Facebook helps strengthen pre-existing offline relationships with friends, family and colleagues?

☐ Yes ☐ No ☐ Don't know

FACEBOOK - continued

25 For each of the following categories of friends, please indicate which method(s) of communication you use to talk to them on Facebook *(please tick all that apply)*

	Close friends	*Acquaintances*	*Colleagues**
Chat	☐	☐	☐
Messages	☐	☐	☐
Wall-to-wall posts	☐	☐	☐
Status comments	☐	☐	☐
Photo or video comments	☐	☐	☐
Group discussion boards	☐	☐	☐
Applications (please state):	☐	☐	☐
Other (please state):	☐	☐	☐

* A colleague is someone with whom you work, either professionally or academically

26 For each of the following categories of friends, is Facebook your primary means of communication?

	Yes	*No*
Close friends	☐	☐
Acquaintances	☐	☐
Colleagues	☐	☐

27 Is your Facebook profile an accurate representation of you?

☐ Yes ☐ No

28 Is your Facebook profile <u>picture</u> an accurate representation of you?

☐ Yes ☐ No

29 If you have intentionally omitted, restricted, obscured or exaggerated information in your profile, please state why *(tick all that apply)*

☐ To protect my privacy
☐ To pretend to be someone else for fun
☐ To make myself look better to friends
☐ To hide potentially embarrassing information
☐ Other (please state): ______________________________

30 Is your mobile phone registered to send updates and receive notifications from Facebook?

☐ Yes ☐ No ☐ Don't know

Thank you for your participation

Please return to: Terry Charlton, Room 818, Daysh Building

CSC2005 Group Project Survey - 08/09

Active Learning in Computing CETL @ Newcastle

Revised 11 February 2009

Please take a few minutes to complete this short survey based on your experiences so far of the CSC2005 group project. Your responses will be analysed as part of our research into student communications and will help us to improve the module and services that we offer you.

Please note that your participation in this survey is absolutely voluntary. All your responses are anonymous and entirely confidential. No personal information is collected.

ABOUT YOU

1 How old are you? ________________ ☐ Male? ☐ Female?

2 Are you a full-time or part-time student? ☐ Full-time ☐ Part-time

3 Is English your first language? ☐ Yes ☐ No

GROUP STRUCTURE

4 Which company are you a member of? ________________________________

5 Do you believe the structure of your team at Newcastle works well?

☐ Yes ☐ No (why not?): ________________________________

6 What is your current role in the team/company? ________________________

7 Have you stuck to this role throughout? ☐ Yes ☐ No

8 Do you have a clear idea of what your responsibilities are? ☐ Yes ☐ No

9 Do you feel an important part of your team/company? ☐ Yes ☐ No

10 Do you feel part of a "community" with your team mates? ☐ Yes ☐ No

11 Do you find it easier to interact with your local team mates face-to-face or via technology?

☐ Face-to-face ☐ Via technology (e.g. email, text message, forums, Facebook, etc.)

12 So far, do you believe the project's workload has been evenly spread between teams?

☐ Yes ☐ No (why not?): ________________________________

TEAM COMMUNICATION

We are also interested in how you communicate with other members of your team at Newcastle and Durham, and the types of social networking and social sharing websites that you use during the project. This helps us to think about the services that we can offer you while you study with us.

13 **To date, how would you rate your <u>own</u> ability to communicate with your team mates…**

	Terrible	*Fair*	*Good*	*Very good*	*Excellent*
…at Newcastle?	**1**	**2**	**3**	**4**	**5**
…at Durham?	**1**	**2**	**3**	**4**	**5**

14 **If applicable, where do you feel communications are breaking down between team mates…**

…at Newcastle? ______________________________

…at Durham? ______________________________

15 **Which of the following do you use to regularly interact with team mates…**

	…at Newcastle?	*…at Durham?*
Telephone (landline or mobile)	☐	☐
Skype	☐	☐
Email	☐	☐
Text message	☐	☐
Instant messenger (e.g. MSN, Yahoo!)	☐	☐
Social networking sites (e.g. Facebook, MySpace, Bebo)	☐	☐
Micro blogging services (e.g. Twitter)	☐	☐
NESS	☐	☐
Company wiki	☐	☐
Forums or discussion boards	☐	☐
Other, e.g VC suite (please state):	☐	☐

16 **Of the technologies chosen above, which is <u>your</u> primary method of communication…**

…with Newcastle team mates? ______________________________

…with Durham team mates? ______________________________

17 **Of the technologies chosen above, which would you say allows <u>you</u> to collaborate best…**

…with Newcastle team mates? ______________________________

…with Durham team mates? ______________________________

TEAM COMMUNICATION – continued…

18 Do you experience difficulties coordinating meetings with team mates…

…at Newcastle? ☐ Yes ☐ No ☐ Not applicable

…at Durham? ☐ Yes ☐ No ☐ Not applicable

19 How do you keep track of who's doing what work and when…

…at Newcastle? ____________________

…at Durham? ____________________

20 Can you tell at any one time what your team mates are working on…

…at Newcastle? ☐ Yes ☐ No

…at Durham? ☐ Yes ☐ No

21 How do you distribute documents, program code and information to team mates…

…at Newcastle? ____________________

…at Durham? ____________________

22 How do you <u>co-create</u> documents and program code with your team at Newcastle…

____

____

____

23 How do you <u>co-create</u> documents and program code cross-site with the team at Durham…

____

____

____

24 If you were to schedule a last-minute meeting, how would you contact your team mates…

…at Newcastle? ____________________

…at Durham? ____________________

25 To arrange a meeting with the Durham team, would you rather use…

☐ Communications technology, or ☐ Arrange a face-to-face meeting

FACEBOOK

Facebook is the most popular social networking website on the Internet, and as such we're interested in how you make use of the service during the project. Please answer the following questions honestly – again, the answers you give are anonymous and will be kept entirely confidential.

Note: *If you do not have a Facebook account then please got to question 37.*

26 Have you ever used Facebook to communicate with members of your team/company?

☐ Yes ☐ No *(go to question 37)*

27 For each of the following, please indicate which methods of communication you have used to interact with team mates on Facebook…

	…at Newcastle?	*…at Durham?*
Facebook chat	☐	☐
Messages	☐	☐
Wall-to-wall posts	☐	☐
Status comments	☐	☐
Group discussion boards	☐	☐
Photo or video comments	☐	☐
Applications (please state):	☐	☐
Other (please state):	☐	☐

28 How many members of your company are *friends* on Facebook…

…at Newcastle?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
…at Durham?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

29 How many were *friends* on Facebook before the project started…

…at Newcastle?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
…at Durham?	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

30 After the project, do you think you will stay *friends* on Facebook with team mates…

…at Newcastle?	☐ Yes	☐ No	☐ Don't know
…at Durham?	☐ Yes	☐ No	☐ Don't know

31 In general, would you ever refuse/ignore a *friend* request from team mates…

…at Newcastle?	☐ Yes	☐ No	☐ Don't know
…at Durham?	☐ Yes	☐ No	☐ Don't know

FACEBOOK – continued…

32 Would you prefer to keep your team mates and friends/family on separate *friends* lists?

☐ Yes ☐ No ☐ Don't care

33 Have you ever sought to learn more about your team mates via their Facebook profile?

☐ Yes ☐ No ☐ Not applicable

34 Do you use Facebook to chat informally with team mates?

☐ Yes ☐ No

35 Would you say Facebook encourages you and your team to be more open with each other?

☐ Yes ☐ No ☐ Don't know

36 Would you say Facebook helps you to build trust with your team mates?

☐ Yes ☐ No ☐ Don't know

CommonGround

We are creating an application for social networking platforms to help team members communicate better. This application, called Common Ground, will allow you to track what team members are doing, schedule work and events, and enable real-time and asynchronous conversation between members.

37 Would you consider installing and using this application on Facebook (or other similar social networking platform such as MySpace or Bebo)?

☐ Yes ☐ No (why not?): ______________________________

38 Would you be comfortable using Facebook to interact with your team mates?

☐ Yes ☐ No (why not?): ______________________________

39 If the application maintains a "status" for all team members, indicating what they are working on, would you prefer to keep it separate from your main Facebook profile status?

☐ Yes ☐ No ☐ Don't care

40 Would you consider interacting with this application using your mobile phone (e.g. to update your project status, etc)

☐ Yes ☐ No ☐ Don't know

Thank you for your participation!

Please return to: Terry Charlton, Room 818, Daysh Building

CSC2005 CommonGround Survey - 08/09

Active Learning in Computing CETL @ Newcastle

Revised 02 March 2009

Please take a few minutes to complete this short survey based on your experiences so far of the CSC2005 Facebook application CommonGround. Your responses will be analysed as part of our research into student communications and will help us to improve the services that we offer you.

Please note that your participation in this survey is absolutely voluntary. All your responses are entirely confidential and no personal information will be used in our study.

YOU AND FACEBOOK

1 Which company are you a member of? ______________________________

2 Were you happy interacting with your team on Facebook? ☐ Yes ☐ No

3 Did interacting on Facebook help team communications? ☐ Yes ☐ No

4 Did you ever seek to learn more about a team mate via their profile? ☐ Yes ☐ No

COMMONGROUND

We are interested to know how well you feel CommonGround helped you to communicate with your team mates – both local and cross-site – during the CSC2005 group project.

5 On a scale of 1 to 5, please rate the following statements…

	Not at all applicable	*Rarely applicable*	*Moderately applicable*	*Largely applicable*	*Totally applicable*
When I have real-time conversations in *CommonGround*, I have my team mate(s) in my mind's eye.	1	2	3	4	5
When I have asynchronous conversations in *CommonGround*, I have my team mate(s) in my mind's eye.	1	2	3	4	5
When I have real-time conversations in *CommonGround*, I feel that I deal with very real persons and not with abstract anonymous persons.	1	2	3	4	5
When I have asynchronous conversations in *CommonGround*, I feel that I deal with very real persons and not with abstract anonymous persons.	1	2	3	4	5
Real-time conversations in *CommonGround* can hardly be distinguished from face-to-face conversations.	1	2	3	4	5

COMMONGROUND – continued…

6 On a scale of 1 to 5, please rate the following statements…

	Not at all applicable	*Rarely applicable*	*Moderately applicable*	*Largely applicable*	*Totally applicable*
CommonGround enables me to easily contact my team mates.	1	2	3	4	5
I do not feel lonely in the CommonGround environment.	1	2	3	4	5
The CommonGround environment enables me to get a good impression of my team mates.	1	2	3	4	5
The CommonGround environment allows spontaneous informal conversations.	1	2	3	4	5
The CommonGround environment enables us to develop into a well performing team.	1	2	3	4	5
The CommonGround environment enables me to develop good work relationships with my team mates.	1	2	3	4	5
The CommonGround environment enables me to identify myself with the team.	1	2	3	4	5
I feel comfortable with the CommonGround environment.	1	2	3	4	5
The CommonGround environment allows for non-task-related conversations.	1	2	3	4	5
The CommonGround environment enables me to make close friendships with my team mates.	1	2	3	4	5

7 On a scale of 1 to 10, how well do you feel CommonGround allows you to connect and stay in touch with your team mates?

0	1	2	3	4	5	6	7	8	9	10

|← Not at all well *Very well →|*

8 On a scale of 1 to 10, how would you rate the CommonGround user experience? Please feel free to include any specific comments on the reverse of this questionnaire.

0	1	2	3	4	5	6	7	8	9	10

|← Very poor *Very good →|*

Thank you for your participation!

Please return to: Terry Charlton, Room 818, Daysh Building

CSC2005 Teamwork Survey - 08/09

Active Learning in Computing CETL @ Newcastle

Revised 03 March 2009

Please take a few minutes to complete this short survey based on your team work experiences so far during the CSC2005 group project. Your responses will be analysed as part of our research into student communications and will help us to improve the services that we offer you.

Please note that your participation in this survey is absolutely voluntary. All your responses are entirely confidential and no personal information will be used in our study.

ABOUT YOU

1 Which company are you a member of? ______________________________

2 Do you feel an important part of your company? ☐ Yes ☐ No

3 Do you feel part of a "community" with your team mates? ☐ Yes ☐ No

4 Do you find it easier to interact with your team mates: ☐ In person ☐ Via technology

TEAM WORK

We are interested to know how well you feel you and your team mates – both local and cross-site – were able to work together during the CSC2005 group project.

5a On a scale of 1 to 5, please rate the following statements…

		Not at all applicable	*Rarely applicable*	*Moderately applicable*	*Largely applicable*	*Totally applicable*
Company members felt free to criticise the ideas, statements, and/or opinions of others.	*Locally:*	**1**	**2**	**3**	**4**	**5**
	Cross-site:	**1**	**2**	**3**	**4**	**5**
We reached a good understanding on how we had to function as a team.	*Locally:*	**1**	**2**	**3**	**4**	**5**
	Cross-site:	**1**	**2**	**3**	**4**	**5**
Company members ensured that we kept in touch with each other.	*Locally:*	**1**	**2**	**3**	**4**	**5**
	Cross-site:	**1**	**2**	**3**	**4**	**5**
Company members worked hard on the project assignment.	*Locally:*	**1**	**2**	**3**	**4**	**5**
	Cross-site:	**1**	**2**	**3**	**4**	**5**
I maintained contact with all other Company members.	*Locally:*	**1**	**2**	**3**	**4**	**5**
	Cross-site:	**1**	**2**	**3**	**4**	**5**

TEAM WORK – continued…

5b On a scale of 1 to 5, please rate the following statements…

Statement		*Not at all applicable*	*Rarely applicable*	*Moderately applicable*	*Largely applicable*	*Totally applicable*
Company members gave personal information about themselves.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
The company conducted open and lively conversations and/or discussions.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members took the initiative to get in touch with others.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members spontaneously started conversations with others.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members asked others how the work was going.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members felt attacked personally when their ideas/statements/opinions were criticised.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members were suspicious of others.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members grew to dislike others.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
I did the lion's share of the work.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members obstructed the progress of the work.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members were unreasonable.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members disagreed amongst each other.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
The company had conflicts.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members gossiped about each other.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5
Company members did not take others seriously.	*Locally:*	1	2	3	4	5
	Cross-site:	1	2	3	4	5

TEAM AWARENESS

We are interested to know how well you feel you are able to track the actions and work rhythms of your team mates both locally and cross-site. Please answer the following questions honestly – again, the answers you give are anonymous and will be kept entirely confidential.

6 On a scale of 1 to 7, please rate the following statements…

		Strongly disagree	*Disagree*	*Somewhat disagree*	*Neutral*	*Somewhat agree*	*Agree*	*Strongly agree*
I am usually aware of the progress of our project.	*Locally:*	1	2	3	4	5	6	7
	Cross-site:	1	2	3	4	5	6	7
I am usually aware of the activities of my team mates.	*Locally:*	1	2	3	4	5	6	7
	Cross-site:	1	2	3	4	5	6	7
I am usually aware of my team mates' availability.	*Locally:*	1	2	3	4	5	6	7
	Cross-site:	1	2	3	4	5	6	7
I am usually aware of how willing my team mates are to communicate.	*Locally:*	1	2	3	4	5	6	7
	Cross-site:	1	2	3	4	5	6	7
I am usually informed of what occurs in our company or shared workspace.	*Locally:*	1	2	3	4	5	6	7
	Cross-site:	1	2	3	4	5	6	7

7 What problems have you encountered interacting with your local team mates…

8 What problems have you encountered interacting with your cross-site team mates…

Thank you for your participation!