Encouraging Interaction and Status Awareness in Undergraduate Software Engineering Projects

The Role of Social Networking Services

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Abstract— **As part of the CETL ALiC initiative (Centre of Excellence in Teaching and Learning: Active Learning in Computing), undergraduate computing science students at Newcastle and Durham universities participate in a year long, inter-institutional group programming assignment. Teams of students act as "virtual companies" and collaborate cross-site to develop software products for real-world industrial clients. This paper investigates the emergence and autonomous adoption of social networking technologies in our students' communication strategies during the project, and explores the role that "status awareness" (knowledge of the current activities of one's team mates) had on the outcome of that collaboration. We also present and discuss the findings of a recent trial of CommonGround, an application created to harness our students' pre-existing engagement with social networking technologies such as Facebook.**

Keywords: computer science education; social factors; facebook; collaborative work; professional communication; programming; technology

I. INTRODUCTION

Active Learning in Computing is the first Centre for Excellence in Teaching and Learning (CETL) for Computing Science in England [1]. The five year initiative is funded by the Higher Education Funding Council for England (HEFCE) and is a collaborative effort between a consortium of North East UK universities: Durham University (who lead the project), Newcastle University, Leeds Metropolitan University, and the University of Leeds. Running since 2005, the CETL aims to better prepare students for the realities of working in their chosen professions by aligning their learning experiences with those sought by today's software engineering industry [2, 3]. In particular, it addresses the distributed working practices of many professional software development companies and, in turn, our need as educators to equip students with the skills required to work in this competitive environment.

As part of this project, we have extended the traditional undergraduate Software Engineering curriculum taught at both Newcastle and Durham universities to include a year long, inter-institutional team programming exercise, in emulation of modern industrial practice. Teams of students act as "virtual companies" and collaborate cross-site to develop software products for real-world corporate clients (projects differ from year to year; examples include a supply chain logistics program and a mobile GPS graphing application [4]). From a pedagogical perspective, this approach places a far greater emphasis on group collaboration and professional skill development than is usually adopted by university computing departments [5], despite research that indicates a number of significant educational benefits [6]. It also encourages greater engagement with the discipline, increases technical and transferable skill sets, and ultimately provides students with a genuine insight into the challenges faced by companies competing in a global market.

In this paper, we provide an overview of the computer-mediated communication (CMC) technologies selected by students for use on-project, and the resultant issues encountered. In particular, we discuss the adoption of the social networking site Facebook as part of our students' local and cross-site group collaboration strategies, and report on a pilot study of *CommonGround*, a Web 2.0 application developed by us to harness and monitor this engagement.

II. TEAM INFRASTRUCTURE

In the four years since 2005 that the group programming assignment has taken place, 556 level 2 students have participated. These students are 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 exercise, a number of "companies" are formed, each comprising a team from Newcastle and Durham (containing on average between 6-8 and 4-6 students respectively). Membership of each team is chosen based on performance and achievement in programming classes during level 1. This is to ensure a fair distribution of programming skills throughout the teams and to give all students an equal chance of delivering a satisfactory end product.

The cross-site teams then have one full academic year to complete the project and are given a set of deadlines spanning two semesters for their major deliverables. Each team must define their own organisational structures and software design methodologies, and project-manage all stages of the development process (from encapsulating requirements

through to the implementation, integration and testing of their final systems). Assessment, including the students' ability to work well as a team, takes place in a number of different ways, including group presentations, documentation delivery, live demonstrations, the completion of individual reflective reports, and observations during meetings (by members of staff who act as team-monitors).

The activity has, on the whole, been very well received by students, as the following excerpt from a team's end-of-project report demonstrates:

> *"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 gained some great life experiences in team working and project management which we will carry with us into any future work."*

However, despite several iterations of this cross-site collaboration, we still find that encouraging and supporting communication between students is one of the most challenging aspects of our work.

III. Communication Strategies

In the early stages of the project, to stimulate and support team collaboration, we provided students with a number of CMC technologies. These tools, representative of the techniques used in industry, ranged from fully equipped Skype-enabled video-conferencing suites to virtual learning environments, file repositories, forums and wikis. However, student feedback (gathered from questionnaires, end-of-project reports and focus groups) indicated substantial resistance to the use of these facilities, attributable mainly to the sheer variety of technologies on offer (see [7] for a full discussion). In particular, students were unaware of the relative benefits of each technology and unfamiliar with their use; as a result they tried to use them all rather than commit to any specific subset.

Feedback also showed that students found it particularly difficult to determine, even after face-to-face discussions, what their teammates were working on at any one time (see Table I). This was particularly evident cross-site, where less than a quarter of students surveyed were able to keep track of the activities of teammates. Almost inevitably, this would lead to duplication of work and increased frustration within the teams.

TABLE I. Student Status Awareness, 2008-2009

Can you tell at any one time what your teammates are working on?				
	Newcastle Uni. (N=61)		***Durham Uni. (N=22)***	
	Locally	*Cross-site*	*Locally*	*Cross-site*
Yes	41	13	16	5
No	20	48	6	17

Paradoxically, despite representing the CMC tool of choice for students, email frequently exacerbated team communication problems; it presented the longest delay in average response times. Furthermore, reports from team monitors suggest 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.

To better highlight these issues, we 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."*

Although the CMC technologies provided by us did play a role in supporting our students' collaborative efforts, when the facilities consistently failed to meet expectations, teams ultimately abandoned them in favour of more convenient, proven technologies. The social networking site Facebook is perhaps the best example of this; it was not introduced into the project by us, but was autonomously adopted by the students themselves.

IV. Creating a Common Ground

A. Social Networking

Social networking sites such as Facebook, Bebo, MySpace and LinkedIn have experienced unprecedented growth in popularity and membership in recent years [8]. Fuelled by considerable media attention, this proliferation has exposed the latent sociability of the internet – people are now accustomed to thinking of the online world as an interactive, social space [9]. Of course, social interaction and community organisation on the web is nothing new [10], but the scale at which people are adopting and actively using the technology is; today, mainstream social networking sites arguably represent one of the most important CMC mediums 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 online communities, but offer myriad variations around that shared theme. Facebook, for instance, connects people from similar educational backgrounds, MySpace connects people with similar social pursuits, and LinkedIn connects people with similar business and employment interests. Following this trend, other mainstream online services such as YouTube and Flickr (collectively referred to as social *media* sites) have also started offering integrated social networking facilities to enhance their core functionalities.

For illustrative purposes, we include in Table II questionnaire results from our investigation into student uses of CMC technologies during the 2008/2009 academic year (at the end of semester 1). 12 companies participated in the survey, represented by 61 students from Newcastle University and 22 from Durham. As can be seen, Facebook was used locally by over 70% of the students surveyed, and over 40% cross-site.

TABLE II. STUDENT CMC TECHNOLOGY USE, 2008-2009

Which forms of CMC do you use to interact with teammates?				
	Newcastle Uni. (N=61)		***Durham Uni. (N=22)***	
	Locally	*Cross-site*	*Locally*	*Cross-site*
Mobile Phone	44	18	14	17
Skype	13	41	18	33
Email	59	52	20	22
Mobile Text	53	14	9	17
Instant Message	39	19	10	13
Facebook	39	27	8	18
NESS[a]	17	2	0	1
Wiki	29	24	5	7
Forum	10	11	2	4
Other	2	2	2	2

a. NESS is a web-based Virtual Learning Environment developed by Newcastle University

B. Facebook

Launched in 2004, the Facebook website is based on the concept of a US-style "year book", where members create publicly-viewable, self-descriptive profiles to describe themselves and their interests [11] (accompanied by a representative, and often flattering, headshot photograph). Members are then invited to articulate their social graph by connecting to other profiles, or 'friends', and in doing so build networks of affiliations based around common interests or shared circumstances (e.g. home town, place of work, political views, recreational interests, etc.). Mutual friends (i.e. connections that have been approved by both parties) are thus able to view one another's profile information, share photos, songs, videos, discussions, and "most other forms of expression" [12]. This process of co-constructing social networks of connections on Facebook, informally referred to as "friending", represents an integral piece of an individual's online self-presentation [9].

Unique to Facebook, 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 [13]. As reasoned by Grossman [14], "identity is not a performance or a toy on Facebook; it is a fixed and orderly fact." Significantly, the ease by which this information can be accessed greatly lowers the transaction costs associated with social searching; that is, finding and connecting to one's known acquaintances [15]. Again, this act of mirroring one's offline relationships online is peculiar to the Facebook community, contradicting the longstanding assumption that CMC relationships predominantly move in an online to offline direction [16].

C. Social Capital

For many of our 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 [17] (i.e. the resources accumulated through relationships with other people). As supporting research into the use of social networking sites in academic and professional contexts shows, Facebook can help crystallise relationships that might otherwise remain temporary or ephemeral [17]. In the business world, particularly where graduate employees are concerned, these informal connections have been shown to return strong payoffs in terms of social support and access to expertise and organisational knowledge [15, 17]. Indeed, these networks of professional affiliations allow individuals to better maintain and strengthen relationships with colleagues [18], and can often facilitate *on-task* interaction (as many productive discussions in team-working environments occur during chance, informal encounters [19]).

Perhaps more importantly, Facebook also encourages inclusion and participation from students with low self-esteem, who present difficulties forming and maintaining offline relationships with their colleagues [17]. The value of social interaction cannot be underestimated when trying to build trust and empathy between distributed team members [20]. Furthermore, as shown by Selwyn [21], 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.

D. CommonGround

Of particular significance to this study, 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 affordances. To exploit these features and further enhance the user experience, Facebook opened its platform to software developers in 2007. This allowed third-party internet applications and web-based services to be seamlessly integrated into the site, taking advantage of the social connections of its users. The release of the Facebook application framework has received notable media coverage and user uptake; as of October 2009 there are more than 210 million users of 350 thousand third-party applications on the platform [23].

Endeavouring to embed Facebook's collaborative and "status awareness" features into our cross-site activity, we have developed our own *proof-of-concept* RIA (rich internet application) called CommonGround, designed to run on the Facebook platform (see Figure 1; profile images have been obscured and fictitious names used to maintain anonymity). The pedagogic motivation behind this work is to foster greater

team interaction, trust [20] and self-disclosure [22] by filling the communication void that arises between students' face-to-face meetings [16]. By reducing the geographic and temporal barriers to interaction and community formation, team members will become increasingly aware of each others' skills, personalities, work rhythms and needs – both online and off – within a pre-existing, persistent, convenient infrastructure.

Figure 1. CommonGround running on Facebook

Developed in Adobe Flex, the application provides a standards-based interactive experience to the user, utilising and extending the inherent communication and social awareness affordances of the Facebook platform. Employing the new Adobe Flash Collaboration Service, the application is able to offer a number of facilities to the student: better team interaction and familiarity (via profile exploration and informal encounters), increased status awareness (via status updates), and greater project planning potential both locally and cross-site (via a simple company-wide task list).

CommonGround's status awareness features represent an area of particular interest to us. As touched upon earlier, the application allows users to publish a simple and succinct one-line textual "status" describing their daily work activities and opinions for teammates to view and comment upon. Of note, during our study 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 is maintained local to the CommonGround application (and each individual company).

To stimulate informal interaction via productive chance encounters [19], and to enable basic online awareness between students, we have also created a "virtual meeting room" that displays presently connected users and their institutional affiliations. We have employed a familiar visual setting; one that is analogous to the students' real-world meeting environment (i.e. an illustrated reproduction of a traditional face-to-face meeting room). Profile images represent users and help put a face to cross-site teammates, many of whom the students may never meet in person. Basic name and team-role details can be accessed by rolling over a profile image, and then clicked upon to view that teammate's full Facebook profile (often including detailed contact information).

A simple chat facility is also available for synchronous discussion with online teammates, supplemented by the integrated and private one-to-one Facebook chat feature (discussion boards, provided by the Facebook service and set-up by us, are also available for asynchronous interaction). CommonGround also offers students a basic scheduling facility providing a team-wide overview of pending project tasks, responsibilities, due dates and progress percentages. Presented in-line, this schedule can be readily viewed and discussed, with roles and timescales collaboratively decided upon. We have also integrated our virtual learning environment NESS (Newcastle E-learning Support System) into Facebook. Accessible via CommonGround, it allows students to retrieve course timetables, share files, submit deliverables, and receive marks and feedback.

Of note, students had initial reservations with regards to using Facebook for the purposes of the project. As one would expect given the recreational use of Facebook and peoples' informal expectations of the service [24], students were particularly reluctant to be "forced" to add their teammates as friends on the service, especially with respect to their cross-site colleagues with whom they were less acquainted. However, our students' privacy is respected by CommonGround and teammates do not need to be "friends" in order to collaborate via the application. Once a company account has been created, members can simply join that group in order to participate; use of the application does not interfere with any other activity on Facebook.

V. FINDINGS

A preliminary pilot study of the CommonGround application was performed during the 2008/2009 academic year. Four companies were invited to use the application – both locally and cross-site – during the final 8 weeks of the cross-site project (when companies typically implement their final systems). A total of 38 students from Newcastle and 24 from Durham took part. Each team reported they had already used Facebook for communication socially with their teammates, but only locally. To form a picture of the students' opinions of the CommonGround application, we interviewed participating teams and administered a second series of surveys during the final week of the project. A 100% response rate was observed.

TABLE III. AVERAGE DAILY ACTIVITY ON COMMONGROUND

Companies 2, 3, 4 and 5	***Newcastle N=38***	***Durham N=24***
Impressions (i.e. application loads)	48	11
Chat Messages	33	18
Status Updates	6	3
Schedule Additions/Updates	1	1

Initial results are encouraging, supported by activity logs showing positive, heavy use of the application (see Table III). Team members, on average, accessed CommonGround more than once each day during the trial, if only to update their own status and view the activities of others. When regarded alongside the high levels of chat recorded, a considerable number of chance encounters were found (i.e. ad-hoc informal meetings with two or more team members). For example, Figure 2 demonstrates a three day single-company snapshot of student activity. Each connecting edge represents simultaneous access to the application (i.e. a chance encounter), with position (i.e. degree centrality) in the network determined by the amount of interaction which occurred during each encounter. Of note, detailed content analysis of the chat logs to determine the "on-task" nature of these interactions is currently underway and will be presented in a future work.

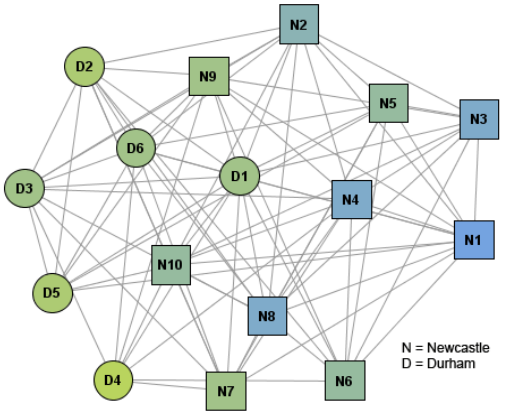

Figure 2. Network diagram of chance encounters (week 2, company 4)

Encouragingly, students in interview reported using CommonGround and Facebook as a "one-stop-shop" to contact and collaborate with teammates. As shown in Table IV, survey data also indicated that they were comfortable using Facebook on-project and integrated CommonGround into their working practices with little resistance (in stark contrast to technologies mandated by us). Indeed, these results indicate that students were significantly better able to maintain awareness of their teammates' activities when using CommonGround, with an increase in confidence of approximately 16% locally and 51% cross-site. The combined communication affordances of CommonGround and Facebook, in addition to readily accessible profile contact information, meant that students could get in touch with colleagues quickly, with standard email utilised only for less pressing matters. Of particular importance, all participants reported they felt "part of a team."

Interestingly, results from this study also show that a lot of the CMC facilities offered by CommonGround and Facebook were already provided by us in other applications (such as messaging and chat), but which the students chose not to use. The fact that this functionality was centralised on Facebook seems to have greatly influenced its adoption and use. Even email, which often tends to dominate students' local and cross-site communication strategies, appears threatened somewhat by the embedded CMC affordances of Facebook. Indeed, this finding is supported by reports of social networking message traffic overtaking that of web-based email [25]. Students feel certain that, even if teammates do not answer their mobile phone or read their email, they will eventually log on to Facebook and feel compelled to respond.

TABLE IV. STUDENT OPINION OF COMMONGROUND

	Newcastle Uni. (N=36)		***Durham Uni. (N=24)***	
	Locally	*Cross-site*	*Locally*	*Cross-site*
Using CommonGround, were you *confident* that you could tell at any one time what your teammates were working on?				
Yes	31	25	19	19
No	2	3	0	3
Were you comfortable interacting with teammates on Facebook?				
Yes	33	28	20	17
No	2	3	2	4
Did you ever seek to learn more about a teammate via their profile?				
Yes	26	27	14	19
No	6	2	5	2
Did interacting on Facebook help your team communications?				
Yes	32	28	16	15
No	0	6	3	7

Note: 2 students left from Newcastle during the activity; "don't know" responses have been omitted

Of note, students were more inclined to formally report team communications via Facebook once they realised "it was okay to do so". Feedback shows they didn't initially perceive social networking sites as an acceptable form of professional communication, despite awareness of large corporate networks on the service. This finding is further highlighted by teams' end-of-project reports, which made only anecdotal reference to the trial use of Facebook and CommonGround for formal communication, despite the majority of participants reporting that it had helped communications.

VI. Discussion and Future Work

In the four years that we have participated in the cross-site project described in this paper, we have gained significant insights into distributed team collaboration and the areas that cause most concern to students. Some of these areas, such as assessment, have been able to improve year-on-year. However, despite our best efforts, both local and cross-site communication issues have presented much more of a challenge. As we have shown, the sheer variety of unfamiliar CMC technologies provided by us has arguably undermined our students' communication strategies, exacerbating the very problem that we were trying to solve.

More and more, however, our students are leading the way for us by autonomously incorporating freely available social networking technologies into their informal communication strategies, fulfilling their group collaboration needs and mitigating the shortcomings of the CMC facilities provided by us. Facebook in particular has emerged as one of their primary collaborative tools for both informal and on-task interaction; it was convenient, familiar, and already in frequent use.

The CommonGround tool described in this work was developed to transparently harness this pre-existing engagement with Facebook. It is a *proof-of-concept* application and, although it has received only limited use, our initial results and feedback from students have proven extremely encouraging. From a collaborative standpoint, CommonGround offers a means to foster group interaction and community-building by providing a centralised application through which students can interact and explore the personal profiles and work patterns of their team mates. By creating a persistent environment that interacts with and leverages the power of existing social networks, team members are able to better maintain their interactive cohesiveness, team awareness and project planning potential beyond face-to-face meetings. The application has helped reduce the barriers to both local and cross-site interaction and team building, and aided somewhat in the inclusion of more "peripheral" students.

It is our intention to further examine how social networks are formed and developed in this environment, and to evaluate the extent to which the added sociability, status awareness and planning facilities affect student motivation and social capital. To this end, a second, more comprehensive version of CommonGround is under development and is being trialled in the current academic year (using local and international cross-site teams, divided into experimental and control groups to allow for a more detailed comparison and exploration of the impact of CommonGround). A further trial of the software in an industrial setting is also underway, and will be reported on in a future work.

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