SOFTWARE ENGINEERING STUDENTS' CROSS-SITE COLLABORATION: AN EXPERIENCE REPORT

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ABSTRACT

This paper outlines preliminary work which is part of the Active Learning in Computing project at Durham University and the University of Newcastle. The aim of the work was to investigate the feasibility of students' projects being developed across sites. This work allowed students to utilise the expertise from their site's Software Engineering (SE) modules and provided strategic coupling of cross-site student groups. The activity investigated the suitability of projects, the technology to support collaboration across sites and the interest and fears of students. Our initial experiences tell us that cross-site working emulates industrial practice well and is, therefore, very beneficial to students in terms of their employability. The assessment requirements of a university and our necessity for quality assurance require that we constantly need to monitor the students' outcomes.

Keywords

Software Engineering, Cross-site collaboration, video conferencing

1. INTRODUCTION

The software engineering process typically involves participation of software designers, programmers, end-users and domain experts. Increasingly cross-site software development in industry is becoming commonplace with new technologies allowing the constraint of collocation to be relaxed. Whilst most ICS departments provide students with experience of group working, the opportunity for these departments to adopt cross-site collaboration is a rarely taken. Such an undertaking is often seen as being prohibitive, with issues such as assessment, finding a 'window of opportunity' in the curriculum and cohort size being especially problematic.

Active Learning in Computing (ALiC) is a Centre for Excellence in Teaching and Learning (CETL) project led by Durham University, with the University of Newcastle, Leeds Metropolitan University and the University of Leeds as partners (CETL-ALiC 2005).

ALiC focuses on increasing the level of student engagement within the Computing curriculum and aims to better equip students for employment by making their experiences more relevant to industry. One of the areas ALiC is looking at is trialling cross-institution software development projects with students at Durham and Newcastle. Research has shown that there are educational benefits for students who are working together in geographically-distributed locations and, therefore, making this work worth progressing (Drummond 1998).

This paper describes AliC's initial work to assess the feasibility and benefits of cross-institution software collaboration and provides the background and motivation for his work. In the following sections, the paper describes the student assignment and assessment issues, use of video conferencing and other communication technologies and discusses student and staff experiences. The paper concludes with future plans for developing and improving the cross-site collaborations.

2. STUDENT ASSIGNMENT

The work reported here consisted of an assignment shared between teams of Level 2 students from Durham and Newcastle who were undertaking an SE module. The cohorts of students were enrolled on Computer Science, Information Systems or Natural Sciences programmes. Twelve 'companies' were formed and each consisted of a team from each instituion.

The team sizes were 4-6 in Durham and 6-7 in Newcastle.

2.1 Assignment description

The pedagogical aims of the cross-site collaboration were to give students an insight into SE in an industrial context, make problem-solving more realistic, allow staff and students to use and evaluate various technologies for cooperative working and also to encourage the development of transferable skills.

To begin to realise these aims, each company was asked to develop software for a holiday company which provides their customers with information that might be relevant, or of interest, to them whilst at their holiday destination. This information was to be provided via a Personal Digital Assistant (PDA) (Newcastle) or a mobile phone (Durham). Hence the teams that made up each company were working to the same scenario but the deliverables were to be implemented using different IDEs and development technologies. The collaborative element of the work was based on the remit that the final systems had the same basic functionality and a similar 'look and feel' to the interface. Each team was asked to document and build prototype software systems to be used on a PDA or a mobile phone. The original intention was for cross-site software development with, for example, Durham implementing of the back end of the system and Newcastle's the front end. This was, however, seen to carry too many potential risks for a company if one team performed badly and as such the compromise was reached as described above.

2.2 Assessment

In any group activity, assessment of both the group and the individual can be problematic. This has been addressed in a number of ways in previous work (Burd, Drummond et al. 2003),(Race 2001). In addition to the known problems of group assessment, it was imperative in trialling this cross-site collaboration that each University would be performing its own assessment. The assessment would involve some evaluation of the inter-site collaboration, but one team's assessment would not be compromised by a poorly performing team in the other University.

It was agreed that a percentage of the marks would be awarded to each team for their collaboration. This included documenting and evaluating the cross-site interactions; the effectiveness of the various communication technologies used, and for the final corresponding 'look and feel' of both the mobile phone and the PDA interfaces.

Newcastle students were not given explicit marks for collaboration but elements of their coursework did depend on their interactions within their company. They had, for instance, to compile reports on what effects using the software on differing hardware would mean for the user and this involved a comparison of features and functionality across sites. Newcastle students also had to report in their team presentations, and in both their individual and team final reports, on how collaborations had gone.

Durham students had to compile a personal diary of all meetings either local or cross-site, logging items agreed and any other issues or concerns that had arisen. In addition each student had to produce a legacy report where they discussed the team project, primarily from a local perspective, e.g. team dynamics, how things could have been improved and how they saw their own contribution to the project. A section of the legacy report also contained their discussion on the how the cross-site-collaboration went and whether it had an impact on the work overall.

2.3 Modes of Communication

The companies were encouraged to use video-conferencing (VC) and email as the main modes of communication. Other methods, however, such as face-to-face, SMS, bulletin boards etc., were not precluded. Microsoft Conference XP (Microsoft) was originally chosen as the primary VC solution but problems were encountered with the fire-wall at Durham and the fact that the student VC room at Newcastle was not ready required that Access Grid (AG) be used instead (Access-Grid). Durham implemented a simple AG set-up utilising a single web cam, directional microphone, speakers and a PC running AG software. This equipment was installed in a project room which could be freely booked and run by students. Newcastle had to utilise their exisiting AG facilities which had to be supervised by a member of staff and shared with other projects running at the University. The Newcastle AG room uses four capture cameras and has two PCs, one for video and one for audio, four speakers, four projectors and three large display screens.

Students were encouraged to use team email accounts when communicating cross-site but were not provided with a company email address. The students were asked to use the team email for correspondence within the company. The intention was that each member would be aware of each others activities. This awareness was felt to be an important issue for a company to function efficiently as each member should be aware of the status of others' tasks, completion dates etc. (Fussell, Kraut et al. 1998). However, Fussell also points out that there is a danger that the effort of communicating can be overwhelming. We found this to be the case as most of the companies

ended up nominating one team member at each site to be the spokesperson.

Newcastle students had access to a team repository in the Newcastle E-Learning Support System, (NESS) in which they could store their documents and files. Durham students were provided locally with a shared group file space.

3. EXPERIENCES

Three key areas were identified from student feedback, via their various reports, from staff observations and from anecdotal evidence.

These areas – where problems arose and where improvements need to be made – can be broadly categorised as being of a technical, social or administrative nature.

3.1 Using the Technology

The AG video conferencing technology is generally stable and reliable and was quite easy to install and use. The majority of technical difficulties experienced during the VC sessions were mainly due, in the initial stages, to the use of inferior hardware by both sites. In the early stages, Newcastle students were frustrated that they could not hear the audio properly from Durham and that the camera did not give much of a picture - it was just a small web cam and they could not clearly see the other team's faces.

Students found the technical problems annoying as there was very little they could do if things went wrong during the actual meeting. Few companies had developed a contingency plan if communication failed during the video conference e.g. they could have used the mobile phone number of a team member at the other site in order to let them know what was happening.

Durham students coped well with setting up and running the VC technology themselves. They were somewhat nervous in the early stages of the assignment but staff were available for support and advice if difficulties arose. Newcastle students did not have to set up or run their AG facility themselves as it was staffed at all times and the staff member dealt with any technical difficulties as and when they occurred.

Some problems were however unforeseen and outside our control e.g. Newcastle experienced problems with the synchronisation of their video and audio in a few conferences. It was eventually discovered this was due to a virus on their video server which resulted in a re-build. On one other occasion the Manchester Bridge (Access-Grid) went down and, as a result, the facilities were out of action for a couple of days and some meetings were cancelled. Unfortunately a symptom of technology's being unreliable is that students can very quickly lose confidence and interest in it and are hesitant to use the technology again.

3.2 Student Interactions

Communication and cooperation are an inherent part of the social process of Software Engineering and these dimensions of social interaction are as important as the technical aspects (Johnston and Miles 2004). During the assignment there were companies that had problems with working together. These problems, however, were not dissimilar to those experienced by the collocated teams. These problems typically related to students who did not attend, students who did not contribute fully and, more generally, to failures in inter-team communications - all of which are not uncommon in the real world.

Face-to-face meetings afford rich interactions simply because people can talk, listen and watch each other. However, for this work, face-to-face meetings between company members prior to the start of the assignment were purposely not organised by staff as it was felt that this would not truly reflect what can happen in industry. Three companies did, however, arrange their own face-to-face meetings which resulted in the remainder of teams being unfamiliar with each other and, therefore, had not built any relationships prior to their first on-line meeting. A major and detrimental consequence of this was that the majority of those companies generally found it hard to view their off-site team as part of the same company.

This lack of relationship meant that students were not greatly motivated to help each other across-site and often found it hard to respond in a timely fashion in order to help solve each other's problems This is a reported problem in industry where cross-site work introduces delays with a significant slow-down of work in geographically-distributed sites (Herbsleb, Mockus et al. 2000). Herbsleb also points out that this may be a matter of perception since remote workers believed that they were as helpful to remote colleagues as local colleagues were. One lament often heard from collocated teams of students at both sites was that they had sent screen-shots, descriptions etc. to each other but had had nothing back in return. In some instances information that had been provided was often too late for it to be useful.

Over time the students were able to sort out most of their differences with the help of their monitors and project managers. They learned to be more professional and precise in their communications in order to achieve results. What these problems highlighted was that the students need to be

trained in how to conduct meetings and be better prepared for working in teams prior to working with

each other. Layzell (Layzell, Brereton et al. 2000) report on similar experiences within other distributed educational and professional software development teams and states that the value of social interaction cannot be underestimated when trying to build up trust and empathy between distributed team members.

At the start of the SE module at Durham there is a team games session. This session introduces students to their collocated team members before they commence work and is popular with the students as it helps them to bond as a team. This currently does not take place at Newcastle and staff feel that Newcastle students would certainly benefit from a similar approach on-site and ideally in the future between sites.

3.3 Administrative

3.3.1 Scheduling meetings

Students found it difficult to schedule meetings around their normal timetables. As both sites had teams made up of students studying a variety of programmes, scheduling cross-site meetings exacerbated this situation. Students at both sites had the perception that all team members needed to attend every VC session and, therefore, viewed finding a suitable time a near-impossible task. It gradually filtered through that it was perfectly acceptable for them to send one or two representatives to a VC session and for these students to report back to the rest of their team. The converse of this is that, if a technical question came up and the other site did not have the appropriate team member available these questions could not be answered immediately.

Students also tended to blame the off-site team-mates if their meetings had to be rescheduled or cancelled.

3.3.2 Differences in Curriculum

Each set of students assumed that the content, delivery and emphasis of the SE module at each site were exactly the same i.e. the practical work had the same objectives and deliverables had the same deadlines. The emphasis during the SE practical work at each site was in fact different. At Durham the emphasis was primarily on the production of a complete requirements specification followed by the design and implementation of the mobile phone software. At Newcastle it was on early implementation followed by marketing, sales and evaluation of other PDA systems.

The fact that their development schedules were different often meant that VC sessions tried to concentrate on whose deadlines had to be met soonest. Teams generally cooperated well with respect to the overall functionality and with requests for documents but were not always sympathetic to the urgency of a request from the other site.

Newcastle students felt it was initially unclear why they needed to interact with the Durham students. This was partly due to the fact that marks attributed to the collaboration were not explicitly specified. This resulted in poor communication efforts between sites in the early phases of the assignment. Durham students complained of the lack of interaction from Newcastle when they were completing their requirements specification which included screen designs. Newcastle students were unsure where they could find common ground as collaboration on 'look and feel' was not explicit enough in the assignment description or deliverables.

4. EVALUATION

4.1 Student Feedback

At each site, students reported that they enjoyed trying out new roles (e.g. chief programmer or head of documentation) that the assignment had provided. They gradually felt more confident about their own abilities as they now had the opportunity of rising to the challenge of roles they had never considered before. Whilst this is common in a group project, it is encouraging because this illustrates that the learning outcomes of the SE modules were not compromised by the additional work the collaboration brought with it

Students liked the VC technology and found using it and collaborating with the other team interesting, different and, in some instances, challenging! They liked the assignment focus and found it interesting not only to see what students at another university did but also to find out the different curriculum foci and the differences between modules at the two sites. They found it a challenge to create something together but were very competitive because another university was involved. There was a sense of being representative of their university and, therefore, having to put on a good show and do their best.

Some students did however comment on their disappointment with the collaboration. They had initially been excited with the prospect of working cross-site using different technologies but the reality of the communication difficulties, both technical and inter-personal, overshadowed this and often de-motivated them. Staff feel that they could have facilitated this early collaboration better

by preparing the students for team-work and, more importantly, by improving the students' communication skills. A large part of this is that we did not know what would happen until the assignment went ahead and, therefore, we could not predict all of the issues that would arise.

Students are motivated to a large extent by marks and assessments but, with the addition of the collaboration, there were increased fears that they would be penalised if the cross-site work did not go well. Student fears also centred on whether their code would be copied across sites and that too much collaboration would be seen as cheating.

Did we address the fears of students? A short answer would be, perhaps, "not enough". We did ensure that students would not be penalised. The fact is that students had to write about their experiences, either negative or positive, and our main concern was always the quality of the arguments presented and the thought put into the content.

4.2 Staff Observations

So, is cross-site software collaboration really feasible for undergraduates? Our initial experiences tell us that it is, as long as problems are recognised and addressed early. The students managed to develop some very good, similar software systems. They were able to bounce ideas off one another and, as each site had differing priorities, they were able to identify the different priorities of themselves and of their off-site team. Indeed, there were more constraints and pressures on them because of the added factor of the other site and this forced them to negotiate and recognise what was really important and feasible. Students usually have to learn to rely on their own team perspective and own site remit. With the added dimension of a cross-site team, they had a larger picture to consider and some other overriding issues, such as a 'company' focus that would not otherwise have been there.

The assignment itself can be viewed as suitable and realistic as students were developing for different hardware and this is certainly what would happen in industry. The fact that the teams had to collaborate on 'look and feel' alone made it more feasible as the dependency between sites was only loosely coupled but closely enough to ensure collaboration while retaining the freedom to be creative. Even if the teams were developing software to solve different problems they would still have to have the corporate 'look and feel' of the software house.

Despite all the technological problems, staff still managed to get video conferences running and this is quite a positive outcome. Students, however, did tend to assume that the VC was a mandatory part of the collaboration. Staff, therefore, had not conveyed strongly enough that communication was the most important aspect of the assignment and that VC was just one way to achieve this.

The disparity between the sequences of deliverables and deadlines caused the students more concern than we had anticipated. This scheduling was a large contributor to the problems that students encountered and, therefore, the timetable for practical slots at each site is to be aligned. This will provided the students at both sites with a much higher degree of flexibility with regard to when they are able to communicate. However, planning and scheduling etc., are part of what we want to teach students and they need to learn how to organise their time. We cannot, therefore, do everything for them or predict all possible problems that they may encounter. We must stress to them that, as project managers and team members, they must take ultimate responsibility for organising themselves.

Whilst Durham explained the motive and context of why this work was being adopted to its students in the first lecture of term 1, it would appear, from the number of emails and discussion which ensued throughout the year in order to dispel student fears of being penalised, that this had been forgotten by many of them. Newcastle had emphasised the importance of the assignment and the team skills that it addressed but students did not totally grasp the significance of this and concentrated mainly on their deliverables.

5. FUTURE WORK

Many issues were brought to light during the running of this assignment that we had not taken into account and these will be addressed next year when the SE modules are run again.

More direction and more support on how to conduct meetings, specifically virtual meetings, are required. In addition, we need to ensure that the VC technology is stable. We need to ensure that students have more confidence in the technology so that they can concentrate on their learning in the virtual meetings rather than their emphasis being on the technology and tools that are there to support the team work.

With regard to assessment, it is imperative that staff at each site outline the aims and motivation of the assignment more clearly. This will avoid the problem of some teams' not collaborating fully cross-site as they had viewed this work as extra.

Newcastle teams had access to the shared central repository NESS, which supported their local team

working. Large documents sent by Newcastle to Durham were often blocked by Durham's email system because of their size and, hence, caused problems. Next year, a shared group space will be available for each company on NESS to upload and download documents.

6. CONCLUSION

There are issues with scalability when considering undertaking a similar collaboration between other institutions. These differences include cohort sizes, curriculum opportunities, learning outcomes, curriculum emphases, assessment methods etc. Despite these issues, this work is worth pursuing as we believe there are many benefits for the students in participating in cross-site collaboration. Students have commented that their experience of this collaboration had enhanced their employability in terms of skills and team working experience.

What the students may not realise is that they have also acquired skills such as negotiation, scheduling, planning, communication, problem solving, organising, conducting meetings etc.

Even when things go wrong, as they invariably can do, students can learn from it. They needed to communicate and organize themselves – they found that it was difficult when things went wrong and that they had to work around it. A particularly valuable skill was learned when they interacted with people who wanted different things from them – they had to learn how to compromise and get not only the best outcome for everybody but also the best out of all members.

The fact is that we, as tutors, cannot organize things so that nothing goes wrong. We also do not want to structure team assignments too rigidly because that would remove some of the learning experiences, thereby detracting from the reality of team-working in an industrial context.

The intention of this work is to develop a model and some general principles for using this approach to Active Learning. This paper has highlighted some of the issues that need some significant consideration.

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