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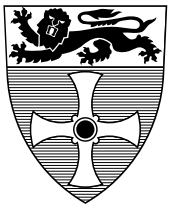

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Software Engineering Students' Cross-site Collaboration: An Experience Report

S. Drummond, M. Devlin.

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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 the 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 and the technology to support collaboration across sites and to address the interests and fears of students. Our initial experiences tell us that cross-site working emulates industrial practice well and is beneficial to students in terms of enhancing their skills and hence their employability.

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 common place 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 practice rarely carried out. Such an undertaking is often seen as being prohibitive with issues such as assessment, finding a "window" of opportunity in the curricula 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 trailing cross-institution software development projects with students at Durham and Newcastle. Research has shown that there are educational benefits to students' working together in geographically distributed locations, 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 the experiment. In the following sections the paper describes the student assignment and assessment issues; use of video conferencing and other communication technologies, and discusses both student and staff experiences. The paper concludes with future plans for developing and improving the cross-site work.

2. STUDENT ASSIGNMENT

The work reported here consisted of an assignment shared between teams of Level 2 students from Durham and Newcastle undertaking a SE module. The cohorts of students were enrolled on either Computer Science, Information Systems or Natural Science programmes. Twelve "companies" were formed which each consisted of a team from each institution. Team sizes were comprised of 4-6 (Durham) and 6-7 (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 that provides their customer 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) and a mobile phone (Durham). Hence the teams that made up the 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 around the remit that the final systems had the same basic functionality and a similar "look and feel" to the interface. Each team were asked to document and build prototype software systems to be used on a PDA or mobile phone. The original remit was for cross-site software development with for example Durham implementing the back end of the system and Newcastle the front end. This was however seen to carry too many risks of a poorly performing team and 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 trailing 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 marks would be awarded to each team for their collaborations. This included documenting and evaluating the cross-site interactions, the effectiveness of various communication technologies used, and for the final corresponding "look and feel" of both the mobile phone and PDA interfaces.

Newcastle students were not given explicit marks for collaboration but elements of their coursework did depend on their interactions within their company e.g. they had 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 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 this report contained their discussion on the how the cross-site-collaborations 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 however other methods 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 problemsencountered with the fire wall at Durham and the student VC room at Newcastle not being 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 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 correspondance within the company, with the intention being 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 communication can be overwhelming. We also 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 Elearning 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

The following discussions are based on feedback from students and staff via the various reports produced by the students and from anecdotal evidence.

Problems which arose or where improvements need to be made can be broadly categorised as being of either of a technical, social or of a more general 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 VC 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 advise 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 so the facilities were out of action for a couple of days and some meetings were cancelled. Unfortunately a symptom of technology being unreliable is that students lose confidence and interest very quickly in using it and are hesitant to use it 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 however these problems were not dissimilar to those experienced by the collocated teams. These problems typically related to students who did not attend, those that did not contribute fully, and generally 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 so they 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 as his study found remote workers believed they were as helpful to remote colleagues as they were to local colleagues. 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 received nothing back in return or that information had been provided 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) reports of similar experiences within other distributed educational and professional software

development teams and state that the value of social interaction should not be underestimated in order to build up trust and empathy between distributed project 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 Issues

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 for example their programmer available these questions could not be answered immediately.

Students also tended to blame their off-site team-mates if the 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 e.g. at Durham the emphasis was primarily on 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 meetings concentrated on whose deadlines had to be met soonest. Teams generally cooperated well with regard to the request for documents or an overview of planned functionality but where not always sympathetic as 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 as their deliverables and schedule were different. 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 also 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 the new roles, (i.e. chief programmer, head of documentation etc.) that the assignment provided and they felt more confident about their abilities because the assignment showed them they were capable of rising to the challenge of roles they had never considered before. Whilst this is common in a group project, it is encouraging for staff to note because it illustrates that the learning outcomes of the SE modules were not compromised due to the additional work the collaboration brought with it.

The students also liked the video conferencing technology and found using it and collaborating with another team interesting, different and in some instances challenging! They liked the assignment focus and found it interesting to see what students at another university got up to and to find out the difference between modules and curriculum focus. They found it a challenge to create something together and yet were also 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 in terms of communication skills. A large part of this is that staff did not know what would happen until the assignment went ahead and therefore 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. One of the main aims of the assignment was to get students thinking about communication. The marks for the collaboration portion of the assignment depended on how well they evaluated and analysed their inter-company communication and team-working experiences, not on how good or bad the actual communications were. Our main concern was always the quality of the argument presented in their work and the thought put into the content.

4.2 Staff Observations

So is cross-site software collaboration feasible for undergraduates? Our initial experiences tell us that it is, if problems are recognised and addressed early. Our students managed to develop some very good similar software systems. They were able to bounce ideas of one another and as each site had differing priorities they were able to distinguish what was important to themselves and 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 i.e. 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 loosely coupled but enough to ensure collaboration with 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 which is quite positive. Students, however, did tend to assume that the video conferencing was a mandatory part of the collaboration therefore staff did not convey strongly enough that communication was the most important aspect of the assignment and video conferencing was just one way to achieve this.

The disparity between sequence 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 provide 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 in our SE modules and they need to learn how to organise their time, therefore we can not do everything for them or predict all possible problems that they may encounter. We must stress that as project managers and team members they have to 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 that this was forgotten by the students based on the number of emails and discussion which ensued throughout the year in order to dispel their fears of being penalised. Newcastle 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 support on how to conduct meetings and specifically virtual meetings is 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 the emphasis being on the technology and tools that are used to support the cross-site 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 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 shared group space will be available for each company in NESS to facilitate the sharing of documents between sites.

6. CONCLUSION

There are issues with scalability for conducting a similar project between other institutions. These differences include cohort size, curriculum opportunity, learning outcomes, curriculum emphasis, 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 has enhanced their employability in terms of team skills and cross-site 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. During this assignment our students needed to communicate and organize themselves – they found out it was difficult when things went wrong and that they had to work around it. A particularly valuable skill is when they encountered people who wanted different things from them – they had to learn how to compromise and get the best outcome for everybody and the best from all members of their team.

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 we will 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 general principles for using this approach to Active Learning. This paper has highlighted some of the issues that need consideration.

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