Crashing a Bus Full of Empowered Software Engineering Students

Lesley Smith, Dr Samuel Mann

School of Information Technology and Electro-technology
Faculty of Art and Technology
Otago Polytechnic
lsmith@tekotago.ac.nz

Nell Buissink-Smith
Otago University

ABSTRACT

This paper describes the application of a catastrophic change in project to an otherwise successful software engineering class that has been previously demonstrated to follow an empowering approach. The class was 'run over by a bus' and groups required to swap projects half way through development. Numerical and qualitative information is presented that demonstrates the success of this approach. Implications for future work are considered along with the theoretical context of the study.

1. INTRODUCTION

This paper describes a study that brings together two areas of research into improving education practice in the field of information technology. The lessons learned from this research may be applied to a wider sphere, particularly in technological and vocational areas where efforts are made to prepare students for careers in changing and difficult environments.

2. TEACHING SOFTWARE ENGINEERING

Software engineering is a diverse discipline utilising a multitude of tools and methodologies. A development project can generate numerous problems for the software engineer: specifications may be ill defined; clients change their minds; the system is often larger than the individual software engineer could know; the challenges of working in a group environment. The teaching of software engineering presents a particular challenge as we attempt to expose students to 'real world' situations, while maintaining a positive and constructive learning environment. As Surendran and Young (2000) argued, "the gap between what is learned in the curricula and what is needed in the industry is rather wide in relation to other engineering disciplines" (pg 350).

Surendran and Young (2000) described the benefits of using a project based approach with real external clients. In preparing students for the 'real world', emulating projects within the relatively controlled and safe confines of education is a powerful tool. Some aspects are easier to emulate than others, for example, project specifications and group dynamics can be manipulated in the classroom environment.

In the commercial environment, individual software engineers would rarely see a project through its entire development, from planning through analysis, design and implementation (Hoffer *et al.* 1998). A large project may be developed by teams of engineers, over an extended period of time, relating to each other as internal customers. Surendran and Young (2000) described how this could be reproduced in the educational setting with an exchange of project documentation at the end of a phase of development. They argued that "there is need to experience the role of being an internal customer (i.e., using someone else's output for further development) and also having an internal customer (i.e., making artefacts for someone else's use)…this made the students realize the need to follow standards in documentation and to communicate with other groups" (pg348). The authors used feedback from students to evaluate the effectiveness of their whole project based approach. They found that 75% of students "liked the idea of swapping projects after each phase" and that "about 85% considered that swapping enhanced their learning" (pg349). Swapping artefacts was seen as a way to establish the importance of "doing a professional job". This appears to be the only reference to such a practice, although anecdotally, at least, it is not uncommon in North America.

2.2 Empowering IT Education

Mann and Buisink-Smith (2000) described an empowering approach to teaching information technology subjects. They assessed an application of IT education against Robinson's (1990) attitudes and practices of empowering education (Table 1). Among other courses the Software Engineering course met both learning outcomes and created a learning experience that was encouraging and empowering. Although it did not involve swapping projects, this course was similar to Surendran and Young's project based approach, here all the students worked in groups in developing a ship safety management system for an external client. Student feedback gives an indication of the success of the course (reported in Mann and Buisink-Smith 2000):

- "We had to be self directed in completing tasks, this is a good thing for additional time management and learning"
- "We did interesting things that where out of the ordinary. This kept us from falling asleep"
- "(What you really liked about this course...) the way it was presented ...the content...it was all good... u go sam...!!, ... the practical of the group work,...the chance to have a real client... being pushed beyond what I thought I could do"
- "It was hard work, but we learned a lot about life in the real world"

Godbey (1996) argued that through both the official curricula and their actual experience, students should develop the capacity for critical thinking, effective communication, self-directed and self-reflective learning, subject competence, cultural awareness, comprehension of technology and moral commitment. The empowerment approach is often placed in contrast to a 'banking' model of education of lecturer discipline, enforcing and being supremely knowledgeable while students are disciplined, comply and are considered to know nothing.

Table 1: Robinson's Attitudes and Practics of Empowering Education

a) The teacher and students both teach and are taught by each other
b) The teacher is aware of not knowing everything and is open to the students' knowledge and experience which are actively valued
c) The teacher and students all engage in critical, reflective, imaginative and collaborative thinking
d) The teacher talks and listens and the students talk and listen; they engage in dialogue
e) The teacher and student interact, striving to meet each others needs instead of being the respective perpetrators and victims of discipline
f) The teacher and students make choices based on what is most meaningful for them with sensitivity to each others verbal and non-verbal cues
g) The students are actively engaged in meaningful experiences that the teacher facilitates
h) The teacher and the students together decide on programme content and revise and change it as their interests and needs change
i) The teacher shows her or his personal charisma, vulnerability, and humanity to create her or his authority based on mutual respect, discovery and love for learning
j) The teacher and students form a collective Subject of the learning process, sharing joint ownership of the classroom life.

2.3 Aims

This paper has two primary aims. First, to attempt to replicate and document in more detail the positive findings of Surendran and Young (2000) with regard to swapping projects. Second, to assess this practice in terms of Robinson's empowering paradigm. In particular, to examine the question: does the control imposed by the lecturer and consequent loss of ownership of the project by the students outweigh the benefits of swapping?

3. METHOD

The course described by Mann and Buisink-Smith (2000) was demonstrated to meet both learning requirements and the empowerment paradigm. To this course in 2000 we administered a swap of projects. Information was gathered from course evaluations, presentations, student log books, reviews and lecturer's notes.

Otago Polytechnic teaches a three year undergraduate degree in Information Technology. Students in Software Engineering (SE205) spend one semester (17 weeks) developing a major practical project through the Systems Development Life Cycle (SDLC following Hoffer *et al*. 1998) up to the implementation phase. The course develops an understanding of the methods and problems of the development and management of information systems, through a focus on data centred analysis, modelling and design. The importance of documentation is stressed as a vehicle in aiding understanding and communication. An external client is used to present a real, if somewhat wide-ranging, business proposal which the student groups develop through the SDLC. An important outcome of the course is preparing students for the final year project, in which they will spend a year working with a client on an industry strength project (McQueen and Mann 1999).

The students work in self-selected groups, using the SLDC to develop a system for the client. The classes are used to present topics that explain and support the current SDLC phase. The students have the opportunity to interview the client in the Analysis and Logical Design phases, and can direct questions to the client through the course lecturers at any time. Although not critical to the outcome of this paper, the system to be developed was a student management system for the Polytechnic, and in that it was a deliberately large and complex development, was not unlike the ship safety management system development from 1999.

The importance of documentation was stressed throughout the course and the possibility of a project catastrophe was suggested to the students from the outset: "Students should be aware that, like any 'real world' project, the progress of the project may take some unpredictable turns during the development" (assignment information).

A "run over by a bus" (ROBAB) scenario was repeatedly used in class to emphasise to the students the necessity of having their project documentation up to date. This was in case they were incapacitated for some reason and other students had to pick up and complete their projects and also as sound practice for the groups themselves in being able to justify decisions. While this is a realistic approach in terms of likely outcomes when working with student groups, and indeed several groups did disintegrate to varying degrees, and work was lost from disk storage, in fact the lecturers had planned a catastrophe of a more extensive nature.

During planning phases of the SDLC each student group was required to produce a management document containing a contingency plan. The students were encouraged to consider all possible scenarios for project disasters, and an extensive list of possibilities was provided that included issues that could arise relating to the group, the client, documentation, ethics and project management. For example:

- A group member who you saw in the first week reappears four months later
- A group member's cat gets sick at the other end of the country and the person disappears off to care for it
- All the work for your project is on a machine that has a drive error and the work is lost
- The client is reassigned to other work and has no time for your project; a new client has no idea what you've been working on
- The client keeps changing his mind as to what is required in incremental but significant way
- The client shows you private information relating to a friend.

The list included some possibilities that were very

close to the actual scenario:

- You are assigned work on a different project
- Your group is told to incorporate some other ideas that don't really match with your own.

All groups submitted the document for each stage at the end of that stage. At the end of the Analysis phase, some groups were required to swap their project documentation. The groups were selected randomly, with six of the ten groups swapping. All groups were called to a meeting in which they were given envelopes containing numbered tokens, six of which were bus shaped, the others were bicycles. Numbers were then drawn out of a box to determine the swapping arrangements of the bus crash groups. The SDLC stage that immediately followed the ROBAB was the Logical Design stage whereby the 'look and feel' of the new information system is developed.

At the end of the semester, students were asked to submit and present a review of the process including their impressions of the bus incident, and to self assess their projects according to a predefined marking schedule. The majority of the feedback recorded here has been extracted from those reviews and presentations and from the online course evaluation.

4. RESULTS

4.1 Initial Outcomes

The initial reaction upon being ROBAB was subdued. One student responded with a dramatic outburst shouting as he slammed the door: "I came here to learn and excel, not be dealing with other people's ****", but most quietly accepted the revision and began to plan their next course of action.

In the final reviews a wider range of initial reactions were reported:

- "I was angry"
- "It was viewed as a new challenge and welcomed"
- "The group had no hesitation about getting ROBAB, in fact it was looked at as an expression of what could happen in a real situation"
- "…our project was turned upside down when the metal monster hit"
- "Initially there was a great deal of confusion…"

Students were concerned about the unfairness of only some groups getting hit by the bus, and felt they would be disadvantaged in terms of their achievements at the end of the semester. This unfairness was related to the anticipated workload in dealing with the changeover to another groups work.

- "…leaving one with the impression that the 'control' group were in a more fortunate situation and had a competitive advantage"
- "The real cause of consternation was the fact that this additional workload was not applied unilaterally."

Those groups who were not hit by the bus were grateful, and felt they had drawn the long straw. Their reviews used terms like "lucky", "thought it was a blessing" and "thankfully" to describe their relief at avoiding the perceived disaster.

Over the next few weeks the groups moved through Logical Design. Some extra effort was required by some groups to bring work up to their standards or to merge the new documentation with their own. An acceptance of the change was not long in coming and most groups settled to work on Logical Design:

- "The bus accident initially caused some concerns but these did not last long."
- "…due to our consistency to our six steps while progressing with SDLC, we did not face any significant difficulties to carry on with the project except additional time were spent on reviewing the documents and data from another group that was being assigned to us"
- "Like a vaccination, it hurt a bit but ultimately it was good for you."

The groups found different strategies for dealing with the "accident". A philosophical approach emerged with a few groups:

- "worse things happen at sea"
- "It was important to keep in mind that the process seemed more important than the final product."

Many groups reported benefits from being given another group's view of the project. For many students this was their first experience of analysing other students' work and this allowed a fresh perspective on their own work:

- "…the final product of the project is better than it would have been without the change of project. This is because we got to see ideas and concepts of others regarding the project"
- "It did have the learning benefit of working from other people's work"
- "…was a good experience because it gave us a chance to experience and study other people's ideas and analysis situation from their point of view."
- "…Maybe the bus theory would have worked in our favour. That way we would be able to see what the other groups were developing, gain ideas that we had previously not thought of and grow from the experience" (group not hit by a bus)
- "Having a bus did however help our group in some aspects aspects as we were provided with some very in depth information from C____'s analysis stage…. This gave us the means to come up with a good logical design phase"
- "We were amazed by the work level of the other group" (presentation).

Negative responses to ROBAB during the Logical phase related mostly to the increased workload of making sense of the new analysis documents, which varied greatly in quality and quantity:

- "A considerable time was spent re-analysing and re-strategising to reach a level to accomplish the next stage, which involved many long late night/ early morning hours"
- "Deciphering this documentation, comprehending and finally implementing their requirements made up a significant additional workload."

Students found it difficult to let their own analysis go, in order to adopt the new requirements. As all the students were working on the same project, the solutions were very similar. Some groups struggled with the extent to which they should adopt the new documentation, or whether they should merge some of the new ideas with their own ideas. They had expected to be working on the same project for the whole semester, and had become attached to a conceptual view of their own solution:

- "By the time we'd finished the analysis stage I was keen to aim for something really good, something that was the best it could be"
- "…the fact that all the groups were working towards a similar goal made this bus crash irrelevant because the previous work could not be forgotten and as in our case we just carried on with our ideas and goal"
- "it was hard to pretend we had amnesia."

The greatest negative impact on many groups was a loss of enthusiasm for the project outcome. This related to their attachment to their own project ideas, and also to the prospect that it could happen again at the end of the next phase:

- "…the bus came and went and with it took all my interest packed neatly on the back seat. … The big difference was that I didn't want to do it anymore and that made it all a bit of a chore"
- "One major drawback to the change was the loss of time, which demoralised the group, and it was hard to get going again"
- "…resulted in a reduction of enthusiasm for the project as a whole. The feeling that by swapping work and working in groups removed individual responsibility and accountability arose and that the project had become an exercise in endurance rather than an opportunity to excel."

Interestingly, this loss of enthusiasm was also reported by groups who were not hit:

- "While our group was not hit by a bus, we definitely felt that the level of cooperation between groups dropped significantly after the incident"
- "…I felt that perhaps an air of complacency did creep into the group's work, and as a result standards did drop…"
- "felt that some groups did bad work because they thought they wouldn't have to carry on."

4.2 Final Responses

Once the projects were completed and the pressure of work eased, the students' opinions of the bus incident mellowed and most were able to see the long term benefits that had come from the exercise:

- "This should definitely be repeated next year as it does stress the importance of documentation"
- "It demonstrated the importance of having every stage well documented"
- "This also helped our group's character…"
- "It is realised now that this was a real-world experience that will doubtlessly prove valuable in later working life."

The impact of the crash on the final outcome was minimal. The bus hit neither the highest nor the lowest marked projects, with the remainder of the projects following a normal distribution:

- "Getting run over by the bus did not have a major impact on the project itself but it did make us think twice about what was expected of the project and its documents."
- "..while the incident itself had the potential to vary the outcome of our project, it was found that the change itself had very little impact"
- "The final outcome was totally different from what I originally conceived. A major cause of this factor would have to be the bus massacre…"
- "I believe the final product of the project is better than it would have been without the change of project."

With only ten groups participating in the study, a detailed statistical evaluation of the results is not possible. However a measure of the success of the course can be seen from the responses to the online course evaluation.

In response to the statement question "The course met the objectives stated in the course outline," 83% of the responses were positive (1 and 2, on a 1 – 5 scale). This is comparable to the 1999 results of 87% for the same question. There was also a positive response to "The lecturer worked to create an effective learning environment", namely 83%.

Overall the course received similar responses to the previous year:

- "The challenge of actually thinking we could understand something! Thinking with an open platform (What if&what if etc going up more levels)"
- "Good experience for 3rd yr project, had fun actually doing the project instead of learning theory!"
- "The pressure the feeling of working in a group and management and responsibility of work required"
- "Both Sam and Lesley are excellent communicators. It must be hard to teach a conceptually difficult subject"
- "Environment was very positive and interesting. Appreciated lateral insights and thinking outside the square."

The students were also asked whether they thought we "should run next year over with a bus?" The majority of responses (72%) were in favour of repeating the exercise, but 50% of the students added the condition that next year the bus should hit all groups.

Almost all students who swapped though ROBAB should be repeated.

5. DISCUSSION

Was the "run over by a bus" incident worthwhile? Yes. The process of swapping project documentation had a number of benefits as reported by students and increased learning certainly occurred. This increased learning came from two areas, dealing with the unexpected and benefits from the actual swap. A large part of project management is the ability to 'bounce back', having systems in place to do this is an important skill. The benefits from the actual swap include the emphasis of the importance of clear documentation, working with the outputs of other groups and incorporating new material in subsequent stages. These findings agree with those of Surendran and Young (2000).

The students were concerned with the impact of the bus crash on their final marks. The approach of the lecturers was the projects were self assessed, we would accept any reasoned approach to dealing with the ROBAB and the marking of both the process and the deliverables. With some groups not swapping this caused some consternation among students (initially amongst swap groups then later among non-swap groups). The effect of the ROBAB needs to be clearly established in the marking schedule. In this case, so as not to defeat the purpose of the swap, the orginal marking schedule did not contain references beyond the warnings about "unpredictable turns". To be allowed to do this, essentially changing an assessement during its course (at least potentially from the students' point of view), we sought written permission from the School Programme Commitee and Ethics Committee.

Should the bus crash happen again next year? Maybe it would not be unexpected and would be a very different event. Would, for example, the students work hard in the first stages, knowing that they were

going to 'lose' their work?

Perhaps, to keep the element of surprise, some other catastrophic event should be used.

The second aim of this paper was to assess this practice in terms of Robinson's empowering paradigm, in particular to examine the question: does the control imposed by the lecturer and consequent loss of ownership of the project by the students outweigh the benefits of swapping? At first glance the process would appear to be in conflict with the concepts of empowerment. Most of the attributes listed by Robinson (1994 Table 1) have been at least dented by the bus crash. In particular are issues of ownership of the process, choices, and possibly even "perpetrators and victims of discipline". The empowerment model, however, does not say that the teacher cannot challenge the students, indeed the model describes students who are "actively engaged in meaningful experiences that the teacher facilitates". Shor (1992) argued that creating a challenging situation the teacher is empowering the students to achieve, however, students do not always immediately like things that threaten their passivity; "by the time they reach secondary school, many students assume that passivity is what best fits the nature of the school…they come to dislike disturbances to their passivity" (Shor 1992, p196).

Harris (1992) described personal control as a prerequisite for empowerment. Often empowerment is not possible because people's choices and actions are steered unnecessarily. For a while our software-engineering students perceived they had no control, but soon realised they could do it, were given a voice and got enjoyment from the process. The students who swapped thought we should repeat the exercise. So, while the locus of control dislocates for a time, it quickly returns and the overall feeling toward the course is positive. The students who did not swap, however, had their ownership removed by the threat of swapping but did not come to realise the benefits.

REFERENCES

Godbey, G. (1996) The agile learning communities initiative (ALCI): Unmasking and transforming educations hidden curriculum. Bethlehem, PA, Centre for Agile Pennsylvania Education (CAPE) http://agilepa.ie.lehigh.edu,

Harris, K. (1994) Teachers: Constructing the Future. The Falmer Press, London.

Hoffer, J. A., George, J. F. and Valacich, J. S. (1998) *Modern Systems Analysis and Design*. Reading USA, Benjamin Cummings, 854pp.

McQueen, M. and Mann, S. (1999) The changing scene of third year projects. Proceedings of the 12th Annual Conference of the National Advisory Committee on Computing Qualifications, Dunedin, National Advisory Committee on Computing Qualifications: p313.

Mann, S. and Buisink-Smith, N. (2000). What the Students Learn: Learning through Empowerment. 13th Annual Conference of the National Advisory Committee on Computing Qualifications, Te Papa, Wellington, New Zealand, NACCQ: 213-220.

Mann, S. and Smith, L.G. (2000) Assignment Information (online) http://bit.tekotago.ac.nz/~sam <viewed Jan 21, 2000)

Robinson, H. (1994) The ethnography of empowerment: the transformative power of classroom interaction. Bristol, Falmer Press

Shor, I. (1992) Empowering education for social change, University of Chicago

Surendran, K. and Young, F. H. (2000). Teaching Software Engineering in a Practical Way. 13th Annual Conference of the National Advisory Committee on Computing Qualifications, Te Papa, Wellington, New Zealand, NACCQ: 345-350.

ACKNOWLEDGMENTS

Permission to carry out the study, using a control group, was given by School level process of the Otago Polytechnic Ethics Committee. All groups complied with a request to include in their management document a statement to this effect:

"All members of this group are aware that our experiences in undergoing this project may be used in research into teaching methods for software engineering. We understand that identities will be confidential and that taking part in this research is entirely voluntary and will not affect in any way how we are treated by the lecturers in this course."

The comments of Frank Young, Maxine Alterio, Graham McGregor and Peter Brook on earlier versions of this paper are much appreciated.