

Software engineering – learning through innovation and interaction

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Subject Area: Software Engineering

This case study has been developed from data gathered through observations of the teaching component; interviews with the tutor and a student focus group.

Background

This case study highlights an innovative approach to teaching software engineering to first year students in the School of Systems Engineering at the University of Reading. The module is a compulsory 20 credit course for the cohort of 200+ students and runs for 20 weeks, starting from the first week of the academic year. The surface learning for the course is provided by a traditional lecture course of two lectures per week. All of the theoretical aspects are dealt with in the lectures and two of Rachel McCrindle's colleagues present the majority of these. There is also one seminar per week and these are divided approximately 50:50 between those that directly complement the lecture course or look at career management and those that relate to the subject of this case study: group work projects designed to generate a board game that when played would teach the players software engineering.

The initial idea for this approach came when Rachel was working at Northumbria University where, with a colleague, she developed such a board game. At Reading, Rachel resurrected the board game idea, this time getting the students to design the games which Rachel would then test and assess. The approach has now been running for the past five years and offers an alternative to setting more traditional forms of coursework. Rachel provides a few introductory lectures and the rest of the process is conducted in the seminar slots. The cohort is divided into eight seminar groups of between 10 and 30 students in project teams of between four and six. The teams select themselves during the first week or two of the course and this year there are 35 teams. Rachel has the assistance of a Demonstrator, Andrew Harvey.

Students are given an assignment specification which tells them what it is they need to do for the seven deliverables and what these are trying to assess. The main end point is a 'paper-based' game but this can be made out of other materials such as wood or perspex. It can't be a software or an electronics based game. Students decide which of the Belbin team roles they align with best and, on the basis of this, the team leaders/project managers are assigned. The first deliverable is to develop their team name and logo and to assess their collective team skills. The groups are given early feedback on their reporting style and how they have gelled as a team. The second deliverable focuses on project management. The teams have to develop a work breakdown structure with a Gantt chart and risk analysis. The third deliverable is of their initial designs and resources. The design ideas can be based on existing board games or be totally original. This then leads through to their final designs and updates for their project management documentation. The designs should be complete enough to allow a third party to make the game. Throughout the project the groups have meetings and these have to be minuted. At a later stage in the project the groups re-assess their risk analysis, documenting those that have materialised and any new issues that may not have been thought of initially. Finally, they get their resources and start building their game. The teams are given a budget of £5 to purchase things like playing pieces. Some materials such as foam board, coloured card and paper are provided. They have to deliver a playing manual with complete instructions for how to play the game. They also put together a poster that describes and explains their game and a professional print is made of this. They also have to make a self-running presentation. All of these six deliverables are presented as a team, while the final deliverable is an individual report that provides a critique of their learning and their contribution to the

team. The report also has to provide their views on how they would improve their performance if they were to repeat the process and suggestions for how this group work could be enhanced in subsequent years.

When student teams hand in a deliverable, they have to say whether they've all worked equally on it. There is a penalty system available to team leaders if people are not contributing. For example, if a student misses a team meeting they might be given a black spot. Three black spots gets a yellow card. Two yellow cards and they have to see Rachel. All of the deliverables presented by all of the teams are assessed by Rachel. The game and all associated deliverables are worth 45% of the course. 5% is for career management, in which the students have to prepare a CV and practice letter of application, and the final 50% is for the exam.

After the exams, Rachel organises an award ceremony. A number of industrial companies sponsor awards. There are five or six independent judges that look at the games, posters and presentations. Each team has a ten minute slot with the judging panel to present their game and field questions. A number of awards are made for the ones deemed best in the various categories and these cover all the elements of the software lifecycle, including best documentation. There is also a lucky draw prize. The School supports the module financially, funding materials, professional printing and one of the prizes at the award day.

In the observed seminar, students were in their groups, finalising the ancillary aspects of their games while they waited for their final designs to be delivered from the professional printer. The groups were all keen to describe their games and explain how the gaming process worked. They also demonstrated their level of software engineering knowledge and how it was incorporated into the games. There was a diverse range of game designs and the level of inventiveness was impressive. The game brief indicates the maximum size of the board. A number of the game boards were expertly designed to be set up into a three dimensional gaming structure, even though they could be put away in a flat box that also has to store all of their gaming pieces and the instruction manual. A selection of the finished games, posters and presentations from the previous year were also observed and the design, construction and presentation quality were again evident.

Reasons for introducing this teaching method

During a re-design of the degree course, the Software Engineering module was moved from the second year programme to the first year. This presented the problem that 'freshers' entering the module may not be sufficiently proficient in computer programming. Rachel thought it would be good to engage the students in a new way, rather than just learning from lectures and text books. Additionally, a number of students had indicated that the theoretical aspects of the subject could be a bit 'dry'. It is, though, an important subject and an important grounding that students often don't appreciate until they've been on placement or embarked on their careers, so there was a need for a learning process that could facilitate deep learning of a complex subject.

Lecturer perspective

Rachel feels that this process in which students have to think of the requirements, design, build and test the product and ultimately deliver it to the client (in this case, Rachel) is similar to those in software engineering but without the actual programming. There is a lot of work involved with planning and overseeing the teams, encouraging the students and managing the relationships. The seven deliverables generate a lot of marking, with the associated need of providing constructive and timely feedback, but she feels that the rewards are well worth the effort.

The teams come a long way quite quickly. In the first week they may often struggle to think of a team name but by the end they have generated “*excellent*” designs for their games, posters and presentations. The groups become quite competitive. Rachel maintains that she gets an appreciation of how the students learn: “*Active learning and getting the students to think creatively seems to work [...] The games are used in University open day exhibits and when the students come back to do this they are often very complimentary about the active learning aspect of the module.*” The skills learnt in the module are useful in other modules, especially their final year project. Also, the transferable skills are very useful to their careers: “*Students who have returned from placements say how useful all the information they gained on software engineering through the board game approach has been to them. They often don’t appreciate it at the time they are doing the games but the learning has obviously been embedded and the placement work reveals their understanding.*” The process helps, not only with initial learning, but also with revision. They have had to amass the information to put into their game and in most of the games this information is sequestered into question cards, thus they have essentially developed a set of revision cards.

The student teams tend to work any issues out for themselves and will often only come to Rachel as a last resort. Rachel and Andrew monitor the students closely to see that the teams are functioning smoothly and so that any group issues can be addressed as quickly as possible. The students have to organise a lot of their team activities outside of formal timetabled sessions. Many of the teams in recent years have used social networking sites such as Facebook to coordinate these activities.

At the outset Rachel was concerned that the students would run out of ideas after a few years but this has not been the case. In the first year the module was run, the student groups mainly reworked pre-existing board games but now they tend to come up with largely original ideas. Rachel considers that the activity would be readily transferable to almost any discipline.

Students’ perspective

The students all said that they enjoyed the process of developing the board game in their teams. There was definitely an element of fun: “*It’s not one of the most exciting subjects to learn in the lecture format.*”

The students appreciated that the board game was preparing them to be software engineers. Although it was the development of a board game, it was felt that it was still the same project-based creative process that would occur in an industrial setting and that similar kinds of problems would need to be addressed: “*It prepares us for being actual engineers because we are going through an actual project.*”

The organisation of the specification was appreciated: “*It’s very well laid out. If you’ve done all the deliverables, you sort of end up with the game, no matter what.*” Feedback from the deliverables was considered to be helpful and the students were really appreciative of the time that Rachel and Andrew devoted to the project.

The team work provided insights into the reliability of others and of their own capability and capacity. They realised that they were learning how to work with others, even if they didn’t get on with them on a personal level, and that this mirrored the situations that could occur in industrial settings. Discussions around team dynamics raised a level of concern about the additional responsibility shouldered by team leaders and the increased stress this could engender, especially for meeting deliverable deadlines. It was clear that team leaders were gaining additional skills in learning how to share tasks around and how to get the most out of team members, but this was offset by the additional managerial and administrative burden. It was also apparent that some team leaders were experiencing the ‘lonely at the top’

phenomenon. The possibility of rotating team leadership over the course of the project was suggested, although it was appreciated that some individuals would shy away from the leadership role. Students felt that the Belbin roles determination early in the process was useful in establishing the sorts of qualities that team members could bring to the table.

There was some discussion over the variable quality of individual contributions to the total team effort and the effect this could have on individual marks. After some lengthy discussion it was agreed that, as with the black dot and coloured card sanctions, the overall process was a reasonably fair one. It was felt that Rachel and Andrew obtained a clear understanding of the contributions by individuals over the course of the year and that they strove to make the process as fair as possible.

The competition aspect was seen as good and motivational. The students were looking forward to the award day and they were pleased that there were prizes for relevance to software engineering and methodology aspects as well as for the game itself. This meant they were still able to win awards, even if they didn't feel their team's game was as good as some of the others.

All were agreed that the project was a good way of both learning and revising. The development of the game got them to screen through their lecture notes and texts far more than they would for a straight lecture course. They all conceded that, as the board game work started from the first week of their degree programme, it also served as a valuable part of their integration into the University.

Issues

- Sometimes team members can be considered as not pulling their weight by the rest of the team and this can be difficult to manage, particularly if these are friends.
- There was concern about the different levels of responsibility for team members and leaders.
- Some students have disabilities, such as blindness or Asperger's syndrome. These have been very good for the development of awareness in the other students although team dynamics have to be handled quite carefully.
- It is very time consuming for staff. It would be a lot easier to just set students an essay.
- One thing that makes the time management more difficult is that the students are on a range of different courses with different timetables. Some students have other group work projects during the academic year: "[...] we have got a team member who is usually triple booked on Wednesday afternoons, which is the only time that all the groups can meet." It is good to get the different disciplines working together, but too many group projects running concurrently was an issue, particularly as some students were reluctant to work on the projects at weekends.
- While the board game work can help with student integration into University life, there are still cases of students dropping out during the year and this can be an additional burden on the rest of that team.

Benefits

- It is enjoyable and provides a fun way of learning a complex technical subject.
- It develops an understanding of the subject of risk. All the students surveyed thought that this was beneficial for their other courses and one student was of the firm belief that it provided a protocol for survival in their personal lives outside of the University!
- It develops the teamworking and transferable skills that will be necessary in industry.
- It is a good way of integrating students into University life.
- It is a valuable and rewarding teaching experience and enables Rachel to get to know the students and their individual characters, something which is useful when she teaches them in later years.

Reflections

One student particularly welcomed a different teaching and learning style: *“It’s good to have a different teaching style [...] because not everyone is an audiovisual learner, there are kinesthetic learners as well.”* Another liked the approach and the marks available because it took some of the pressure off the exam.

All were in agreement that this was a novel approach that definitely aided the learning process: *“The actual module, I think, would be much worse without it because it is so much information, it just wouldn’t go in.”* *“Rather than being forced to learn, it reinforces what you are learning.”*

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