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Contents

Experiences with building intrinsic motivation through self-directed projects

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Abstract

In the effort to control and manage the task of assessing student work, there is a strong tendency in computer science (and many other disciplines) to give well-defined tasks that are variations on or combinations of examples students have previously been shown. Although this makes assessment straight forward as students are expected to produce largely homogenous, convergent answers, it stifles students' ability to be creative in their solutions and offer (possibly better) alternatives or to apply their knowledge to the less well-defined problems that exist in practice. In addition, as the tasks are defined by the lecturer, students may or may not see them as interesting or relevant.

In this paper, I argue for allowing students to define their own projects for assessment purposes as a way of generating intrinsic motivation for their studies. I discuss how this is implemented in one course and the challenges and outcomes for the students and lecturers. Finally I present some guidelines for others who want to implement student-defined projects in their courses.

Introduction

Employers and institutions of higher education often cite the ability to undertake self-directed study as a desirable graduate attribute that universities aim to develop in their students (UA 2008; ComputerScience 2008). However, this ability for independent learning is seldom explicitly developed and even more rarely assessed in computer science courses. Instead assessment generally supports dependent learning where students are given a technique to learn and are asked to reproduce the technique possibly applied to a slightly different problem. Although this does develop a set of skills in students, it does not encourage deeper learning (Martin 1993) and contributes to students who are unable to apply knowledge to new situations they encounter as practitioners (Brown et al. 1989; Narayanan & Neethi 2005). There are several factors that encourage assessing students on well-defined problems. The first is the challenge to lecturers of assessing tasks that result in divergent answers equitably (Eris 2006; Biggs 1999). The second is the challenge of motivating students to willingly take on an independent learning task (Hiemstra & Brockett 1994). Students often expect to be taught information and are often uncomfortable or reluctant to take on a task without a clear idea of exactly how to accomplish that task. The challenge of learning to do something on their own (even if they have a teacher/guide to assist them along the way) is one that many students find frightening rather than motivating.

One way of motivating students is through open ended group projects. Working within a group gives students a "community of inquiry" to support their learning (Lipman 2003). Open

ended group projects are also an effective way of challenging students to employ independent learning skills and can help motivate students to engage more deeply with a topic (Newman et al. 2003). We can further increase this intrinsic motivation by allowing students to define their own projects. In a large class, it is unlikely that students will all have the same level of interest in a given project that is largely specified by the lecturer. By relinquishing control on the choice of project to the students, we allow them to follow their own interests, increasing their own intrinsic motivation for the task.

Although group projects are a feature of some computer science courses, the assessment of projects that students define themselves is not common. In this paper I present a case study of the use of student-defined projects within a postgraduate elective course in Mobile and Wireless Networks. I give evidence of the high level of intrinsic motivation that this approach generates. I also present some of the challenges encountered and how I address these challenges. Finally I present guidelines for including student-defined projects in courses to assist others who want to include such projects in their own courses.

A Case Study of Student-Defined Projects -Challenges and Rewards

The project scope

Mobile and Wireless Networks is a postgraduate elective course taught to approximately 30-50 students each offering. The students come from a range of programs: coursework Masters (with and without a major project component), Honours students and Defence Science (predominantly mature age) students. The course covers a broad range of topics from designing applications for mobile and wireless devices to environmental impact on communication quality. Although the course gives a rigorous understanding of the topics, any one of these topics could be a course on its own and an early goal was to have students develop their understanding and skills in at least one area to a greater depth through independent study. As the course is an elective one, students who choose to take the course have already expressed a personal interest. I aim to build on this interest and give the students flexibility and support within the course to further explore their own interests. Therefore, rather than limit the way in which students can explore an area, students are able to define their own projects.

The student-defined group project is part of the assessable work in the course accounting for 20% of a student's summative assessment. Students take the knowledge they are learning and extend it in an area of interest to them. They select a topic area after the overview lecture. Through their initial reading, they propose a project. These projects range from application development to experimental research, but the common theme is that they allow the students to explore much more deeply a particular subtopic of interest to them and to apply that knowledge in building a real system. The final lecture time is used as an open poster session held in the school foyer that allows students to demonstrate what they have done and allows other students and staff to see the work the students have produced. This enables students to employ all of the skills that they have learned in their degree: technical skills, group work, independent study, analysis, and presentation skills in a project that they personally care about and is relevant to them.

Outcomes and Student Feedback

Student Experience of Learning and Teaching (SELT) feedback and informal feedback indicates that the projects are the students favourite aspect of the course and they feel it is particularly beneficial in their understanding. This can be seen in some of the SELT comments given below:

> "The project was a definate (sic) highlight of the course, along with the presentation session. It was good to see what other groups had done, and also just to be able to show off what we'd acheived. The other staff and students coming along added to the atmosphere as well."
>
> "Enjoyed freedom for project work"
>
> "projects helps to know more about the course"
>
> "The project she started in MWN is fantastic. Should start for the other level 4 courses as well."
>
> "it (Mobile and Wireless Networks) is one of the rare opportunities for them (students) to discuss their works as peers within the community. I consider this course a significant contributor to training for their Masters thesis and similar to a minor thesis for the MIT students". (academic staff comment)

Each group has individual forums to supplement face to face meetings with asynchronous communication related to the group's project. Separate forums are available for course questions unrelated to the projects. Use of these forums is not required or assessed. The significant amount of traffic that is generated by some groups is indicative of the intrinsic interest in the projects. Group forums registered 97 discussions, 355 posts and 3402 views in 2006 (class size 50) and 33 discussions, 124 posts with 1160 views in 2007 (class size 32). What is more significant is that most groups chose to work face to face or used other means of communication. Of the groups that used the online group forums to discuss their project, the mean number of posts was 67 for a group of 4 students, with a range of 12 posts to over 200 posts. Considering that these group discussions were in addition to the development work and face to face discussions, this is a significant amount of engagement with the projects. In comparison, there were 51 discussions and 209 posts (2006) and 34 discussions and 88 posts (2007) in the student forums set up for discussions of all topics other than the projects.

Considering the project is worth only 20% of the summative assessment, the quantity of activity indicates that students put in more time and effort into the projects than would be accounted for by the external motivation of assessment. This along with the comments from the SELTs indicates that the ability to choose their own project acts as a strong intrinsic motivator for the student.

Challenges

Although student-defined projects can be motivational, they also bring with them challenges for both lecturer and student, moving both outside of a comfort zone of the familiar. In the following sections, I discuss some of these challenges for students and lecturers and the approaches taken to address these challenges in the course.

Fear of the unknown

The first challenge is convincing the students they are capable of independently selecting a project and forming groups. Although the majority of students quickly select a topic and find a group of similarly interested students, some students lack confidence in their ability to select the topic and are concerned about finding other group members. I address this in several ways, the first is to begin the course with an overview of the topic areas. This exposes students to the various challenges and areas of interest. I advise students to first decide on an area that appeals to them. Second, I provide example project topics in each area. These are not detailed project descriptions just interesting problems/questions in each area. Third, I provide an online bulletin board for students and encourage them to post messages if they have a project idea but need more members or are seeking a group looking for more

members. This is an effective use of technology and can lessen the fear of rejection and time involved in asking fellow students to join a group, particularly when many groups have already formed and may not have space for more members.

This approach has been successfully used for three offerings of the course. All students were able to organise themselves into groups without teacher intervention. Anecdotal evidence based on feedback from students and staff indicates that there are fewer group dynamics issues than in other group-based assessments. To date I have only had one group experience problems within the group that required my intervention. One concern with the current approach is that students may choose their group-based on friendships rather than common interest (Mitchell et al. 2004), which might reduce the potential for intrinsic motivation for the project. However, even if this is the case, the motivational aspect of working with friends may at least partially offset that disadvantage and it may also be a cause of the low level of group dynamics issues.

Learning to Self-Direct Study

With the vast resources now easily available to students on the World Wide Web, one surprising discovery is the inexperience that many students have with using this resource. In computing, not only is there a large amount of tutorial information on the Internet, our major peer reviewed journal and conference papers are also available as well as pre-web seminal papers. It is also common practice for authors to retain the right to publish their papers on their own websites. So many journal and conference papers are available without requiring a subscription. For many of our students, the web will serve as their primary source of information as they move into their careers or further education. As our students are computer science majors, I initially assumed a high level of information and communication technology (ICT) proficiency.

The problem that I discovered was that although all students have a high degree of technical proficiency, that does not always equate to high levels of cognitive proficiency in using the information. The importance of this skill is reflected in the Educational Testing Services release of *iSkills* assessment to test for "information literacy" in digital environments (Katz & Macklin 2007). Several groups have difficulty starting their background reading and tend to either not know where to start or choose literature that is too narrow (non-survey technical articles), which they have difficulty understanding. Other groups favor survey articles and wikipedia entries without seeking more in-depth knowledge, which leads to a surface understanding that prevents them from addressing challenges they face during their project. I use two approaches to help the students with lower levels of information literacy to develop their skills. The first is to give the students guidelines on the differences between survey articles written for different audiences (non-technical, technical, research) and how they can locate and identify these articles. The second is to give them guidelines and assessment criteria that define the expectations of knowledge depth.

Assessment and Feedback

One of the primary concerns of the course lecturers when first considering introducing student-defined projects was the unknown time commitment needed to provide feedback and guidance to the student groups. Fortunately, we discovered the projects do not require a significant amount of time on the part of the lecturing staff and certainly no more than needed to support more traditional practical programming assignments. Groups meet with lecturers on request and most groups discuss their project with staff three or fewer times over the semester. These meetings are primarily seeking feedback, where students have developed a plan for their project and want feedback as to strengths and limitations of their

approach. These meetings are typically less than 30 minutes each and are conducted face to face.

One of the main challenges of giving the students the opportunity to select their own projects is determining how to equitably assess heterogeneous projects. This is compounded by the challenges in assessing group work. Giving the students the choice of project means that I can not test out the projects in advance to ensure that there will be no unexpected challenges. This degree of uncertainty places a greater importance on assessing the process of the project and not just the product. A group may undertake a project that on the surface appears straightforward but turns out to involve significant challenges. Focussing on the product would mean that the group would receive a lower assessment if such challenges meant they didn't have sufficient time to achieve all of their goals, regardless of whether they were able to creatively and independently overcome these challenges. I therefore assess the process of the project as well as the product. I ask students to present how they chose their project and why, what information they used in their project and how they sourced it, the challenges of the project and how they overcame them, as well as explaining and demonstrating the outcome of their project.

As well as feedback from the co-lecturers, I make use of peer review of the projects. These peer reviews do not influence the summative assessment of the group being reviewed but only serve as another source of feedback for the group. The reviews do contribute to the summative assessment of the group writing the review. Not only does this give the students additional feedback from their peers, it also helps the students to see the strengths and limitations of their own work and helps them develop skills in providing constructive criticism and in self-critiquing. Students find this surprisingly challenging, as there are few opportunities to develop their own critiquing skills in their studies. A common misconception is that peer reviews or critiques are strictly about saying what is "wrong" with a project. As with the information literacy skills, I give guidance and examples on how to give constructive criticism. The combination of teacher feedback and peer feedback as well as their own reflections in providing feedback to their peers gives the students a much clearer understanding of the strengths and weaknesses of their own work and how to improve, which, after all, is the main purpose of feedback. The benefit of this to the students is reflected in SELT results that indicate a significantly higher feedback satisfaction level in this course than average (mean 5.4/7, 78% broad agreement compared to the school and faculty 4.7, 60%/56% broad agreement and university 4.6, 57% broad agreement) (CLPD Adelaide 2005, 2006).

A Model for student-defined Projects

The introduction of student-defined projects in the Mobile and Wireless Networks course has resulted in a high level of student engagement and motivation as reflected in the SELT responses and the level of participation in project related activities. In addition, the quality of the projects is generally very good and reflects a significant amount of thought given to the design and experimentation. All students so far have presented work that met with our expectations of showing evidence of independent study, planning and reflection. Several of the groups have exceeded our expectations and presented work that was technically challenging, innovative and highly insightful. Still, to reach these successes, there are challenges that need to be overcome as both students and lecturers move out of their traditional expectations with regard to learning and assessment. From my experience there are some key issues that must be addressed by the lecturer to make such independent projects a successful and positive experience. I summarise these issues here.

Overcome the fear

Students are generally unaccustomed to defining their own course of study. This is for most students not something they have ever been asked to do. A common reaction from students is "what happens if I can't find a group or topic?" It is important to provide students with multiple ways of forming groups. Providing a student forum where they can advertise or seek groups assists many students, particularly those who may not have a pre-formed social group and would feel uncomfortable asking others individually.

Another alternative is for lecturers to define the groups. There are several advantages to lecturer defined groups. The groups can be made more even in ability thus giving them a more equitable ability to solve the task as a group. However, that can also limit what students can achieve within a project. Students are likely to consider their own enthusiasm and that of a fellow student for a project in selecting their project group, something that is difficult for a lecturer to gauge. The selection of their own group also gives them ownership of their group, which may give them a stronger sense of responsibility for managing group problems. However, the freedom to choose the people you work with rarely occurs in employment. Learning to work with others who may not be an immediate part of your peer group and with a diverse range of backgrounds is also a skill worth developing.

I believe the answer to this dilemma lies in identifying the purpose of asking the students to work in groups. If it is for developing group interaction skills, then lecturer-selected groups may serve that purpose better (Mitchell et al. 2004). If the purpose is to form a community of inquiry and engage students with their work, then student-formed groups at least need to be considered. Further research needs to be done to determine the impact of student versus teacher formed groups on student engagement with their group work.

Provide a community

It is widely accepted that students learn better and in greater depth when they are involved in a community of inquiry and there are many practical examples of this in computing and engineering (Newman et al. 2003; Baron & Maier, 2004). Although choosing individual, rather than group projects could also generate intrinsic motivation through allowing students to undertake projects of their own choosing, this would remove the community of inquiry from the project. This is particularly of concern as the ability to choose ones own project has the potential to undermine the existing community of inquiry in a course as students could potentially all be working on unrelated or peripherally related projects, reducing the opportunity for collaborative problem solving. Though making the projects individual rather than group would remove one of the assessment challenges, an environment that supports a community of inquiry needs to be developed. One alternative to group projects might be to form students working on similar projects into communities. The effectiveness of this approach compared to project groups is an area for further research.

Make use of peer assessment

Students want detailed feedback on their work and the students' experience with feedback reflected in the SELT figures presented earlier, indicates that nearly half of students feel they do not receive adequate feedback. The diversity of student selected projects requires a higher level of assessment capability and expertise when compared with assessment of convergent tasks. As classes become larger and more specialised (where it is difficult to recruit candidates with the necessary background and experience to assist with assessment) providing detailed feedback becomes an almost insurmountable task.

Peer assessment can significantly assist in providing students with a greater amount of more detailed feedback than would be possible for a single lecturer to provide, as well as improving their skills on assessing their own work through reflecting on the strengths and weaknesses of others' work. Students tend to see peer assessment as positively contributing to the learning rather than as a time saving device for the lecturer when the peer assessment does not contribute to the summative assessment of the student being critiqued. They also feel less reserved about providing a balanced critique of the work when they know that they will not be responsible for a fellow student's result. When used to provide additional feedback and for developing self reflections skills, students welcome the additional feedback and insights that peer assessments bring. As reflected in the SELT scores, the students also feel more satisfied with the level of feedback received.

Assess the process not just the product

If we allow students to choose their own projects, then it is unlikely the lecturer will have detailed knowledge of the challenges that will occur in each project. Project goals may need to change as challenges are encountered. This makes it important to assess the process and to take account of the challenges and how the students overcome them.

Conclusions

The effectiveness of using group-based projects to motivate students and to engage them with deeper learning is well supported in the literature. The use of open ended projects to better prepare students for the the ill-defined problems they will face in the "real world" is also supported by previous research. Allowing students to define the topic and scope of these projects places even more control and ownership of learning in the hands of the students. A self-developed project, with only guidance from lecturers, gives students the opportunity to practice and improve their independent learning skills. My experience with student-defined projects presented in this case study shows that they can indeed motivate and engage students with their studies, without placing an excessive workload on the lecturer.

This paper has discussed my experience with several cohorts of students through one course. There are several ideas that require further research such as the impact on motivation of teacher selected versus student selected groups and the effectiveness of forming communities of inquiry around similar individual projects rather than groups of students sharing a project. In addition there are likely to be additional challenges to be explored in extending such projects into earlier undergraduate years and larger class sizes.

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