Open Ended Group Projects a 'Tool' for More Effective Teaching

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Abstract

Open Ended Group Projects [OEGP] offer an educational 'model', or tool, that has many benefits in terms of how and what students learn. This paper contains an explanation of the ideas that underlie OEGP and relates them to the concepts of problem based learning and educational constructivism. It shows how OEGPs can be used to encourage reflection on and application of the fundamental, subject specific, principles the students have learned and can contribute to the development of professional and 'social' skills which will be essential for their future careers. The holistic approach promoted by OEGP is argued to reduce the 'techie' flavor of CS education and thus help in attracting and keeping female students.

The paper discusses the role of OEGP in increasing student motivation, reinforcing other educational approaches and allowing new 'fast breaking' topics to be explored in some depth without changing the curriculum. Finally the issue of fairly assessing group projects is considered with particular emphasis on the social skills aspects.

The ideas are based on the experiences of the authors working in different institutions. They are illustrated using one course (IT in Society), which will be given for the fifth time this fall. This course is based on the idea that to make efficient use of Computer Science knowledge and skills in real life also requires the use of soft skills. Teachers from different disciplines supervise student groups solving real world problems with an emphasis on communication and group working and the application of acquired CS knowledge.

Keywords: OEPG, problem based learning, constructivism, motivation.

Introduction

Developing Computer and Information Science and Software Engineering skills in undergraduate students requires more than learning material by heart. Students need the ability to apply the material they have learned to novel situations (Narayan and Neethi, 2001). Conventional lecture based approaches may be suitable for conveying general ideas and facts, perhaps even in encouraging students to speculate about the nature of the material but finally what is required is that students are able to use the material they have learned in situations which might not be familiar or predictable. This is, of course, true of most subjects but it is particularly important in the computing disciplines because of the high probability that graduates will seek jobs in this sector.

There is a noticeable mismatch between the conventional academic approach, where achievement is measured as individual success with a focus on demonstrating technical knowledge, and the building of successful practical computer based systems which requires collaborative team working and is highly people oriented (people set objectives, most 'products' will be used by people and it is always people who pass judgment on the finished product). Furthermore, the traditional emphasis on a competitive, technical and individualistic approach and the significant disparities between the perceptions of boys and girls (Christie, 2002) has frequently been argued as being a major reason that there are relatively few female undergraduates despite the success stories of many women working in the industry.

Two other problems which have been widely reported are difficulties with student motivation, and the corresponding difficulties in getting students to undertake programming exercises, and the fast changing nature of the subject which cannot easily be matched by changes in the academic curriculum. The rapid changes in what is expected of people working in the computer industry in terms of programming skills and programming language expertise may well be a partial explanation of the motivation problem. There is a substantial difference here between computing based subjects and any other science or engineering subject. At no time has there ever been agreement amongst educators about the most appropriate programming language to teach 'first' and most institutions have changed the first language that is used several times (ALGOL, PASCAL, PL1, ADA, C, C++, JAVA). The changes are not just in the language, they have also occurred in the programming paradigm that is promoted (procedural, declarative, object oriented). The current focus on the web and on scripting languages such as ASP and PHP (or PERL), and the widespread use of 'wizards' to set up systems, has also led many students to either feel that they ought to be specifically taught these 'languages' at an early stage or to question whether they really need to learn to program in the conventional sense at all. Added to this, students find programming difficult so these problems exacerbate an already problematic situation. Jenkins (2001) has commented at length on the attitudes towards

programming of first year undergraduates and the difficulties they face.

These rapid changes in what appear to be the fundamentals of the subject would be unthinkable in other science and engineering subjects where the principles are generally agreed and stable. This fluidity in the subject matter, and the wide diversity of possible curriculum content, also makes it practically impossible to include all of the possible subjects in a single degree programme and consequently makes it likely that topics that students may regard as important will not be offered in their degree programme.

This paper makes the case for adding Open Ended Group Projects (OEGP) as a new pedagogic 'tool' which can be used effectively within undergraduate degrees to supplement the conventional teaching approaches. It is argued that putting students into a 'team' context and facing them with a problem for which there is no 'right' answer helps them think about what they have been taught, internalize some of the material that has been presented in lectures and laboratories, and develop the 'soft', people oriented, skills which are essential in the 'real world'. The requirement to consider what needs to be achieved and agree it within the group and with the lecturers helps overcome the purely technical image of the subject. This allows groups with different abilities to achieve the goals they are set which improves motivation and assists in demonstrating the value of the soft skills. Since these are often also thought of as 'female' skills it also helps female student recognise that they have a very useful role that they can play which helps significantly in retaining them on the course.

The next section of the paper considers the pedagogical underpinnings of the tool and shows how the OEGP approach relates to constructivism and problem based learning. This is followed by a discussion of the way in which OEGP can be used both to promote and reinforce conventional subject material which has already been taught and to encourage the development of more vocational skills such as group working, communication/presentation and problem solving. This section also explains why OEGP are being promoted as a tool which can (should) be added to the teaching toolset in use at educational establishments.

The value of OEGP in improving student, and staff, motivation and also in introducing students to new ('hot') topics at some depth without needing to explicitly modify the curriculum is discussed in the following section. The ideas are then illustrated by considering as an example a particular course (module), the IT in Society module which has been presented for the fifth time in fall 2002.

The penultimate section of the paper addresses the issues associated with assessment. In the experience of the authors it is difficulties in assessing students which is most frequently cited by staff as the reason that the use of group project work is not considered useful as an educational tool in academia. The paper is concluded by summarizing the benefits that have been obtained by the authors in practice using this tool and the readers are strongly encouraged to consider the possibility of adding the tool to their teaching armoury.

Problem Based Learning, Constructivism and OEGP

One strategy which can be used to facilitate students in both learning material and deploying their knowledge is Problem Based Learning (PBL) (Kolmos and Algreen-Ussing 2001, Kolb 1984). PBL is a method that sits well within the ethos of constructivism that is learning as an active acquisition of ideas and an assimilation of those ideas into a framework that the learner already possesses. Constructivism seeks to bring about the modification of learner behaviour after the experience of learning. It is not simply the accumulation of facts which is normally thought of as the outcome of the more conventional means of instruction. Students are not simple vessels to be filled up with facts; they need to be able to apply their knowledge in the real world and in circumstances that are not always predictable. Constructivism rather requires learners to be active in their relationship with the material to be learned. In order to bring this about it is perhaps most effective to set the learner a problem to solve, hence the link between PBL and constructivism. Brooks and Brooks (1999) recognize that the constructive approach presupposes the existence of a worthwhile problem that needs solving by the learner. A worthwhile problem can be defined as one that: requires students to make and test a prediction; can be solved without the need for expensive equipment they do not already have access to; is realistically complex; benefits from a group effort; and, finally, is seen as relevant and interesting by students (Brooks and Brooks 1999). In fact, all of those concepts sit quite nicely with the form of OEGP and are aims that any designer of an OEGP would understand and see as necessary for a successful project.

More importantly, as others have already noted, the constructivist learning environment is one that shares knowledge among teachers and students. To some extent, authority and responsibility for the activity are also shared between the students and the teacher. Perhaps most importantly, the teacher's role changes from instruction to guidance (Kolmos and Algreen-Ussing 2001). Finally, the constructivist approach requires students to be working in heterogeneous, small groups (Tam 2000). Again, all of these factors are ones that sit comfortably within the framework of OEGP. Copley (1992) suggests that constructivism expects the teacher to act as a facilitator 'whose main function is to help students become active participants in their learning and make meaningful connections between prior knowledge, new knowledge, and the processes involved in learning' (Copley 1992). OEGP once again allow that type of activity to take place. A large project is unlikely to concentrate on one area of expertise and is more likely to bring together various skills and learning that the student has already acquired or is in the process of acquiring. The constructivist approach frequently makes reference to the student as an apprentice and OEGP set up a scenario that is at the same time both realistic and safe. The student experiences a real project but is as it were allowed to

paddle to the shallow end or shout for a lifebelt if the project becomes problematic. The teacher can decide whether help is really needed or encouragement and/or reassurance will suffice. This safety and realism is one of the main attractions of OEGP for both educators and learners (Daniels, Faulkner and Newman 2002).

It must be emphasised that OEGP are a 'tool' in the educator's armoury not an end in themselves. In the experience of the authors, asking students to undertake an open ended group project increases motivation, aids students to learn new material and to internalise material they have been taught, and can help develop communication and group-working skills. However, each project can only be used to achieve a limited number of specific goals and these need to be considered carefully when the project is specified. As will be discussed when motivation and assessment are considered, it is necessary to ensure that the desired objectives are closely linked to the required outcomes and to the assessment scheme if students are to be encouraged to achieve specific goals.

OEGP Combining Education and Vocational skill development

As has been argued in the previous section, an OEGP is a form of experiential learning (Kolb, 1984) which can, in principle, be used to advantage to teach any subject with a practical application. This is clearly quite relevant in Computer Science, maybe especially so in the Software Engineering area, where theory and practice are natural educational concerns and where both knowledge and vocational skills are expected by employers. As examples, drawn from the authors' experiences, OEGP can be used to motivate students undertaking requirements capture or to help them understand systems analysis, software development lifecycles, specific software design support tools, entity relationship modelling, entity life histories, database design, web site design, or web server programming (Daniels, Faulkner and Newman 2002).

In addition to supporting knowledge acquisition, OEGP can be used to help the students gain and improve skills. The most obvious skill areas which are involved are interpersonal communication and group working. However, suitably designed OEGP can ensure that the students must consider the problems of communication with manager and client and can help improve both report writing and presentation skills. The positive side of this is that these requirements emerge naturally from OEPG and do not have the stilted, artificial, aspect that asking students to carry them out for an assignment quite often creates. OEGP can also assist in getting students to analyse problems and synthesise solutions while examining, and trying to mitigate the risks of things going wrong: all valuable skills for the software engineering project managers of the future (Ford and Gibbs 1996).

Many of our students will end up working for multinational companies and will therefore be presented with opportunities to work abroad. Preparing our students for working with colleagues from other cultures is something industry has requested we undertake as teachers. There are both preventive and constructive reasons for this. Defensively, today, it is common for companies to expand into new markets by buying existing companies. Cultural differences might however make this a costly exercise which prior experience with international collaboration might help to alleviate. A more positive reason for internationalism is the expectation that workers will encounter and be inspired by new ways of thinking, an aspect that might be easier for them if they have had previous exposure to working across cultures while students. There are also other academic reasons for including international collaboration in the undergraduate education, e.g. the potential for increasing the motivation for the course in which it is included as well as access to non-national staff expertise. This is, however, easier said than done, since international collaboration is likely to present students with difficulties when they attempt to carry it out. We argue that using OEGP is a convenient way to deal with all the unforeseen problems that are likely to occur in international collaboration, since a significant part of the OEGP ethos is to encounter and deal with new ideas.

OEGP are thus a natural way to set up an international collaboration. It is also true that international collaboration is a particularly attractive component of an OEGP, since it is ripe with potential benefits for subsequent work. In particular, the requirement for communication, analysis and reflection (all important professional skills) are amplified in an international collaboration setting (Daniels and Asplund 2000).

It is also true that students enjoy communicating with students in other institutions and especially abroad and the problems that they encounter, time differences, language problems, cultural differences, technological failures and inadequacies are much the same as they will encounter when they work in the real world. Students appreciate that and enjoy the challenges it gives rise to. Additionally, due to differences in educational/cultural background there will be plenty of opportunities for each group of students to act as teachers to the others and teaching is widely acknowledged to be the most effective way to reflect on and internalise one's own knowledge. For staff too, the chance to work with academics from different institutions is one that can inspire research opportunities and challenge thinking. Teaching is a very isolating experience for many academics and the chance to collaborate with other staff can be a source of inspiration and support that should not be underestimated.

One example of an international project involved students from two widely separated countries (8 hours time difference). The students were required to collaborate in virtual teams on a project that lasted 10 weeks. The groups which were put together by the instructors consisted of six students, three from each country. The project was a capstone project which offered the chance of a simulated real world experience requiring technical, social and communication skills. Various tasks have been used over the five years that the project has run but, basically, they all involve the students at one site controlling mechanical devices at the other with a camera providing the vision. This activity requires the students

to gain a deep understanding of networking, image analysis and real time systems. It also develops their software engineering skills and reinforces the paramount requirement for effective communication (the large time difference heavily penalises failures of communication but cultural differences and the fact that the students from different countries never meet make understanding difficult) (Pears, Daniels Berglund and Erickson 2001).

OEGP as a means of reinforcing conventional teaching motivating students and introducing 'hot topics'

The value of OEGP in reinforcing conventional teaching by getting the students to try to apply the ideas to a practical situation has already been discussed in the previous two sections. In this section we will use an example to show how the introduction of an OEGP which required the students to design and build a database as part of an OEGP to provide a web based IT Help Desk support system appeared to significantly improve the students' understanding of this subject. After a discussion of some of the published views on student motivation (and motivating students), this example backed by logical reasoning is used to demonstrate how motivation can be improved by using OEGP. Finally, it is argued that OEGP can be used to introduce new subjects into a course without either needing to revise the curriculum or resort to a very superficial treatment.

Learning to design and build databases had proved a difficult task for 'computing' students in the second year at one of the authors' universities. The problems had been demonstrated by lower than expected marks in exams, a low take up of the 'advanced database module' in the final year, comments from students on feedback forms about the difficulties that they were having and poor database design in their final year project work. The conventional module which provided the database knowledge was given in the first semester and it was decided to use an OEGP in the second semester to try to improve the performance of the students in this subject (Newman, Dawson and Parks, 2000). The OEGP problem required the students (in 25 groups of 5 to 7 students) to design and build two complementary systems. The first was to provide web based support for IT Support staff in a company. This would permit the staff to record problems, to record the assignment of staff to investigate the problem and to be informed when a solution was available. The second system was to permit ordinary members of staff in the company to be able to browse problem descriptions and solutions to see if they could find an existing solution to their problem, to be able to enter their own problem directly into the system and then to 'progress chase' it. In order to get the students to focus on the required database knowledge, they were explicitly required to produce entity relationship diagrams for the database underlying their proposed system and to provide the corresponding database table descriptions. These were required as an intermediate deliverable for the project and the students were given feedback on their performance and permitted to resubmit these designs if they did badly. More than half of the 30+ groups produced a poor or flawed initial design. However, having to explain what they had done as part of a demonstration/presentation associated with the intermediate deliverable helped most of them appreciate the problems associated with their proposed design. By the time of the final deliverable, over 80% of the groups had produced workable database designs. Although this OEGP came too late to have any effect on the marks for the examination for the 'formal' second year database module, the feedback received from students was very positive (many of them commented on the improvement in their understanding)[$], both the take-up of the final year advanced database module and the marks recorded at the end of the module improved relative to previous years. The results were quite striking and could be demonstrated to be statistically significant because the group taking the final year module in the 'test' year consisted of 42 students (52%) who had completed an intern year and 39 students (47%) who had gone straight into the final year after taking the 'OEGP module'. In the previous (control) year none of the students had had the benefit of having an OEGP module and there were 33 interns (53%) and 29 direct entrants (47%) so the split was very similar. In the control year the average score for the interns was 59% while it was 58.2% in the test year (essentially the same). The direct entrants scored 48.4% on average in the control year and 58.7% on average in the test year. The difference is even more striking when the mark bands are considered. In the control year only 28% of the direct entrants obtained more than a 60% mark for the module while in the test year this was 51% with 10% of them getting more than 80% (0% in the control year).

Supervisors also reported that there were fewer problems with databases associated with final year project work. Furthermore, the fact that most groups had actually managed to build a working database also appeared to improve their confidence and their motivation, an area that is discussed next.

As illustrated by the example in the previous paragraph, motivation is not fixed and unchangeable. Teachers can have a profound effect upon the motivation of their students. Beckett (1998) talks about the 'eros' of learning and teaching. By this he means the love of learning for learning's sake. This is a profound motivator for students and one which educators wish to instil since it makes the process of acquiring skills and knowledge so much easier. The converse is also true, students who do not want to learn are very difficult to teach. Ideally we want to create an atmosphere where both student and teacher are performing their various roles because they enjoy them.

[$] Comment from one student group: "We have also learned what it is like to work for a client in a real life business situation. We had to complete this assignment for clients; it was not like any ordinary piece of work. This meant that we had to find out what the clients wanted and how they wanted it to be done. … A very beneficial coursework, which we all feel, has stretched some of our limits but also extended our skills and knowledge in many areas." See Newman, Dawson & Parks (2000) for further student comments

We argue that OEGP as a teaching tool facilitate a good teaching/learning atmosphere. This is well illustrated by a comment from one student undertaking an open ended group project run for 75 students in 10 groups by one of the authors (XF) in the fall of 2002: "It doesn't feel like study. I'd do this even if it wasn't an assignment. I just want to know now."

Mueller and Dweck (1998) suggested that motivation can be classified into those motives concerned with performance and those concerned with mastery. They added a third null condition of the non-motivated student. Archer (1997) classifies these goals slightly differently, identifying three types of attitudes that students might hold. She labels these the mastery goal, the ego goal and the avoidance goal. With the mastery goal, the student wants to be competent in the area of study and is driven by a desire to learn as much as possible to achieve as high a standard as possible in the chosen area. The student driven by the ego goal, on the other hand, is more concerned about their personal standing, how they feel about themselves. This will be affected by their attitudes to the people around them. The marks they obtain are the reason for studying, not a demonstration of how much expertise has been achieved. The final category, the student pursuing the avoidance goal, is the type of student that most of teachers hope not to meet, a student who wants to do as little as possible.

If students are driven by the desire to develop expertise then understandably the marks they receive for the work they do will be seen as a measure of how close they are to achieving the expertise they crave. A student who is driven by ego or performance goals will see marks as the goal; high marks are desirable, low marks are not. It is important to appreciate this difference since a student who wants to perform well in order to achieve high marks might seem like a good student and one a teacher would want in the class. However, because they are interested in the symbols of achievement rather than the achievement per se, they will take short cuts and are more interested in the marks than the learning. The student driven by avoidance will do as little as possible perhaps hoping to pass or perhaps not caring either way.

Archer (1997) argues that ego related performance is likely to be explained by the student in terms of innate ability rather than hard work and students tend to describe their performance in terms of that: “I did well because I am good at that.” “I did badly because I am bad at that.” The student pursuing a mastery goal will see marks in terms of how much effort has been expended and how close they are to achieving the expertise they crave. They are much better at coping with failure and have a genuine desire to learn out of a love of learning The marks are seen as an indication of expertise so if they score low marks they see the necessity to plug gaps in their knowledge and will work harder at these areas. Conversely, Mueller and Dweck (1998), argue that performance oriented students will react badly to failure and will not try to improve because they believe that they cannot do so, their perception of their innate inability to do well at the subject precludes doing anything about low scores.

Jenkins (2001) suggests that student motivation has a profound effect on the way in which students cope with studying while Archer (1997) believes that student goals can affect not just learning but how they deal with success and failure. As educators we want to encourage students to adopt goals that will infuse them with enthusiasm for the subject as this will help them overcome difficulties and make the learning an easier and more enjoyable experience. Our question then is how can we mould student goals to ensure they are ones that will help students learn? Archer suggests this can be done by choosing appropriate tasks that encourage a love of learning and by providing certain types of feedback.

When students undertake course work on their own, the goals and motivations they hold are not challenged. The student who wants to master the subject will try to do so and may put in many extra hours. The student who is obsessed with performance will not question that attitude since they are working alone and will have no obvious challenge to their preconceived ideas. The student who wishes to avoid work, will and there is no one to goad them out of their inactivity. However, if students with different motivations are put in (or volunteer to join) a team, as happens with OEGP, then it would be expected that their assumptions will be challenged by the existence of other approaches in the same team. Even if the differences are not explicitly examined by the members, the different working practices and corresponding expectations will usually cause most reasonable members to reconsider their attitudes and approaches. The student who wants to master the subject may well take the lead. The egoist will work hard so as not to feel inadequate and the indolent avoider may well try to do that but will hopefully be dragged out of inertia by the self discipline of the more active members. In fact, the authors have regularly experienced students explaining how they had to work harder than they usually would (or would have wanted to) because they did not want to let the other students down (Daniels, Faulkner and Newman 2002). For a lot of students doing well for someone else’s sake is more important than doing well for their own sake.

Tam (2000) argues that constructivism requires collaboration. For a constructivist approach to be adopted the learner must discuss the material with others. The aim of the teacher is therefore to construct an environment in which discussion can take place naturally. OEGP do just that by providing a framework for the activity so that the learners have a sense of direction and a common goal and therefore a structure for their discussions. At the same time, the open ended nature of the project means that the discussion has to take place, because there are many possible solutions none of which is 'obvious'.

Open ended problems which can be related to real world settings and have no self-evident solutions are the essential starting point for an OEGP. It is, therefore, necessary to choose subject areas where most of the students have very little existing knowledge. This suggests that taking a 'new' topic as the starting point would be desirable. This can also help with motivating students because they are being asked to work on current 'hot topics' which they have read about in the computer

press and which they will then be able to boast about having worked on to other people, most importantly, to prospective employers.

This is important in most university level studies because the way in which components of a unit of study and indeed a degree course itself, are constructed does not typically allow for flexibility and rapid response to change. Yet in computer science, particularly, the ability to respond quickly to changes in methods or expertise is something that we would like to be able to have. Quite clearly, constantly having courses revalidated is not viable and actually some new and emerging ideas are effective for only a short space of time and then might disappear with or without trace to be replaced by another new idea. In the past the comparatively rapid changes in programming languages, platforms and even operating systems can be cited as examples. Some courses attempt to adopt a generic approach, slotting in the new 'sexy' ideas as examples which act rather like icing on the cake. This can lead to dissatisfaction amongst the students and can be a frustrating experience for the tutors since neither group has the opportunity to experience the ideas sufficiently and is left with a tantalizing taster.

OEGP have, of themselves, sufficient natural structure to act as a framework around which new ideas can be introduced into a course without adversely affecting the course and its outcomes. OEGP, because they are 'open ended', are ideal for introducing new ideas or for pursuing concepts where the outcome is not necessary, certain, or clear, simply because the tutor does not have a preconceived idea where it will end up. There may well be no obvious, right answer or indeed no single solution. OEGP can act as a small mutable component within a fixed course without destabilizing what is already a sound product from a teaching and learning perspective. The advantage of using OEGP for new ideas is that they can indeed be tried out in an almost experimental way and then merged with the course should those ideas prove to be fruitful and long lasting. It also means that the focus of an OEGP can change from year to year making its relevance fresh, ensuring that tutors don't become stale and showing students and potential employers that graduates have indeed come into contact with the latest ideas. Changing the focus of a project from year to year can also help protect against plagiarism which today is a problem that many institutions are having to tackle (Daniels, Faulkner and Newman 2002).

There is also an advantage in using OEGP for new topics in that, because of their nature, OEGP can be given to students as a research based exercise, the solution of which is unknown and compromises may need to be made. Perhaps, finally, OEGP might not be completed in the way that students expected at the outset. As an example of this a project with the stated aim of entering a team to win the international Robocup competition transformed, in the first two years it was run, into the problem of producing something that could actually appear as a team (Daniels and Asplund 2000). Although the groups entered the competition during the first two years, it wasn't until the third attempt (that is year 3 of the project) the students finally produced a team that could score and actually win some of the games.

An example of OEGP in Practice - the IT and Society Module

This module is a typical example of an OEGP and the main idea behind the set up is to inspire our students to learn "soft skills" by using their motivation to bridge the gap between academic studies and working in "real" life. The scenario, for the course is that the teachers own a consulting firm, which has landed a major project with a real customer. The students are hired as consultants to carry out this project. How to actually make this happen is an open ended question. There are however some course content motivated restrictions, e.g. the project team will be divided into groups of 5-7 students in order to provide a ground for learning first hand about group dynamics, and all groups need to collaborate towards the solution for the project. Having to work inside a small group but co-operate with the rest of a cohort is a novel and exciting challenge for our students and one which is typical of a real world scenario. The truth of this is manifested by the strong approval we receive from the real customers and the enthusiasm the students show for such projects.

We have found, from past experience, that our students, especially the female students, have appreciated the need for a holistic approach to make the customer satisfied. The obvious need for a working project method and suitable ways to interact with a wide variety of people has made acquiring such skills a natural learning component of the course. It is also probable that the students will, apart from dealing with the multi-disciplinary issues, also need to address the problems and possibilities of a multi-cultural environment (or student cohort). There is also ample room for the students to work within their intended field of expertise (CS) to reinforce their earlier learning, while still providing opportunities to learn about new hot topics.

The appeal to female students, which is an important issue, can be made stronger by the choice of customer. It was thus rewarding to note that the project "Information systems at intensive care units at a general hospital", that we used this year (2002-3), was stated as the reason for changing to this course by two female students. One typical OEGP feature of this particular project is the "deep water" feeling stemming from sorting out what the customer really wants at the same time as trying to find ways to collaborate and keep track of what is going on under the strict time constraint of completing the project within one semester. The need for communication within the small group as well as within the project 'team' as a whole (that is all of the groups) due to the need to find out what the issues are and how they should be addressed is another typical OEGP feature. The way this is done, or rather not done, is used as a concrete example to give feedback and insights to the students. The respect for the people in the work place has proven to be a strong additional motivating factor for mastering social skills and for using their technical knowledge in a way that is useful for the customer. All of these aspects are ones that

students see as relevant as they know those skills will be needed in their future careers.

Overcoming Staff Worries about Assessment in an OEGP

Assessment is perhaps the major concern of both tutor and student when it comes to group projects in general, and it is considered by most academics even more difficult to assess the performance of groups undertaking open ended projects in a fair and consistent manner. The conceived importance of grading can be illustrated by the suggestion in (Friedman & Kahn 1994) that students need to have marks allocated if they are to be expected to consider a subject. Another concern is how to allocate marks to the individuals within the groups.

If the project is open ended and the groups negotiate the requirements on an individual group basis then they will inevitably be performing different tasks or attempting different goals. This has big advantages for the avoidance of plagiarism and for student motivation (Daniels, Faulkner and Newman 2002). However, it does have the drawback of making the setting of expected assessment outcomes rather more problematic than they would be if everyone was doing the same thing. Additionally, there is an imperative in many universities to specify precisely what students are being expected to do and this is usually suggested as being a requirement which is designed to ensure fairness to the students to give them a predictable and planned workload. This requirement is on the surface incompatible with OEGP, as well as being impossible in the world into which the graduate will emerge.

A demand for detailed assessment criteria can, however, be satisfied without compromising the advantages offered by OEGP by fixing some of the requirements of the exercise and making the assessment relate to those fixed requirements. Thus requirements for intermediate and final reports and for arranging and performing demonstrations can be written in to the module specification along with the dates these are required and the marks which will be allocated to each assessed element. This reinforces the idea that OEGP are focusing on process rather than product. By measuring student performance at points along the project, the educator makes sure that the project achieves certain goals but at the same time the assessment is made uniform for everyone. Providing intermediate assessments also permits feedback and, as noted in the example of the IT Help desk support system, also permits students to demonstrate that they have learned from their mistakes and can get an improved mark. This ability to see what their improvements are is an effective motivator. Additionally, some marks can always be ‘saved’ for effort rather than attainment; though again, given the aims of university education and the expectations of society these marks might need to minimal. Nevertheless, as discussed earlier, where students are motivated by mastery goals, all possible sources of marks are important to them so that although in reality they are but a small proportion of the overall allocation, the significance of attaining the marks can place them in high esteem with their colleagues. For many students knowing that their efforts have been appreciated is very important.

The other consideration here is the allocation of marks to individuals within the group. Ideally, if the group was effective, all of the members of the group would have contributed equally to the outcome and, therefore, all of them should be awarded the same mark. This is a simple solution and corresponds to what happens, usually, in the outside world. However, it does unfortunately have a number of disadvantages. Firstly, many students say that they dislike group activities because they feel that their marks might well be eroded by the effort (or, rather, lack of effort) of the remainder of the group. Secondly, not all members of a typical group necessarily contribute equally since they tackle different tasks and this can be a problem in assessing who did what and how much it counts towards the final mark. Thirdly, other members of staff might well feel that assessment at a university is about individual performance and certainly when universities grant degrees they do so on individualistic and performance related criteria which has nothing to do with effort and everything to do with actual performance. The problem can be overcome by allocating the bulk of the marks to the group but allocating some marks on an individual basis. There are many possible ways of doing this, five of which will be outlined here.

The first is to get staff who have been working with the group to allocate marks based on their experience with the group. This has the disadvantage that the staff members have not seen how the group was working when they were not present and can lead group members to compete for attention when tutors are present which is neither desirable nor efficient and certainly not in the spirit of PBL or the constructivist approaches. The second is to ask the group to subdivide some of the marks amongst themselves. This seems attractive, providing they all concur, but causes difficulties if there are disagreements and also requires the groups to develop and adopt an inclusive model of what contributes to a successful outcome (e.g. how are technical contributions in different areas compared, what is the value of someone who concentrates on encouraging and motivating others and helps where there are difficulties but does not take the lead in any technical area). In the third, students are asked to assess their own performance and to explain their contribution. Although on the surface this might seem like giving them a blank cheque, students can be disarmingly honest about what they have achieved and the impact it has had. In fact, the danger is they underestimate rather than overestimate their worth. The fourth requires the group to identify who contributed to each specified deliverable and to identify their contribution as part of the group submission. The fifth is to require each individual to submit a report either on some specified technical area or on group dynamics and for this to be part of the assessment. In practice, it is usually sensible to adopt a combination of the techniques described.

In order to encourage a professional approach and to improve motivation, it is wise to make clear at the project outset that if an individual has made little or no

contribution to the group effort then their individual or group mark or both marks can be reduced accordingly provided appropriate evidence is provided. In all other cases, everyone can be awarded a group mark with an addition based on their individual submission. This ability to withhold or reduce a group mark from a group member is usually sufficient to ensure that the members pull their weight even if the concept of the project does not manage to inspire them. We have to add that, from our experience of using this tool (about 40 years between us) most of the time OEGP themselves will be a sufficient motivator but they cannot guarantee that success and most staff would be happier with checks in place to cater for any strongly non-motivated students in the cohort.

Conclusions

The paper has presented an argument for using Open Ended Group Projects (OEGP) as a tool to supplement the more conventional lecture and laboratory teaching approaches. The relationship between OEGP, problem based learning and educational constructivism was explained and the case for considering OEGP as a tool was outlined.

An example was used to show that OEGP can successfully reinforce the teaching of a subject by getting the students to think about how the ideas can be applied in practice and by receiving feedback on their performance. It was suggested that the effectiveness of the approach was partially due to improvements in student confidence and motivation. The aspect of student motivation was examined in more depth explaining how OEGP could help in overcoming poor approaches to learning which were consequent on different motivational 'types'. It was also suggested that using 'new' topic areas for the scenarios for OEGP both helped motivate students by allowing them to be able to feel that they had some experience in the new topic (with potential employability advantages) and allowed staff to introduce new topic areas into the curriculum without having to go through the major, and slow, process of formally revising the curriculum itself.

The IT in Society module was used as an example to explain both how the idea does work in practice and to explain the advantages OEGP, with their emphasis on holism and the social skills, can improve the attractiveness of a 'computing' course for female students and can increase the probability of retaining the female students that are recruited because they feel more included (and because the males are often forced to recognise the usefulness of the skills provided by the females in the group work situation).

Finally, the task of assessing group and individual performance in the context of open ended group work was considered. It was acknowledged that concerns about assessment have been a significant reason for both staff and students to be resistant to the idea in the past. However, a number of approaches to assessment were suggested which the authors have found most effective in their own institutions. Between them, this experience covers more than forty years of using OEGPs, involving hundreds of groups and using the tool to teach or reinforce many different subject areas.

Overall, the authors can strongly recommend the approach, not as a substitute for conventional teaching but as a supplement to it. OEGP can help: reinforce knowledge acquired by more conventional teaching methods; improve student motivation; improve student confidence and also make our students more employable by giving them something to talk about at interviews. OEGP do not offer an easy option for staff since the essential open-ended nature of the task leads to unexpected solutions and unplanned requests. However, team projects will usually be supervised/managed by teams of staff and this, coupled with the enthusiasm of many of the students makes the otherwise potentially rather lonely life of a teacher a more exciting and rewarding one. We, therefore, strongly commend the use of the tool and encourage others to consider its use as an addition to the other approaches that they currently use.

References

ARCHER, J. (1997): Encouraging Students' Motivation to Learn, http://www.newcastle.edu.au/services/iesd/publications/eunexus/articles/teaching_guides/encouraging/encouraging_1.htm

BECKETT, D. (1998): Disembodied Learning: How Flexible Delivery Shoots Higher Education in the Foot, Well Sort of. Electronic Journal of Sociology: 3, 3, http://www.icaap.org/iuicode?100.3.3.2

BROOKS M.G. and BROOKS J. (1999): The Courage to Be Constructivist. Educational Leadership 57(3) .

CHRISTIE, A. (2002): Perceptions and uses of technology among adolescent boys and girls. In Networking the Learner, Computers in education. 257-265. WARSON, D. and ANDERSEN, J. (eds). Kluwer Academic Publishers, Dordrecht.

COPLEY J. (1992): The integration of teacher education and technology: a constructivist model. CAREY, D., CAREY, R., WILLIS, D. and WILLIS J. (Eds.), *Technology and Teacher Education*, Charlottesville, VA: AACE, 681.

DANIELS, M,. and ASPLUND L., (2000): Multi-Level Project Work; A Study in Collaboration. 30th ASEE/IEEE Frontiers in Education Conference, Kansas City, USA.

DANIELS M, FAULKNER X and NEWMAN I (2002): “Open Ended Group Projects, Motivating Students and Preparing them for the 'Real World” IEEE Proceedings of 15th Conference on Software Engineering Education and Training, ISBN 0-7695-1515-0. pp 128-139.

FORD, G. AND GIBBS, N. (1996): A Mature Profession of Software Engineering. Technical Report CMU/SEI-96-TR-004, Carnegie-Mellon University, Software Engineering Institute.

FRIEDMAN BATYA and KAHN, JR. PETER H (1994) Educating Computer Scientists: Linking the social and

technical, Communication of the ACM, vol. 37, No.1, pp. 65-70, January 1994.

JENKINS, T. (2001): The Motivation of Students of Programming, Proc of ACM ITiCSE. Canterbury, UK, pp 53 –56, ACM Press.

KOLB, D., (1984): Experiential Learning - Experience as the source of learning and development. New York, Prentice Hall.

KOLMOS, A. and ALGREEN-USSING H. (2001): Implementing a Problem-Based and Project Organized Curriculum. Das Hochschulwesen, 1, pp 15-20.

MUELLER, C. and DWECK, C. (1998): Praise for Intelligence Can Undermine Children's Motivation and Performance. Journal of Personality and Social Psychology, Vol. 75, No. 1

NARAYAN, R. and NEETHI S., (2001): Building Software Engineering professionals: TCS experience. Proc. 14th conference on Software Engineering Education and Training, Charlotte North Carolina, pp 162-171, ACM Press.

NEWMAN, I., DAWSON, R. and PARKS, L., (2000): Reflecting on the Process, Some Experiences of Teaching Students to Think About how they Produce Software in a Real Environment. in INSPIRE V Quality & Software Development Teaching and Training Issues, British Computer Society, GB, pp 25-36.

PEARS, A., DANIELS, M., BERGLUND, A. and ERICKSON, C., (2001): Student Evaluation in an International Collaborative Project Course. Proc. 2001 Symposium on Applications and the Internet Workshops, IEEE Computer Society, USA, pp74-79.

TAM, M (2000): Constructivism, Instructional Design, and Technology: Implications for Transforming Distance Learning. Educational Technology and Society, 3(2) pp 50-60.