Applying the Community of Practice Approach to Postgraduate IT Projects

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Abstract

This project applies the *action research* educational method to the application and evaluation of the Community of Practice (CoP) principle to eScience postgraduate project courses in IT at the Australian National University.

A CoP was formed comprising of the seven graduate students enrolled in the various eScience project courses and the project co-ordinator (the author) of the first semester 2006. An action research method was applied over two phases, the first in weeks 1–7 (involving 5 meeting sessions), and the second in weeks 10–15 (involving 4 meeting sessions).

Data for evaluation includes student feedback (including an entry and exit survey, and anecdotal remarks), observation of the CoP, and evaluation of student performance in relevant aspects of their project work.

The results of the evaluation indicate that the CoP approach, combined with the action research method, was very effective in teaching research skills and significantly improved the students' project experience. There was consistent evidence of desirable group behaviour emerging, including the establishment of a mutually supporting environment. Even through the projects were individual, the commonality of learning research skills and peer feedback were sufficient to establish a cohesive and effective community. While this was a limited trial of the approach, we feel that it is promising to apply to technical student projects in other areas, and it is a valuable approach in supporting research-based education.

Contents

1 Introduction

This project is concerned with applying and evaluating the Community of Practice (CoP) principle to eScience postgraduate project courses in IT. The CoP formed between the project co-ordinator (the author) and the project students will concentrate on common, generic research-related skills. The co-ordinator played the role as the facilitator of the CoP.

Section 2 provides background for the eScience projects, both historically and for the current situation of this project. The project's objectives are then defined in Section 3. Relevant educational research literature is then reviewed in Section 4, after which Section 5 then outlines the project's plan, including its research methodology. The project's implementation in two phases, including its design, session descriptions and evaluation, are then given in Section 6. An overall analysis and evaluation taking into account student performance and final survey results are given in Section 7, with conclusions being given in Section 8.

1.1 About this Document

This document is the central component of the portfolio which represents the output of this project.

To facilitate this, it has been prepared with the LaTeX Hyperref package. A PDF version of this document, when displayed on-line, will display hyperlinks as coloured sections of text, as is shown above. If a web browser is active, clicking on these links will conveniently point the browser to the referred web document.

There are similarly links to citations, sections, figures and tables internal to the document, which again may be useful for on-line reading of this document.

2 Background to the eScience Projects

The MIT (eScience) project courses [5] form the capstone of the Graduate Diploma in IT (eScience) (Grad Dip) and the Masters of IT (eScience) (MIT) degrees [6] at the Australian National University. The courses are of two types:

- implementation projects: COMP6701, a 6 unit project for the Graduate Diploma, and COMP6703, a 12 unit project for the MIT. In these courses, students are expected to design, implement and evaluate a non-trivial software artefact, applying the principles and methodologies of software engineering in an eScience-related context.

- research projects: COMP6720 (6 units) and COMP6702 (18 units), both for the MIT. These are taken over successive semesters and together form a research project equivalent to that for an Honours year.

While of different types, there is commonality in the sense that any project may (and often does) have both research and implementation aspects. Furthermore, both expose students to generic research-related skills, such as literature searching, critical evaluation of key research, giving presentations, and writing coherent reports. In both cases, the projects are individual ones, with students being assigned an internal supervisor, and possibly also an external supervisor or client.

However, the teaching of these skills has traditionally been left largely in an ad hoc basis to the supervisor and student. The student typically worked alone on their project, and gave

their presentation with only their supervisor, the project co-ordinator and another examiner present. Before becoming the project co-ordinator, the author in the role of examiner observed the final presentations of semester 1 2005. As the subsequent examiner's meeting, it was felt that the presentations and reports were of very varied quality, and furthermore there was a major problem of insufficient attribution in a third of the reports. The author also felt that it was both intimidating and unsatisfying for the students to give their presentations to such a narrow audience.

When the author became project co-ordinator in semester 2 2005, these issues were partially redressed by including all project students in the audiences for the initial and final presentations, and by providing a small session on the whys and hows on quotation, attribution and citation. Still, the lack of social context for the projects remained; this troubled the author, particularly considering they were for the capstone of a degree that many students had come a long way to undertake.

After exposure to the idea of the Community of Practice approach through the EDUC8003 course, the author was inspired to apply this approach to the eScience projects in semester 1 2006, to see if such shortcomings could be overcome thereby.

In 2006, only seven students enrolled in the eScience project courses (2 in COMP6720, 2 in COMP6702, 1 on COMP6701 and 2 in COMP6703). Considering the split between research and implementation projects, this is a small number for a CoP, i.e. below what might be needed for a 'critical mass'. This is exacerbated by the fact that two students are working and part-time, spending minimal time on the campus. On the other hand, the structure of the eScience research projects meant that COMP6702 students had project experience over the previous semester, and thus can provide somewhat of a mentoring role in a CoP context (these students will be referred to as the 'senior' members).

Descriptions of the projects undertaken by the students are available from 2006 semester 1 projects web page [1]. From this page, final presentation slides and reports are also available.

3 Project Objectives

This project will introduce the Community of Practice (CoP) approach [20] to the eScience project courses over semester 1, 2006. It will apply the *action research* method [10] to refine and evaluate the effectiveness of the approach.

The objectives of this project are as follows:

1. to provide a more supportive and enjoyable experience for the students in their projects.

2. to improve the student understanding and performance of various generic research issues studied in the CoP:

   > giving presentations, elements of report writing (citations, structure, style), project planning, implementation and evaluation issues.

   This is both in the execution of their projects and in their broader understanding of these issues.

3. to evaluate the CoP as a general educational approach for student groups undertaking technical projects.

4. to evaluate the effectiveness of the CoP approach in supporting aspects of research-based education.

These following indicators will be used to measure the effectiveness of how these objectives have been met:

1. the students' perceptions of how their participation in the CoP has improved their understanding and practice of the research methods studied (in both their projects and in their general understanding).

2. whether this is reflected in the formal assessment of the projects.

3. evidence of good group behaviour emerging within the CoP over the semester. This includes, at its most fundamental level, attendance of the CoP sessions. It also includes evidence of support being developed between the students (e.g. informal sub-CoPs), and an improved understanding of the main issues of other student projects.

4 Relevant Educational Literature

This section summarizes relevant educational literature for this project, including that for the Community of Practice approach [20, Ch 1-2] and the related approach of Cognitive Apprenticeship [3]. Research on establishing good group characteristics [17, Ch 1] is also relevant here. Of particular interest is any literature applying these concepts in a similar context (advanced tertiary-level technical projects).

The Community of Practice approach arises from the observation that learning is a fundamentally social phenomenon; hence social aspects are central to learning [20, Ch 1]. The term *Community of Practice* "*refers to the process of social learning that occurs when people who have a common interest in some subject or problem, collaborate to share ideas, find solutions, and build innovations*" [12]. Its practice consists of three key elements [20, Ch 2]:

1. mutual engagement. Here, the contributions of others is used to complement our understandings through meaningful connections.

2. a joint enterprise. The community operates through a process of collective negotiation; it also has a context of being part of a broader system, for example, part of an organization.

3. a shared repertoire. The community, sharing a common purpose, develops a common understanding of terms used in discussions.

Applied in this context, this suggests a model where the project co-ordinator and students, sharing the common purpose of enhancing the quality of the eScience projects (and the associated learning of research-related methods), meet to discuss common aspects of project work, and evaluate and help improve each others' work.

The CoP thus forms a co-operative group, whose effectiveness can be measured by the following profiles [17, Ch 1]:

1. a supportive working atmosphere.

2. group goals are co-operatively structured.

3. the group is committed to the shared task and to each other.

4. discussions remain focussed and relevant but members are free to express feelings (including criticism).

5. the leader (if any) does not dominate; different members can take different roles.

In this context, the leader would be the project co-ordinator, but would encourage group decision-making and active contribution of each member in discussions.

A related concept to the CoP is the Cognitive Apprenticeship model [3]. In this model, the teacher exposes the reasoning and strategies of an expert to the student in the settings of a series of tasks with a real-world context, in which they both engage in. A particular aspect of this process is *scaffolding*, in which the support the teacher gives to the student in carrying out the task is gradually withdrawn as the student gains competency. This could be applied in the eScience project context to a limited extent in group meetings with the eScience co-ordinator playing the role of the teacher/expert. However, the more apt application here is with the supervisor and the student, during their individual meetings. It would be an interesting essay to apply this method to research projects, but that is outside of the scope of this project.

The eScience CoP will concentrate on developing various research-related methods and skills, for the immediate purpose of improving the quality of the projects, and for the broader purpose of improving the students' understanding and aptitude for future use. Thus, it aims to enhance this element of Research-based Learning, and in particular for the important skills of effective oral and written communication [13, Ch 1]. Research-based learning has been noted as an area of current strategic importance at the Australian National University [18].

An important concept in higher education is that learning and assessment should be regarded as linked activities. In particular, *formative assessment* [2] has been introduced for preparing students for a "learning society", where learning is an essential lifelong skill. In this, the development of self-assessment is seen as vital, with the encouragement of mutual assessment between peers [2]. However, such assessment should be related to feedback (*formative assessment*), rather than grading (*summative assessment*). The eScience projects formerly offered no substantial *formative assessment*, outside of the draft-revise loop of the supervisor and student. Formative assessment could be enhanced by a CoP approach with the students evaluating each other's work, informally and semi-formally.

4.1 Related Work in Communities of Practice

To our knowledge, there is little literature dealing directly with Communities of Practice in the context of individual student research projects. A comprehensive book covering the various applications of CoP is [8]; most contexts are from non-university organizations, especially the commercial sector, and there is also much research on distributed, virtual communities (a survey concentrating on these is [9]). An important aspect is the supporting web-based technology used, which normally includes on-line chat rooms.

This could be applied to a small extent in the context of the proposed eScience Projects CoP, in that a on-line chat room could be provided for raising technical issues (especially for the members who are largely off-campus), and for document sharing.

A specific example of a study of virtual CoPs is by Rogers [14]. Here, some 26 English as a Second Language middle school teachers met for a three-week on-line workshop. The chat room discussions were analysed using the case study method of non-equivalent pattern

matching, as well as the author's experiences as a participant-observer. The dialogues were analysed, according to sub-categories of the three key CoP elements mentioned in Section 4. The conclusion was that all three elements were strongly present. The paper concludes with some useful suggestions for enhancing these elements, e.g. from the joint enterprise element, "*providing ill defined problems for which the solution trajectory as well as the solution itself is negotiated*", and encouraging the development of multiple viewpoints and reflection [14].

The closest related work we know of is a study on establishing CoP between IT digital media student projects with start-up companies [15]. Here, CoPs consisting of a small team of students and member(s) of an IT start-up company would be formed; the common purpose of the CoP is to work on a project of mutual interest. It was recognized that the CoP also required a "distinguished supervisor" for effective facilitation. Both face-to-face meetings and on-line tools provided contact for the CoPs. The effectiveness of the CoPs was evaluated using semi-structured interviews, and analysed against a theoretical framework based on Social Identity Theory. The situation bears some similarities with ours, including a module on presentation techniques; however, there is a very significant difference: there, the CoPs had inherently a much stronger common purpose as its members all worked on a single project. This gives a much stronger opportunity for interactions, and technological aspects of the CoPs were thus emphasised over the social aspects.

4.2 Literature Relevant to Research Methodology

This section reviews the evaluation methods of Action Research [10, Ch 2], Reflective Writing [11] and qualitative analysis [4, Ch 2]. These give relevant concepts that will be used to develop the project's research methodology.

The Action Research method consists of a cyclical process aimed at improvement of practice; in this case, it will be used to improve the effectiveness of the CoP and the benefits thereby obtained. The cycles consist of planning, acting, observing and reflecting [10, Ch2]. It is important that the observations be performed systematically. Applied to the context of this project, the method can then be applied in small cycles between CoP sessions, and a larger cycle between the two main phases. One aspect which has a resonance with the CoP context is that it is concerned with social interactions, with participation of all stakeholders being the ideal situation. For this project, this can be obtained implicitly through the use of anecdotal and systematic feedback from the CoP members.

Reflective Writing [11] relates to the Action Research method in that it provides a way of obtaining meaning from our experiences and transforms this into knowledge for future action [19]. It may be applied on three levels: the technical view, where one's performance is measured against goals; the practical view, where one establishes morally defensible decisions on one's practice; and the critical view, where one examines the underlying assumptions of one's practice [19]. In this project, the technical view will be manifested in the analysis, the practical view will be manifested in the design, and the critical view will be manifested in the conclusions.

A major part of this project will be to evaluate the effectiveness of the CoP, both in principle and in its actual implementation, in an individual technical research project setting. Thus, this project will also be concerned with educational research, of which there are two main approaches: qualitative and quantitative [4]. Of these the qualitative seems more promising due to several factors: (1) the lack of previous experience of the author in similar context, (2) the small number of people (and hence data points) available, and (3) the inherent reflective and subjective nature of the situation. Furthermore, a qualitative approach matches a major inten-

tion of this study, which is to understand how community support can change the experience of undertaking a project. The qualitative analysis can be based on textual data provided by survey, augments with observation and anecdotes; from, these a wider meaning of the project's findings may be thereby obtained. While there is some scope for collecting numerical data (e.g. ratings from surveys), there seems little scope for these to be meaningfully correlated for the purposes of quantitative analysis.

5 Project Plan

The CoP is planned in two phases, the first in weeks 1–7 (involving 5 meeting sessions), and the second in weeks 10–15 (involving 4 meeting sessions). More details on the topics and scheduling can be found on the eScience Project CoP web page. The action research method is thus applied over two phases, with feedback and reflection on the first used to improve, where possible, the facilitation of the CoP over the second (as well as providing improvements within each phase).

Surveys are to be carried out in weeks 3 and 15. These will provide an initial and final evaluation of the CoP. Observations and anecdotal feedback will also be recorded throughout.

Evaluation of the first phases, including an analysis of the data collected from the first phase, and design of the the second phase, will be undertaken in weeks 8–10.

An analysis of the final assessment of the projects (in week 16) with respect to the CoP topics will also be undertaken. The final analysis and evaluation will take place after that time.

5.1 Research Methodology

After the fashion of [7, Ch 1], we propose to use a constructivist epistemology, as we are investigating an educational paradigm where social issues are central; therefore, most meanings will arise from the engagements of the individuals concerned. While there is some scope for (semi-) objective analysis, e.g. evaluation of various aspects of project reports and presentations as evidence of effectiveness, due to the small numbers involved and a diverse range of participant backgrounds, the interpretation of these must be made relative to the participant, and therefore will have a strong subjective element.

Our research methodology will be a combination of phenomological research and action research. The former will concentrate on the perceptions of the CoP by the participants, and will be provided by participant surveys and observation. The latter will also involve these elements, but combine them with the semi-objective evaluations mentioned earlier.

This leads us to the plan mentioned earlier in Section 5. The surveys will concentrate on the students' perceptions with regards to Objectives 1 and 2, and will contain some direct questions on these issues. Objectives 3 and 4 will be evaluated by direct and indirect methods, both in the survey questions and in observation of the CoP.

6 Implementation

This section describes the implementation of the CoP. This occurred over two phases: the first (5 sessions) was towards the beginning of the semester, with topics chosen to help orient the students to get started on their individual projects. The second was towards the end of the semester, aiming to help students on finer issues that they can apply to their projects.

Reflecting the action research method mentioned above, this section is structured in terms of the design, session descriptions and analysis of the two phases.

As previously mentioned, the topics (including references to be studied at the sessions) and their schedules are on the eScience Project CoP web page. Collated CoP email reminders, containing proposed agendas, are also available on-line. See Appendix A for a complete list of materials available on the sessions.

The main references for the sessions was excerpts from *Writing for Computer Science* by Prof Justin Zobel [21]. This book covered all aspects of research, in a computer science context, and was felt to be of excellent quality. Supplementary references came from ANU's Online Materials [16].

6.1 Phase 1

6.1.1 Design

The guiding principles in the design of these sessions were to:

1. choose topics where a need was known for study, based on previous experience with the eScience projects.

2. choose other topics which would be useful for early stages of project work.

3. make use of previous students' work, as good or bad examples.

4. make use of the diverse range of experiences of the CoP members, by facilitating discussions where these could be brought in.

The second and third principles were intended to strengthen the *joint enterprise* aspect of the CoP, in that the members should have a strong common purpose. The fourth principle would contribute to enhancing a *shared repertoire*.

From the first principle, *giving good presentations* dominated the first three sessions, centred around the students giving a brief (5 minute) presentation on their project topic and initial plan. Session 1 would thus introduce the principles, studying some relevant materials and slides from previous students' presentations. The second session would involve the students' evaluating each others presentations and giving feedback. The third session would be partly devoted to reviewing this topic.

From this principle also, *citations and attributions* was studied in the third session.

From the second principle, the topics of *managing projects*, *literature reviews*, and *report structure* were included over sessions 3 to 5. In all of these, the project reports of previous students could be used to illustrate the general principles studied.

6.1.2 Session Descriptions and Observations

CoP 1, *Elements of Good Presentations*, was carried out in week 2. There were 7 attenders [1]. After an introduction of the idea of a CoP (basically, the summary in [12], plus the ideas of how it might be applied here (as outlined in Section 4) and of the members, the first 20 minutes were spent discussing key points from key references on the topic (including two ASLC documents).

[1] The facilitator is not included in the attendance counts.

We then displayed the presentations from the previous semester, evaluating them on these key points, with particular attention to those from the two 'senior' members.

CoP 2, *Initial Project Presentations*, was carried out in week 3. There were 7 attenders. The students each gave a 5 minute presentation to introduce their chosen project, define its scope and propose an initial timetable. Two minutes were reserved for questions and transitions. Students evaluated each other's presentations using a form from an ASLC document *Preparing and Presenting Oral Presentations* (copies of these were not kept). Surveys were distributed at the end of the session. The session ran 15 minutes overtime.

CoP 3, *Presentation Review; Managing Your Project*, was carried out in week 4. There were 6 attenders, and 6 surveys were collected. The session began with overall feedback of each presentation, based on my evaluations (see Section 6.1.3), that given by the peers, and self-evaluation. Feedback on session 2 was also given: more time was needed for transitions, and for evaluating each others' talks, a schedule was needed and it was hard to make positive comments for everyone. The next 20 minutes were spent discussing project management principles from key references on the session's topic (including the ASLC documents). This was followed by a general discussion based on the members' experiences; some interesting points such as "*poorly defined requirements are often the downfall of a software project*" were made.

CoP 4, *Literature reviews, Citations and Attributions*, was carried out in week 5. There were 7 attenders. For each of the 3 topics, excerpts from references were studied, followed by a general discussion. The senior members in particular added their experiences on literature reviews. The CoP then broke into pairs, each taking two reports from similar projects from the previous semester, and evaluated them on these aspects. The meeting concluded with a discussion of the members' understanding of the CoP concept, and whether it would be possible to set up a project working space (suggested in the initial Survey) to promote casual interactions (it was concluded this was not practicable).

CoP 5, *Report Writing: Structure and Setting Out*, was carried out in week 7. There were 6 attenders. This session again began with a study of excerpts from relevant references. Then there was an exercise in evaluating previous semester's reports, for structure and the use of figures, tables and other features to improve visual interest. Finally, there was an exercise in evaluating the structure of their own draft reports at this stage (they were requested to add a draft outline of all anticipated sections of their reports – all those who attended complied). The meeting concluded with a review of the CoP so far, and discussion on the topics and scheduling for the next two sessions.

6.1.3 Analysis and Evaluation

The initial survey gave some direct feedback on **CoP 1**. The reference materials were rated as 'useful', while the previous students' talks were 'very useful'. As well as this, half said the encouragement / knowing about other participants as the best part of **CoP 1**.

From **CoP 2**, student feedback indicated more thought should be given into obtaining smoother transitions between presentations. The talks' quality on key broad criteria are summarized in Table 1.

Note that speakers 2, 3 and 4 were ESL speakers. Considering the students' background and experience, the results are overall very positive, indicating that **CoP 1** was effective.

From the initial survey, the students felt **CoP 1** was 'very useful'-'useful' in both preparing and delivering their presentation. However, they felt 'happy'-'a little unhappy' with how their delivery actually went.

criteria	1	2	3	4	5	6	7
preparation	good	good	good	good	good	good	good
clarity	good	good	good	fair	good	good	good
motivation/interest	good	good	good	fair	good	good	poor
right level of detail	good	too much	mostly good	good	mostly good	good	poor

Table 1: Initial presentation evaluation (from **CoP 2**)

Managing Your Project	4.5
Literature reviews, Citations and Attributions	3.5
Report Writing: Structure and Setting Out	4.0
Implementation and Testing Issues	4.0
Writing up your Report and Preparing Your Presentations	4.5

Table 2: Averaged student ratings of the potential interest/benefit of proposed session topics (0 = not at all, 5 = very much)

Also from the initial survey, the students felt the CoP could be 'very helpful', with comments on "sharing experience" and creating a "friendly environment" cited. At **CoP 4**, one of the two 'senior' participants said that the CoP created a definite improvement in morale over the previous semester; this was seconded by the other.

The students' rated the potential interest/benefits of proposed future CoP topics as shown in Table 2. Several responses suggested more on report writing be included. This confirmed that the initial selection of topics was well matched with the students' interests.

There were a few signs of the CoP establishing informal contact between members: e.g. before **CoP 5** one student reported meeting with another and discussing his project with him (the students did not seem to know each other before the semester).

6.2 Phase 2

6.2.1 Design

The guiding principles in the design of the second series of sessions were:

1. choose topics which would be useful for later stages of project work.
2. make use of the students' work in progress more.
3. foster the CoP by allowing students more say in both the meetings' topics and timings.

These reflect the evolution of the CoP in its maturation. While feedback (including that of the surveys) indicated that Principle 3 from Phase 1 had popular support, observations and anecdotal feedback from the last session of Phase 1 indicated that its usefulness was passing.

Also, as a first implementation of Principle 3, there was a call for Phase II topics and timings during **CoP 4**. This resulted in the deferment, by one week, of the first two sessions from the original schedule, and the students also nominated the topic for session 8 (which was at that stage unspecified).

Finally, from a practical issue arising from **CoP 2**, the problem of time wasted in talk transitions, more effort would be put into overcoming this (in **CoPs 8 & 9**).

6.2.2 Session Descriptions and Observations

CoP 6, *Implementation and Evaluation Issues*, was carried out in week 10. There were 6 attenders. The session began with a review of what attributes were expected in the implementation of a good eScience project, followed by a discussion of the importance of *reproducibility*, both within this context and in scientific research in general. Excerpts on the principles of evaluation from [21, Ch 11] were then briefly discussed. The remaining 2/3 of the session was spent discussing the main issues encountered so far on the session's topic, with the others offering suggestions on how the outstanding problems could be solved.

CoP 7, *Writing Up Reports: Finer Details*, was carried out in week 12. There were 5 attenders (one student was overseas that week). The session began with finer points on writing reports, supported by the text. The last one being the importance of proofreading - there was a discussion on how the CoP could be used to facilitate this when reports were near-finalized. The CoP discussed the timings of the next 2 sessions, with the decision to defer them both one week. The remainder of the session was spent in a small group exercise: the latest draft reports were brought in and evaluated against the principles studied in this session (and also in **CoP 5**). 4 draft reports were brought in; the students divided into 2 groups and gave mutual feedback, with a summary of the strengths and weaknesses of each draft at the end.

CoP 8, *Improving Presentations*, was carried out in week 14. There were 5 attenders (one student was attending an examination at that time; the other sent his apologies due to a family-related incident). The session began with a review of the key ideas from **CoP 1**, followed by discussing some excerpts on finer points on the topic. The CoP then discussed on what equipment would be used in teach talk, for both presenting slides and the more difficult issue of a demonstration of their project artefacts (the students decided to use their own laptops). An exercise involving draft presentations took the remainder of the session: a student first showed the overall structure and content of their slides, and the audience then selected a short sequence for them to present. Feedback was given on both. Each of the 4 draft presentations took 15 minutes, which was rather too long; some technical problems were exposed.

CoP 9, *Final Project Presentations*, was carried out over three hours in week 15. There were 7 attenders; there were also a small number of academics and other students in the audience. Each student member of the CoP gave a presentation (from 20 to 35 minutes in total, including questions), which included in some cases a live demonstration of their software artefact as well. The presentations were evaluated using a custom-made form by all CoP participants. The respective forms would be returned to the respective speaker after copies were taken. The facilitator ensured that the presentations were kept to time. With the exception of one speaker (who did not attend **CoP 8**), all transitions were fluent. Surveys were also handed out. Finally, the facilitator proposed that the CoP meet for a last and informal time in next week (after the projects were handed in) at a bar.

6.2.3 Analysis and Evaluation

After **CoPs 7 & 8**, despite both sessions ending 15 minutes over the nominal hour, the CoP spontaneously split into two sub-groups and continued discussions for an extra 5 minutes or so.

There were several instances of valuable feedback offered by student members of the CoP (that the facilitator could not have given). For example, in **CoP 6**, a senior member offered advice on user evaluation methods taken in a common courses.

In **CoP 7**, students were able to give good feedback on the more obvious aspects, but some tended to be hesitant to criticise (the facilitator provided some more criticisms when this was

the case). Student mutual-evaluation and critiquing strengthened slightly for **CoP 8**.

In an individual meeting in the week before **CoP 8**, one student told me that another student, whom I was very worried about, had in fact made good progress with his project recently.

Other anecdotes indicating the strong support for the CoP concept and the emergence of good group behaviour, respectively, were the offer from one of the senior members to contribute to future CoPs as an experienced practitioner / mentor, and the spontaneous gathering of all CoP members for lunch at the end of **CoP 9**.

Finally, in the following week, there was an informal meeting at a Bar (**CoP 10**?), with the usual 6 attenders and the facilitator. A draft of this document was shown: another 'fruit' of the CoP's efforts.

7 Overall Evaluation and Analysis

Sections 6.1.3 and 6.2.3 have already given some anecdotal observations which indicates the effectiveness of the CoP. This effectiveness has two dimensions: (1) the impact on student learning in the research methods studied and (2) the perceptions and experiences of the CoP members of how it operated. Section 7.1 gives an objective evaluation of the first dimension, from the author's, as project examiner, perspective. This is followed up in Section 7.2, with the students' perceptions of the effectiveness of the CoP. The remainder of this section then provides the main body of data for the second dimension.

7.1 Student Performance

This section gives an evaluation student performance in their projects, in relation to criteria explicitly studied in CoP sessions. From this, a judgement of the effectiveness of the CoP sessions for teaching these aspects can be made.

Table 3 gives the course examiner's evaluations of the final student presentations. The criteria listed were explicitly studied in **CoPs 1** and **8**. The top 5 rows may be compared with Table 1, except it must be noted that the final presentations were now of substantial length. For this reason, it is meaningful to allow 'very good' ratings here.

With the exception of speaker 4, all speakers have at least maintained their presentation quality from the initial presentations, with speakers 1, 2, 3, 6 and particularly 7 showing improvement. It should be noted that speaker 4 did not give a draft presentation for feedback in **Cop 8**, and that speaker 5 did not attend **CoP 8**.

The ESL speakers (2-4) all spoke well and clearly; they were notably less effective however in the use of body language and maintaining audience contact. This seems to arise from cultural differences as well as the extra mental burden of using a second language, and is a factor that normally requires sustained practice for people with such backgrounds.

Aside from this, all but speaker 4 showed strong presentation skills on most criteria. Overall, I rate the quality of the presentations to be slightly better than the previous semester's students (which were rated by the founder of the eScience degree programs as the 'best ever' group of project students, particularly in their presentations).

Table 4 gives a collation of the presentation evaluations by the student members of the CoP. The criterion were selected from the completed CoP Presentation Evaluation forms[2]. One student's responses were were discarded, since 'very good' ratings were given in almost all

[2]The students were instructed that giving two ticks / crosses corresponded to 'very good / bad'

criteria	1	2	3	4	5	6	7
preparation	v.good	good	v.good	mixed	mixed	good	v.good
clarity	good	good	v.good	neutral	good	v.good	good
motivation/interest	v.good	good	good	neutral	good	v.good	v.good
right level of detail	good	good	good	good	good	good	v.good
presentation structure	v.good	good	good	good	v.good	good	v.good
slide format	good	good	v.good	poor	v.good	good	good
slide readability	good	good	good	good	good	good	v.good
effective visual aids	v.good	mixed	v.good	neutral	v.good	v.good	v.good
use of voice	v.good	good	good	good	good	good	good
use of body language	v.good	neutral	neutral	neutral	good	v.good	v.good
audience contact	v.good	neutral	neutral	neutral	good	good	good
adequate introduction	good	good	good	mixed	v.good	v.good	v.good
strength of conclusions	good	good	neutral	poor	good	good	good

Table 3: Final presentation evaluations by the course examiner

categories for all speakers. Note that a response of 'mixed' could not be given in this case ('mixed' in Table 3 can be regarded as being 'neutral' here). We see a reasonable level of agreement between the students, and, comparing with Table 3, a reasonable level of agreement with the course examiner (with the students tending to give slightly more critical responses overall).

After the submission of the reports (which occurred almost one week after the presentations), the reports were examined. A component of this examination were criteria in report writing studied in the CoP sessions; the evaluation of these is given in Table 5. The numbering of the students is the same as for the presentations. 'Visual aids' included diagrams, graphs and tables; 'visual aids used' indicates whether these were used in situations where they could be reasonably used, and 'visual aids effective' gives an indication of their quality and effectiveness. Note that for the implementation projects (reports 3–5), the use of citations is not considered as important as for the research projects.

Again, with the exceptions of reports 4 and 5, the reports met the criterion well. In terms of the report-writing criteria, report 7 rates as the best I have ever seen in a student project.

It could be suggested that the analysis of the above evaluations (particularly the presentation evaluations by the students) could have been sharpened with numerical values (enabling precise averages and standard deviations to be calculated). However, considering the problems of calibration (i.e. some people are more (or less) critical than others) and the inherent degree of subjectivity involved, we feel that this would impute a degree of objectivity that is not appropriate.

7.2 Student Surveys

The responses from the second survey provided a systematic evaluation of the CoP. Table 6 provides the students' ratings of the effectiveness of individual sessions. These ratings are largely consistent with those of the corresponding topics proposed earlier (see Table 2), indicating student expectations were largely met. The most notable exception was for **CoP 6**: it was rather difficult to find general principles which were applicable across most projects for this topic. For

criteria	1	2	3	4	5	6	7
preparation	v.good	good	good	good	good	good	v.good
clarity	v.good	good†	good	good	good†	good	good
motivation/interest	good	good‡	good‡	good†	good‡	good†	good
right level of detail	good	neutral†	neutral†	neutral‡	neutral†	good	good†
presentation structure	good	good	good	good	good	good	good
slide format	good†	good	good	good	good	good	good
slide readability	good	good‡	good	good†	good†	good	v.good
effective visual aids	good†	good†	good‡	neutral‡	good†	good	v.good
use of voice	v.good	good	neutral†	good†	good	good	good
use of body language	v.good	neutral	neutral†	neutral†	good	good†	good†
audience contact	good	neutral†	neutral‡	neutral	good	v.good	good†
adequate introduction	good	good	good	good	v.good	good	v.good
strength of conclusions	good†	good	good‡	good	neutral†	good	good

Table 4: Final presentation evaluations (averaged) by the students (†: moderate variability in responses; ‡: high variability)

criteria	1	2	3	4	5	6	7
use of citations	v.good	v.good	v.good	poor	poor	v.good	v.good
use of quotations	good	good	n/a	n/a	n/a	v.good	v.good
report structure	v.good	v.good	v.good	good	good	v.good	v.good
grammar	good	mixed	good	good	good	good	v.good
succinctness	good	good	mixed	neutral	good	v.good	v.good
visual aids used	v.good	good	v.good	good	v.good	good	v.good
visual aids effective	v.good	good	v.good	v.good	good	v.good	v.good

Table 5: Final reports evaluated by course examiner on criterion studied in CoP sessions

CoP session:	(A)	(B)
(1) Elements of Good Presentations	4.2	4.0
(3) Presentation Review; Managing Your Project	4.2	4.2
(4) Literature reviews, Citations and Attributions	4.2	3.7
(5) Report Writing: Structure and Setting Out	4.3	4.3
(6) Implementation and Evaluation Issues	3.8	3.6
(7) Writing Up Reports: Finer Details	4.5	3.3
(8) Improving Presentations	4.3	3.2

Table 6: Averaged student ratings of the CoP sessions in (A) improving the quality of their project work and (B) in their general understanding of project/research-related issues (0 = not at all, 5 = very much)

reviewing good/bad examples of previous work	(2)
peer review of draft presentations / reports	(2)
communication skills	(1)
group discussions / support / feedback	(2)
help in project management	(3)

Table 7: Student comment characterizations (with numbers) on "what were the best parts of the CoP sessions?"

CoP 4, one student responded this was not helpful as he had completed this part of his project in the previous semester (these were the only responses for all sessions that were below 3). A comparison of columns (A) and (B) indicated that the most benefit was towards their projects.

The students gave overall ratings (same scale as for Figure 6) of the CoP of 4.5 and 4.3 in its actual implementation and in principle for supporting IT projects, respectively. Table 7 gives the results of a qualitative analysis on comments on what were perceived to be the best parts of the CoP sessions. Oral and written communication skills are dominant here (the first three rows come under this category). More unexpectedly, project management also figured prominently, with two students stating the CoP's structure itself helped their projects significantly with this issue.

The survey also questioned students on whether the exposure to the other students' projects was beneficial in itself. All responded positively, with reasons of interest (3), reassurance in knowing others were encountering similar difficulties (2) and learning about pitfalls (1).

Table 8 collates students' suggestions for improvement for the CoP sessions. Session scheduling was important; although it should be noted that sessions were set at 4:00 pm to accommodate the two students who worked more or less full-time. Reducing the amount of time reading during the sessions is another theme that emerges here. The final comment indicates that opportunities for socialization should not be missed.

The other parts of the survey examined the social aspects of the CoP, summarized in Table 9. For Q3, 3 students commented that they felt that the sessions were very open for participation. Examples of outside-session interactions between students that were possibly facilitated by the CoP included continued discussions (3), arranging studying together (1), and occasional technical help (2). One response to Q6 was that "*student feedback was acted on wherever possible*". The two negative responses to Q6 were from ESL students, who both commented that the

hold sessions earlier in the day	(2)
allocate more time or have more, shorter sessions	(1)
set Zobel as a text and request pre-readings	(1)
should not be too much theory in sessions	(1)
more time on presentations / reports	(1)
more time on testing / evaluation / conclusions	(1)
a larger group size would be desirable	(1)
hold a mid-semester lunch	(1)

Table 8: Student comment characterizations (with numbers) on "how could the CoP sessions be improved?"

Ref:	Question	response
Q3	Extent felt able to contribute to the sessions	(5, 1, 0)
Q4/5	Outside-session interactions were facilitated	(4, 2, 0)
Q6	Had sufficient say in CoP activities	(3, 1, 2)
Q7	Extent the CoP made the project experience more enjoyable	(4, 2, 0)

Table 9: Responses to survey questions on social aspects of the CoP (clearly positive, weakly positive, negative)

different language [and cultural] background made it hard for them to speak out in such a situation. For Q7, those that gave clearly positive responses said it was due to the mutual support / friendly environment (3), the reduction of loneliness (1) and improvement of self-confidence (1).

8 Conclusions

In this project, the Community of Practice principle was applied to the eScience postgraduate individual IT projects, forming a CoP comprising of seven students and the project co-ordinator. The CoP was targeted at studying generic research-related principles and skills common to all projects. This implementation of the CoP was refined by applying the action research method.

A limitation of the action research method in this context is that a CoP is an evolving entity. Reflections and new knowledge gleaned from earlier stages may thus be no longer be applicable for later stages. However, the experiences will still be useful for future years. Having said this, the method worked synergistically in a CoP context, since the soliciting and applying of members' feedback within short timeframes contributed to the sense of ownership and cohesion of the CoP.

A research methodology combining phenomological and action research was applied, to discover the perceptions of the CoP by the participants. This comprised of participant surveys, observation of the CoP and semi-objective evaluations of student performance. All of these combined to give a consistent impression of the operation of the CoP.

Anecdotal observations (Sections 6.1.3 and 6.2.3), student survey results (Section 7.2 and student performance evaluations (Section 7.1) form the basis of the evaluation of the CoP's implementation, which will be given in Section 8.1. Taking into account the various circumstances

of the eScience projects for this semester (Section 2), an evaluation of the potential of the CoP principle will be given in Section 8.2. Suggestions for future work are then given in Section 8.3.

8.1 Evaluation of the Implementation of the CoP

From the initial surveys, the students' felt that participation in the CoP sessions (as proposed at that stage) was of high to very high potential benefit (Table 2), and their expectations were maintained (Table 6). Topics relating to presentation skills and report writing were particularly valued[3]. Overall, the averaged student rating of the effectiveness of the implementation of the CoP was high to very high.

Student performance, in report writing and presentations, were for the most part very good. However, there are many other factors influencing this: the prior abilities of the students (including their language and cultural backgrounds), and the effect of their supervisors. In terms of the latter, the author was also their supervisor; the 2 students who did not perform so well also did not respond in all cases to direct advice from the supervisor in improving their work in these respects. These caveats, coupled with the small numbers involved and the lack of a control group, mean that the semi-objective evaluations taken in this project should not be regarded as providing hard evidence. Nonetheless, it is still reasonable to claim that the CoP sessions had an overall positive impact on improving student performance in these research-related skills.

Taking both the students' perceptions of their learning and the above together, we claim Objective 2 of this project has been met to a high extent.

Attendance at the CoP was maintained; apart from exceptional circumstances, only one student regularly did not attend (this student's circumstances made it difficult to make progress with their project at all). This, coupled with the positive anecdotes observed in increasing frequency over the semester (see Section 6.2.3), and the survey responses from Table 9, indicates that the desired social characteristics have been attained, and that a close and supportive group had been established. Another social advantage of the CoP comes from the exposure to the other student projects: all survey responses were that this was beneficial, from improved general knowledge, finding out about pitfalls and improvement in self-confidence (from seeing others having the same difficulties). From these results, we claim that Objective 1 also been achieved, to a high extent.

There are however a few exceptions. One is that a way needs to be found to give students with an ESL background a better way of having a say in CoP activities, as they felt it difficult to do so in group discussions. Possibly, a Suggestion Box may be useful. Another is that while all had experienced beneficial outside-session interactions that may have been facilitated by the CoP, these seemed to be rather small in number. This seems to be largely due to factors such as the relatively small number of students coupled with fact that the projects shared little in common in the technical sense, and the fact there was no natural place where the students could meet outside the sessions. More attention to the timing and the duration of the sessions should also be given.

8.2 Evaluation of the CoP Concept

As mentioned in Section 8.1, uncontrollable external factors limited the potential for informal CoP interactions, which could have have also been very beneficial. We would expect that in

[3] It should however be noted that the students' generally high ratings and general positively should also be tempered with the fact that this was a new initiative, which added to a sense of specialness.

more favourable circumstances, these would occur to a greater extent.

One external factor that was however highly beneficial was having a range of experience within the CoP; in the case of the eScience projects, this arose from the fact that the research projects are split over two semesters. Achieving this effect in other circumstances (e.g. enlisting a former project student, or perhaps a PhD student) is likely to be worthwhile, if possible.

The key underlying issue is whether there is sufficient commonality of purpose and mutual benefit. Our study has shown that even the common purpose of improving communication and project management skills was sufficient to establish a cohesive and effective CoP.

The group size of about seven was in itself close to optimal; large enough to get a diversity of opinion and promote lively discussions, but small enough to manageable and for people to get to know and trust each other. In situations with larger numbers, splitting them into sub-communities (based on project similarities) would be advisable.

Face-to-face contact was clearly important in establishing the social aspects of the CoP. Electronic support for virtual meetings may be useful especially for discussing technical aspects, but should not be seen as a substitute.

With respect to Objective 3, we feel that this preliminary study indicates the CoP can be an appropriate and effective educational approach for individual student technical projects. This is backed by opinions of the students in their surveys (Section 7.2). As one student (himself a member of the Open Source Software Community) wrote in his survey response "*expert level peer communities work well*".

With respect to Objective 4, we believe that it also indicates that CoPs can be a very effective way to teach research skills that are common across the range of projects: certainly more efficient, systematic and effective than the traditional method of replying on individual supervisors. Over teaching these skills in a separate course, a CoP approach has several advantages: the students are more motivated in the context of doing an actual project, they can relate general principles with their current experience (experiential learning), and they seem to appreciate the element of peer review (see Table 7). It can further be noted that the students felt the CoP sessions improved the general understanding and abilities in research shills highly (see column (B) of Table 6). However, further studies and evaluations are needed to establish this in a broader sense.

8.3 Recommendations for Future Work

It is our hope that the CoP approach can be trialled in further contexts, such as for individual and small group projects in IT, engineering and the sciences. Honours year projects could in particular benefit from this.

We hope that the experiences, structures and even the materials used in the eScience CoP can be useful in this context. However, the most valuable is applying the action research method, as not only can this improve teaching practice in general contexts, it can also be used to promote cohesion within a CoP. Every CoP that is formed will have individual needs and objectives, so that flexibility in how it is facilitated is most important.

The role the facilitator plays is important, and in particular their knowledge of the student projects themselves can be valuable. In the case of the eScience CoP, the facilitator had some supervisory role in all but one of the projects, and this helped the relevance of the sessions.

We also hope to continue the CoP in the eScience projects; in the words of one of the CoP students "*I feel strongly that the CoP portion of the [eScience] projects should stay*". While we feel that the CoP's implementation this semester was effective, some improvements

in the implementation could still be made; Table 8 lists these. The most important point is to encourage pre-reading of the materials before the sessions: this would have the benefit of saving some time, give ESL students a better chance to understand the material promote discussions, and diminish the domination of the facilitator (who presented the material). The next most important point is to use all reasonable opportunities for socialization, e.g. the suggestion to hold a mid-semester lunch (Table 8). Issues with ESL students (language and culture) in this context are important and should be more carefully considered.

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A Appendix: List of Supplementary Materials

The following lists supplementary materials produced by this project; together, with this document, they comprise the project's portfolio.

1. eScience Project CoP web page,
   http://escience.anu.edu.au/project/meetingsS12006.en.html
2. collated CoP session email reminders (containing proposed agendas),
   http://cs.anu.edu.au/people/Peter.Strazdins/escience/CoP/meetings.txt
3. CoP sessions: distributed reference materials and session notes
4. CoP Survey 1 document,
   http://cs.anu.edu.au/people/Peter.Strazdins/escience/CoP/SurveyMtg2.pdf
5. CoP Survey 2 document,
   http://cs.anu.edu.au/people/Peter.Strazdins/escience/CoP/SurveyMtg9.pdf
6. completed CoP Survey I & II forms
7. CoP Presentation Evaluation form,
   http://cs.anu.edu.au/people/Peter.Strazdins/escience/CoP/PresEval.pdf
8. CoP Presentation Evaluation forms, filled out for each speaker