Applying the Community of Practice Approach to Individual IT Projects

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Abstract

This paper reports a study of utilizing the *action research* educational method to the application and evaluation of the *Community of Practice* (CoP) principle to individual postgraduate project courses in IT at the Australian National University.

Two CoPs were formed, comprising the students enrolled in research and implementation project courses and the project co-ordinator (the author) of the first semesters of 2006 and 2007. The 7 students in the 2006 CoP were predominantly local students, whereas the 10 in the 2007 CoP were almost all international students, having significantly different language and cultural backgrounds. The action research method was applied over two phases each semester, the first in weeks 1–7 (involving 5 meeting sessions), and the second in weeks 10–15 (involving 4 meeting sessions), and also between semesters.

Data for evaluation includes student feedback (including an entry and exit survey, and anecdotal remarks), observation of the CoPs, 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 behavior emerging, including the establishment of a mutually supporting environment. Even through the projects were individual, the commonality of learning research skills and peer feedback was sufficient to establish a cohesive and effective community. A number of design principles and factors that are important to achieve positive results are identified. 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.

1 Introduction

Project courses usually form an integral part of advanced IT coursework degrees, acting as a 'capstone' where skills and knowledge built up previously in the degree are integrated in a single work. Whether implementation (i.e. producing a substantial software artefact) or research oriented, an important aspect of project work involves various generic skills, such as project management, verbal communication and written communication. The latter is particularly crucial, as typically the assessment of a project is primarily focused on the quality of the thesis or report produced.

The importance of such generic skills in university education is widely recognized, to the point that Australian universities are rated on the teaching of Generic Skills on the Course Experience Questionnaire (CEQ), run by DEST.

The question arises, how and where in the degree should these skills be best taught? Most commonly for individual projects, it is left to the supervisor(s) to teach them during the course of the project. Given that the supervisor's focus is on the project work itself (as opposed to its presentation), and that the supervisor may not have either the interest or expertise in teaching generic skills, this method is prone to unsatisfactory educational outcomes. Furthermore, it is resource intensive for busy supervisors to do this on an individual basis. Even with the best of intentions (as has sometimes been the case with the author's own Honours students), the fact that time for the teaching and learning such skills is not explicitly set aside in advance can lead to needlessly disappointing outcomes.

A second method is to teach generic (research-oriented) skills in a separate (preceding) course. As well as being highly resource intensive and having impact on the degree's structure, this method also has the drawback that, if taught in isolation, the principles will seem 'dry' and difficult for the students to relate to their experience. For the same reason, students may find motivation difficult.

A third method is to systematically integrate the teaching of these skills as part as the project course, using a teacher / facilitator. This has the advantage that students can relate the principles to their current project work, thus facilitating *experiential learning* (Toohey 1999, Ch. 3), and enhancing student motivation as their efforts can have a direct contribution to the outcome of their project.

This study investigates the third method, applying and evaluating the Community of Practice (CoP) principle (Wenger 1998). Here a CoP is formed between the current postgraduate project students and the project co-ordinator (the author of this paper), who acts a the facilitator of the CoP. This principle is chosen as it can extend the available teaching resources beyond the teacher, making use of the students' collective knowledge and experiences. The resulting social interactions also has the potential to improve the quality of the students' educational experience. The *action research* method (Kember 2000, Carr & Kemmis 1986) is used to evaluate and refine the application of the CoP approach, and it will be seen that it can act synergistically in supporting it.

This paper is organized as follows. Section 2 provides background for the postgraduate projects, both historically and for the current situation of this study. Section 3 reviews relevant educational research literature together with indications of how it might be applied in this context. This is then followed up in Section 4 which outlines the study's objectives and plan, including its research methodology. Principles for the design of the CoP are given in Section 5, followed by a description of its implementation in Section 6. An overall analysis and evaluation tak-

ing into account student performance and survey results is given in Section 7, with conclusions being given in Section 8.

2 Background to the Masters Projects

A number of project courses form the capstone of the Masters of Information Technology degree at the Australian National University. The courses, which each run over a single semester, are of two types:

- implementation projects. For the purposes of this paper, these are named IP06 and IP12, 6 and 12 unit courses respectively[1]. 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 the context of a project topic.
- research projects: RP06 (6 units) and RP18 (18 units), These are taken over successive semesters and together form a research project equivalent to that of 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, project management, 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.

Traditionally, the teaching of these skills was left largely in an ad hoc basis to the supervisor(s) 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. The lack of social context for the projects also troubled the author, particularly considering they were for the capstone of a degree that many students had come a long way to undertake.

When the author was the co-ordinator for these projects in semester 1 of 2006 and 2007, it was decided to see if these issues could be redressed by using a CoP approach. Table 1 gives statistics on the student composition of the CoPs formed, in terms of project courses, study intensity (full/time or part/time), gender, background and association with the facilitator.

'Background' is given in terms of whether English was the second language (ESL); in this case, all ESL students were international students of a South-East Asian origin. This is significant in the CoP context as there are inherent language and cultural barriers for such students in participating in group discussions (and also extra challenges in communication skills in English). This is compounded by the fact that a larger proportion of the students were female. In this sense, the composition of the 2007 group was substantially different from that of 2006, and presented a challenge to applying the CoP approach.

A final factor is the number of students for which the facilitator was assigned as primary or secondary supervisor to the students. This can influence the CoP in two ways: (1) if a meaningful positive relationship is independently established with the facilitator, the student is more likely to aid the facilitator by contributing more strongly to the group, and (2) knowledge of the projects and their current status aids the facilitator in the running the CoP sessions. Again, the situation in 2007 was more challenging due to this factor; although the facilitator did act to some extent as a second supervisor to all of the students.

A partially mitigating factor is that, in 2007, seven of the students were paired with another student who was working on a similar project with the same supervisor(s). This provided an opportunity for 'sub-communities' to form.

Note that the structure of the Masters research projects meant that RP18 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').

3 Relevant Educational Literature

This section summarizes relevant educational literature for this project, including that for the Community of Practice approach (Wenger 1998, Ch 1-2) and the related approach of Cognitive Apprenticeship (Collins, Brown & Hollum 1991). Research on establishing good group characteristics (Tyson 1998, Ch 1) is also relevant here.

The Community of Practice approach arises from the observation that learning is a fundamentally social phenomenon; hence social aspects are central to learning (Wenger 1998, Ch 1). The term *Community of Practice* refers to a situation where a group of people with a common interest in a particular area collaborate to solve problems in that area, and learn of each others' ideas and experiences. Its practice consists of three key elements (Wenger 1998, Ch 2):

1. mutual engagement. Here, the contributions of others are used to complement individual understanding 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 projects (and the associated learning of research-related methods), meet to discuss common aspects of project work, and evaluate and help to improve each others' work.

The CoP thus forms a co-operative group, whose effectiveness can be measured by the following profiles (Tyson 1998, 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 focused 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 CoP is the Cognitive Apprenticeship model (Collins et al. 1991). In this model, the teacher exposes the reasoning and strategies of an expert to the

[1] 48 units is considered a year of full-time study.

year	course				intensity		gender		background		facil. supr.	
	IP06	IP12	RP06	RP18	P/T	F/T	M	F	ESL	non-ESL	prim.	sec.
2006	1	2	2	2	1	6	6	1	2	5	2	5
2007	0	5	1	4	1	9	7	3	9	1	0	4

Table 1: Breakdown of student CoP membership

student in the settings of a series of tasks with a real-world context, in which they both engage. 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 Masters project context to a limited extent in group meetings with the Masters 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 paper.

The Masters CoP concentrates 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 (Boyer Commission 1998, Ch 1). Research-based learning has been noted as an area of strategic importance at the Australian National University (The Australian National University 2005).

An important concept in higher education is that learning and assessment should be regarded as linked activities. In particular, *formative assessment* (Boud 2000) 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 (Boud 2000). However, such assessment should be related to feedback (*formative assessment*), rather than grading (*summative assessment*). The Masters projects formerly offered no substantial *formative assessment*, outside of the draft-revise loop of the supervisor and student. Formative assessment could be implemented within a CoP approach with the students evaluating each other's work, informally and semi-formally.

3.1 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 projects. A comprehensive book covering various applications of the CoP principle is Hildreth & Kimble (2004); most contexts are from non-university organizations, especially the commercial sector, and there is also much research on distributed, virtual communities (see for example Rogers (2000); a survey concentrating on these is Johnson (2001)). An important aspect is the supporting web-based technology used, which normally includes on-line chat rooms.

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

The closest related work we know of is a study on establishing CoP between IT digital media student projects with start-up companies (Rohde, Klamma & Wulf 2005). Here, CoPs consisting of a small team of students and member(s) of an IT start-up company was 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. Another difference is that technological aspects of the CoPs were emphasised over the social aspects.

3.2 Literature Relevant to Research Methodology

This section reviews the evaluation methods of Action Research (Kember 2000, Carr & Kemmis 1986, Ch 2), Reflective Writing (Moon 2006) and qualitative analysis (Creswell 2002, Ch 2). These give relevant concepts that will be used to develop this study's research methodology.

The Action Research method consists of a cyclical process aimed at improvement of practice. In this case, it can be used to improve the effectiveness of the CoP and the benefits thereby obtained. The cycles consist of planning, acting, observing and reflecting (Kember 2000, Ch2). It is important that the observations be performed systematically. In the context of this study, the method can then be applied in small cycles between CoP sessions, and a larger cycle between the two main phases.

Reflective Writing (Moon 2006) 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. 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 (Carr & Kemmis 1986). In this context, the technical view can be manifested in the analysis, the practical view can be manifested in the design, and the critical view can be manifested in the conclusions.

A major part of this study is the evaluation of the effectiveness of the CoP, both in principle and in its actual implementation, in an individual technical research project setting. Thus, this study is also concerned with educational research, of which there are two main approaches: qualitative and quantitative (Creswell 2002). Of these, the qualitative approach seems more promising due to several factors: (1) the lack of previous experience of the author in a 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 intention of this study, which is to understand how the participants' experiences were affected. The qualitative analysis can be based on textual data provided by surveys, augmented with observations and anecdotes. From these, a wider meaning of this study'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. The *action research design* (Creswell 2002, Ch 2) was chosen, as this study's focus is on trialling and improving practice.

4 Objectives

The objectives of this study 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 (and in particular in supporting the learning of research-related skills in the context of research-based education).

These following indicators are 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 behavior 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.

4.1 Research Methodology

As we are investigating an educational paradigm where social issues are central, most meanings arise from the perceptions and 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 has a strong subjective element.

Our research methodology is a combination of phenomenological research (Polkinghorne 1989) and action research. The former concentrates on the perceptions of the CoP by the participants, and are provided by participant surveys and observation. The latter also involves these elements, but combines them with the semi-objective evaluations mentioned earlier.

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

5 Design of the CoP Sessions

The CoP meetings were 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). The action research method was 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 being used to provide improvements within each phase).

Surveys were carried out in weeks 3 and 15. These provided an initial and final evaluation of the CoP. Observations and anecdotal feedback were also recorded throughout.

An evaluation of the first phase, including an analysis of the data collected from the first phase, and design of the the second phase, was undertaken in weeks 8–10.

An analysis of the final assessment of the projects (in week 16) with respect to the CoP topics was also undertaken, with a final analysis and evaluation taking place afterwards.

The guiding principles in the design of sessions of Phase I were to:

1. choose topics where a need was known for study, based on previous experience with the Masters 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.
5. give members opportunities for a say in the running of the sessions and other aspects of the CoP, both in surveys and in short discussions at the end of meetings.

The second and third principles were intended to strengthen the *joint enterprise* aspect of the CoP, in that it should give the members a strong common purpose. The fourth principle was intended to enhance a *shared repertoire*. The fifth principle was intended to enhance a *joint enterprise*.

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

From this principle also, *citations and attributions* were 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 were used to illustrate the general principles studied.

The guiding principles in the design of the Phase II sessions were:

1. choose topics which would be useful for later stages of project work.
2. make more use of the students' work in progress.
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 Phase 1 session indicated that its usefulness was passing.

6 Implementation

This section describes the implementation of the CoP session over two phases.

The main reference for the sessions was excerpts from *Writing for Computer Science* by Prof Justin Zobel (Zobel 2004). This book covered all aspects of research, in a computer science context, and was felt to be of excellent quality. Supplementary references came from the Australian National University's Online Learning Materials website.

Only an outline of how each session was conducted is given here; this is because the action research principle implies that flexibility in terms of the needs and interests of the CoP should dictate the finer, and to some extent the broader, details. Nonetheless, in the event, the sessions were run in a surprisingly similar fashion over the two years; Table 2 indicates that for 2007.

Each session (except S9) ran for an hour to an hour and a half on a set time on Thursday afternoon. Student attendance at S2 and S9 were mandatory, in that participation directly contributed to formal project assessment. Note however that peer assessment was used for feedback purposes only.

Student feedback influenced the implementation of the sessions, both in broad aspects (e.g. requesting more emphasis on presentation and report writing skills, timing issues) and in fine details (e.g. design of presentation evaluation forms and managing transitions better).

More detailed information on the sessions, including a precise description of references used in each session, session agendas, survey forms and presentation evaluation forms can be found from the Masters Project CoP web page (Strazdins 2007). The page also contains links to the Master degree descriptions, project courses description and assessment schemes, and the web pages for the student projects for the respective semester (each containing project descriptions, final reports and slides for final presentations).

7 Analysis and Evaluation

The effectiveness of the CoP approach in this context has two dimensions: (1) the perceptions and experiences of the CoP members of how it operated, and (2) the impact on student learning of the generic skills studied. Sections 7.1, 7.2 and 7.3, based on initial and final student survey responses and anecdotal evidence, deals with the first. Section 7.3 also treats the second, in that it gives the students' subjective evaluations of their own learning. Section 7.4 gives a semi-objective evaluation of the second dimension from the perspective of the author, as project examiner.

Except where otherwise noted, there was broad agreement of the overall survey responses and the nature of anecdotes over both years.

7.1 Initial Survey Responses

This section gives an indication of early student evaluation of the CoP, based on responses from the initial surveys given out in S2.

The initial survey gave some direct feedback on S1. The reference materials were rated as useful, while the previous students' talks were very useful. As well as this, half said the encouragement from / knowing about other participants was the best part of S1. The students felt that S1 was very useful–useful in both preparing and delivering their presentation. However, they felt happy–a little unhappy with how their delivery actually went.

The students rated the potential interest/benefits of proposed future CoP topics as shown in Table 3. It is noteworthy that the 2007's CoP ratings were consistently lower than their predecessors, possibly indicating a less favorable predisposition to the proposed CoP.

year	S1	S2	S3	S4	S5	S6	S7	S8	S9
2006	7	7	6	7	6	6	5	5	7
2007	9	10	8	7	6	7	6	8	10

Table 4: CoP Session Attendance

7.2 Anecdotal Observations of the Function of the CoP

This section details some anecdotal evidence of how effectively the CoP functioned for the students. These indicate the level of student support towards the CoP, and the emergence of good group behavior in the CoP. Specifically, item 3 gives an indication of *joint enterprise* (Section 3); items 4 and 5 give an indication of the level of *mutual engagement* in the CoP.

1. **Attendance**. Table 4 indicates that the CoP session attendance. In 2006, after taking into account absences due to work commitments or clashes with exams, the attendance rate is almost 100%. In 2007, however, only a third of the absences were accounted for in such a way, with one student attending only the plenary sessions (S2 and S9).

2. **Expression of attitudes towards the CoP**. Most student comments from the early sessions indicated that they felt the CoP could be very helpful, with reasons such as "sharing experiences" and creating a "friendly environment" cited. At S4 (2006), one of the two 'senior members' said that the CoP created a definite improvement in morale over that of the previous semester; this was seconded by the other.

3. **Ownership of the CoP**.

   Where it was practicable, meetings concluded with a short discussion for planning future activities, and there were generally enthusiastic suggestions and responses. During S3–S5 in particular, there were clear positive expressions that student feedback (from the initial surveys and informal comments) was being acted on, both in small and large details. *This indicates how the action research method can act synergistically to support a CoP*.

4. **Student contributions to the CoP**. There were several instances of valuable feedback offered by student members of the CoP (that the facilitator could not have given). For example, in S6 (2006), a senior member offered advice on user evaluation methods taken in a common course.

   In sessions S5, S7 and S8, students were asked to prepare draft reports or presentations for peer evaluation. The compliance rate was 50–80%. In S5 and S7, students were able to give good feedback on the more obvious aspects, but some tended to be hesitant to criticize (the facilitator provided some more criticisms when this was the case!). Student mutual-evaluation and critiquing strengthened slightly for S8. All students seemed happy to evaluate each other's presentations using the forms (S2 and S9).

5. **Emergence of 'enthusiasts'**. These can be of great help to the facilitator. In 2006, one of the 'senior members' was the clearest enthusiast, who offered to contribute to future CoPs as an experienced practitioner / mentor. In 2007, despite now being full-time employed, he indeed kept this promise and his presence was a great support to that CoP.

   In 2007, somewhat surprisingly considering the student's cultural background, two enthusiasts did emerge, with one again being a 'senior member'. Their presence 'brought life' to the discussions. Two of the three enthusiasts had an independent positive

#	week	description
S1	3	*Elements of Good Presentations* Introduce the idea of a CoP and its application here; discuss key points of topics from references; display and evaluate on these points the presentations from the previous semesters (with particular attention on those from the 'senior members').
S2	4	*Initial Project Presentations* A 5 minute presentation by each student introducing their project topic, with other students evaluating them on the key points on simple forms (with each speaker's name and topic pre-written on each); distribution of first survey. Two minutes were reserved for transitions and form completion.
S3	5	*Presentation Review; Managing Your Project* Collection of surveys; overall feedback for S2 talks (and S2 itself) based on peer-, self- and facilitator evaluations; discussing project management principles from key references; general discussion based on the members' experiences.
S4	6	*Literature reviews, Citations and Attribution* For each topic, study excerpts from references, followed by a general discussion with the senior members particularly adding their experiences from the previous semester. Exercise in pairs: select reports from similar projects of previous semester, and evaluate them on the principles given by the references. Reflection on the CoP so far (understanding of concept, how it is functioning, how to encourage interactions outside the CoP sessions).
S5	7	*Report Writing: Structure and Setting Out* Study excerpts from relevant references followed by similar evaluation exercise (e.g. use of figures, tables and other features to improve visual interest). Evaluate each other's draft reports (concentrating on structure). Hold a review discussion and planning of Phase 2 sessions.
S6	10	*Implementation and Evaluation Issues* Review which attributes are expected in a good implementation of a project; discuss the importance of reproducibility; discuss excerpts of evaluation of data from references; discuss the main issues encountered so far in implementation of the members' projects, with other members offering suggestions. Hold a review discussion and planning of Phase 2 sessions.
S7	12	*Writing Up Reports: Finer Details* Discuss excerpts from references; discuss how the CoP could facilitate proofreading in the coming weeks; discuss the timings of the final 2 sessions. Perform a small group exercise: evaluate the latest drafts of reports against the principles studied from the references (and those in S5).
S8	14	*Improving Presentations* Brief review of the key ideas from S1 and excerpts for S8 (read beforehand). 'Dry runs' of (part of) final presentations (limited to 10 minutes), with 5 minutes in between for feedback and transitions. Brief discussions for preparation of S9.
S9	15	*Final Project Presentations* This was run like S2, except there was 18, 28, and 33 minutes for each presentation (for those in 6, 12 and 18 unit project courses respectively; this included time for a live demonstration and questions), with a mandatory 2 minutes in between for transitions and completing evaluations (a form with detailed criteria was provided). This was run in two sittings, the talks ordered according to their research themes. Supervisors, clients, some academic staff and some postgraduate students also attended. Handout of final surveys.

Table 2: Outline of the CoP sessions

topic:	2006	2007
Managing Your Project	4.5	3.7
Literature reviews, Citations and Attribution	3.5	3.4
Report Writing: Structure and Setting Out	4.0	3.9
Implementation and Testing Issues	4.0	3.7
Writing up your Report and Preparing Your Presentations	4.5	4.0

Table 3: Averaged student ratings of the potential interest/benefit of proposed session topics (0 = not at all, 5 = very much)

relationship with the facilitator (primarily through supervision) established prior to this.

6. **Emergence of good group behavior**. At the end of the later sessions, the CoP began to spontaneously split into two sub-groups and continued discussions for an extra 5 minutes or so. In 2006, there was a spontaneous gathering of all CoP members for lunch at the end of S9, which was followed up by a meeting at a bar the week after.

7.3 Student Surveys

The responses from the second survey provided a systematic evaluation of the CoP (6 responses were obtained in 2006, 7 in 2007). Table 5 provides the students' ratings of the effectiveness of individual sessions These ratings are largely consistent with those of the corresponding topics proposed earlier for the same year (see Table 3), indicating student expectations were largely met. The most notable exception was for S6: it was rather difficult to find general principles which were applicable across most projects for this topic. For S4, one student responded this was not helpful as he had completed this part of his project in the previous semester . A comparison of columns A and B indicated that the most benefit was towards their projects.

Comparing the years, one interesting trend is that in terms of overall positivity, the 2007 data is now actually higher, in contrast to the initial survey results (Table 3).

The students gave overall ratings (same scale as for Figure 5) of the CoP of 4.5 (4.0) and 4.3 (4.0) in its actual implementation and in principle for supporting IT projects, respectively, for 2006 (2007).

Table 6 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 but one responded positively, with reasons of interest (3), reassurance in knowing others were encountering similar difficulties (4) and learning about pitfalls (1).

Table 7 collates students' suggestions for improvement for the CoP sessions. The starred suggestions indicate which comments were acted upon (by applying the action research method) for 2007. 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 8. 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 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 (4), the reduction of loneliness (2) and improvement of self-confidence (1).

7.4 Student Performance

This section gives an evaluation of student performance in their projects by the author (who also acted as one of the course examiners) 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 9 gives evaluations of the final student presentations. The criteria listed were explicitly studied in S1 and S8. The numeric scale used here (and subsequently) is: -2 = very poor, -1 = poor , 0 = neutral, 1 = good, 2 = very good.

The overall standard of the three 2006 ESL students was similar to the 2007 cohort (who were almost all ESL); however, their performance was appreciably lower overall than the 2006 group in total.

The ESL speakers mostly 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 4 of the ESL speakers across both years showed strong presentation skills on most criteria. Overall, I rate the quality of the 2006 presentations to be slightly better than the previous semester's students (which were rated by the founder of the Masters degree programs as the 'best ever' (at that time) group of projects, particularly in terms of presentations). The 2007 presentations are more mixed, which is unsurprising considering the unusually high proportion of ESL students.

For 2006, a collation of the presentation evaluations by the student members of the CoP was made and analysed. There was a reasonable level of agreement between the students, and, a reasonable level of agreement with the course examiner (with the students tending to give slightly more critical responses overall).

The week after the presentations, the reports were examined. A component of this examination was criteria in report writing studied in the CoP sessions; the evaluation of these is given in Table 10. '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, the use of citations is not considered as important as for the research projects. For some implementation projects, the criteria was deemed to be not applicable.

With the exceptions of two reports in 2006 and three in 2007, the reports met the criterion well. In terms of the report-writing criteria, one report from the 2006 CoP rates as the best I have ever seen in a student project, closely followed by a report from the 2007 CoP..

To compare student performance with the alternative method of instruction, relying on supervision, the reports of semester 2 2006 were evaluated similarly, with the averaged results tabulated in the third column Table 10. In this cohort of students, there was a different project coordinator who chose only to run the meeting sessions related to the presentations. However, one difference is that 5 students had the benefit of a very experienced and conscientious primary supervisor (such a primary supervisor was not available in semester 1 2007). The two students doing the RP18 course had the benefit of attending the CoP in semester 1, and so were excluded from the cohort. Otherwise, the cohort is very much like that of semester 1 2007: 9 ESL students (again all of South-East Asian origin), with 2, 5 and 3 students enrolled in IP06, IP12 and RP06 respectively.

While there is a subjective element in such an evaluation, and the numbers are too small for statistical significance, a comparison of the last two columns in Table 10

CoP session:	2006: (A)	(B)	2007: (A)	(B)
(S1) Elements of Good Presentations	4.2	4.0	4.4	4.4
(S3) Presentation Review; Managing Your Project	4.2	4.2	4.2	4.2
(S4) Literature reviews, Citations and Attributions	4.2	3.7	4.0	4.0
(S5) Report Writing: Structure and Setting Out	4.3	4.3	4.5	4.5
(S6) Implementation and Evaluation Issues	3.8	3.6	4.1	4.2
(S7) Writing Up Reports: Finer Details	4.5	3.3	4.2	4.1
(S8) Improving Presentations	4.3	3.2	4.5	4.1

Table 5: 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)

	2006:	2007:
reviewing good/bad examples of previous work	2	
peer review of draft presentations / reports	2	4
communication skills	1	1
group discussions / support / feedback	2	
help in project management	3	1

Table 6: Student comment characterizations (with numbers) on “what were the best parts of the CoP sessions?”

	2006:	2007:
hold sessions earlier in the day	2	
allocate more time*	1	
have more sessions	1	1
set Zobel (2004) 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	
have guest presentations		1
show more connections between topics		1
have an on-line forum		1

Table 7: Student comment characterizations (with numbers) on “how could the CoP sessions be improved?”

Ref:	Question	responses 2006:	2007:
Q3	Extent felt able to contribute to the sessions	(5, 1, 0)	(4, 0, 1)
Q4/5	Outside-session interactions were facilitated	(4, 2, 0)	(1, 3, 2)
Q6	Had sufficient say in CoP activities	(3, 1, 2)	(4, 2, 0)
Q7	Extent the CoP made the project experience more enjoyable	(4, 2, 0)	(3, 2, 0)

Table 8: Responses to survey questions on social aspects of the CoP (clearly positive, weakly positive, negative)

criteria	2006 ESL	2006 all	2007
preparation	1.0	1.1	0.9
clarity	1.0	1.1	0.6
motivation/interest	0.6	1.2	0.2
right level of detail	1.0	1.1	0.2
presentation structure	1.0	1.4	0.7
slide format	0.6	1.0	1.0
slide readability	1.0	1.1	1.0
effective visual aids	0.6	1.4	1.2
use of voice	1.0	1.1	0.8
use of body language	0.0	1.0	0.3
audience contact	0.0	0.7	0.5
adequate introduction	0.6	1.2	0.7
strength of conclusions	0.0	0.5	0.0

Table 9: Final presentations evaluated by the author (scores averaged over student groups)

indicates better performance in all categories in the 2007 cohort, especially in citations, structure, and visual aid effectiveness. Also, the authors of the two reports for the RP06 course from semester 2 2006 undertook the RP18 course in semester 1 2007. One of these did not engage at all in the CoP and did not improve, whereas the second engaged fully and improved in several criteria.

8 Conclusions

This study has shown the the Community of Practice principle can be successfully applied to the postgraduate individual IT projects, with the target of the teaching and learning of generic research-related principles and skills. Its effectiveness can also be enhanced by applying the action research method.

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. However, a limitation of the 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, although they will still be useful for the future.

A key underlying issue in CoPs 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. This proved to be the case even when the language and cultural background of the student group is not ideal for this purpose. The indicators of this were the sustained positive attitude of the students over the semesters, the emergence of good group behavior, and subjective and semi-objective measures of high student performance.

The CoP approach is also quite cost-effective in terms of staff resources, maximizing learning resources by utilizing the students' collective experience. Survey responses and anecdotal evidence also indicate it has significantly enhanced the student experience of the culminating phase of their degree.

As well as giving guiding principles on how to design and details on how to implement such a CoP, this study has also identified factors that can contribute to its success. These includes the rapid implementation of student feedback (facilitated by the action research method), the promotion of collective ownership by group decision making, the concentration on topics of most interest to the members (in this case presentation and report writing skills), utilizing support from 'senior members', the use of peer evaluation for formative feedback, and the evaluation of previous and current projects by the students. The benefits of the latter were reported to be improved general knowledge, finding out about pitfalls and improvement in self-confidence (from seeing others having the same difficulties). The facilitator's expertise, degree of knowledge / involvement of the student projects and prior/current relationship with the students (outside the CoP sessions) are also important factors.

A group size of between 6 and 12 seems optimal, as it is large enough for a 'critical mass' and small enough to manage by a single facilitator in a single session. Face-to-face contact is clearly important in establishing the social aspects of the CoP. Electronic support for virtual meetings may be useful, especially for discussing technical issues, but should not be seen as a substitute.

However, there are many external factors which can influence the effectiveness of this approach. Cultural and language factors are probably the foremost; personalities are also important, especially with the experienced members who have potentially much to give, but may feel they personally have little to gain, by active participation. The quality of the students and their supervision support are also important.

There are still a number of improvements that could be made to the approach that was taken. One is that a way needs to be found to give students with an ESL background more 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 some had experienced beneficial outside-session interactions that may have been facilitated by the CoP, these seemed to be rather small in number. An electronic discussion board and a common meeting area could help in this respect. A greater utilization of social opportunities could also be made.

Our preliminary study indicates that this approach can be a cost-effective way to teach generic research-related 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 (Table 6). There is evidence that the students feel the CoP sessions can improve their general understanding and abilities in research skills (see column B of Table 5). As one student (himself a member of the Open Source Software Community) wrote in his survey response "*expert level peer communities work well*".

In terms of future work, it is hoped 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. It is hoped that the experiences, design principles, factors identified and even the materials used in this study can be useful in this context. More evaluations in different contexts are needed, and, while it is inherently difficult, more objective ways of evaluating the approach need to be sought.

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criteria	S1 2006	S1 2007	S2 2006
use of citations	1.1	0.8	0.2
use of quotations	0.8	0.6	0.3
report structure	1.7	1.3	0.1
grammar	1.0	0.5	0.4
succinctness	1.0	1.1	0.9
visual aids used	1.5	1.5	1.1
visual aids effective	1.7	1.0	0.3

Table 10: Final reports evaluated by the author (scores averaged over the student groups) on criterion studied in CoP sessions

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