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Peer-Assisted Tutoring in a Chemical Engineering Curriculum: Tutee and Tutor Experiences

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Cover Page Footnote
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Patricia Kieran and Geraldine O'Neill

INTRODUCTION

Engineering is characterised by the application of scientific and engineering principles in the solutions of problems. In Chemical Engineering, for example, the core subject of Unit Operations is a unifying topic, which integrates the principles of thermodynamics, fluid mechanics, heat transfer and mass transfer, with chemistry and/or biology, in the design of process systems (e.g., distillation, evaporation, extraction, centrifugation, filtration, etc.). In industrial settings, such systems are employed in the large-scale provision of valuable products (such as pharmaceuticals and petrochemicals) and of essential services (such as energy and clean water). Assessment of student achievement of learning objectives in undergraduate Unit Operations modules typically involves problem-based examinations and/or assignments. These problems, which are indicative of the design problems encountered by working engineers, present challenges to students, in terms of the appropriate engineering principles to apply, the sourcing of essential information (which is often not explicitly provided) and the use of 'rules-of-thumb' or informed estimates in undertaking preliminary calculations. Access to complete worked solutions (much favoured by students) deprives students of the opportunity to develop the appropriate skills and confidence in problem-solving. The objective of the initiative described in this paper was to support students in their efforts to develop the problem-solving skills essential for Chemical Engineering and to encourage and facilitate effective group work. While the initiative was implemented in the context of a Unit Operations module, the approach employed can be extended to any other subject area in which students may benefit from

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collaborative and peer-facilitated work in the development of discipline-specific problem-solving skills.

Tutorials are commonly used in Engineering to support undergraduate students in working through problems associated with course material. Most frequently, problems are undertaken by a tutor/lecturer with varying degrees of participation from the students. The most effective modes of teaching are those in which students are engaged in 'active learning' (e.g., Chickering and Gamson, 1987, 1999; Felder, Woods, Stice and Rugarcia, 2000), which is well-established in Engineering education (Prince, 2004). And the value of tutorials in which students are wholly engaged in the problem-solving process is effectively illustrated in an enquiry-based learning initiative, recently introduced at the University of Manchester (Roberts, 2008).

Chemical Engineering at University College Dublin (UCD) is a 4-year honours degree program, professionally accredited by Engineers Ireland and (at Masters level) by the Institution of Chemical Engineers (UK). The program is modularised and semesterised, with two 12-week teaching semesters per year. A form of PAL was introduced to CHEN30020 (Unit Operations), a one-semester, 5-credit, core module for Stage 3 Chemical Engineering and Bioprocess Engineering students. The module was previously delivered via lectures, with a small number of lecturer-directed tutorials. For 2008-09, Peer-Assisted Tutorials (PATs) were introduced, in addition to lectures (three 50-minute lecture periods per week throughout the semester). Attendance at PATs was optional, but marks were awarded for attendance, participation and associated homework assignments. During PATs, students worked on problems, in groups of 5-6, with each group facilitated by a peer Tutor. The peer Tutors were Stage 4 Chemical Engineering students, recruited on a voluntary basis and who were trained in group-based problem-solving and in directed questioning. For the current academic year, Tutors were modestly remunerated for their efforts; for the future, Tutors will receive academic credit. The one-hour PATs were carefully structured; each session involved a review of previously assigned work and the introduction and exploration of a new problem.

'Learning from others', variously implemented as Supplemental Instruction (SI), Peer-Assisted Learning (PAL) and Peer Assisted Study Sessions (PASS) is widely and successfully used in higher education across a range of disciplines. A useful review of early development of peer-learning strategies is presented by Whitman (1988). Using the terminology of Topping (1996), the UCD PATs can be described as "small group, cross-year tutoring". The UCD adaptation is less 'Tutee-led' than more traditional manifestations; most importantly, the content of each session is predetermined by the Module Coordinator. Table 1 indicates differences between PATs and PAL (as developed at the University of Bournemouth (Fleming, 2009)).

Table 1 Summary of key differences between PAL (Fleming, 2009) and PATs

PEER-ASSISTED LEARNING (PAL)	PEER-ASSISTED TUTORIALS (PATs)
Agenda set by *students*	Agenda set by *lecturer*
Content and outcomes confidential	Tutor update Lecturer on *group* progress
Not compulsory	Not compulsory, but marks awarded for attendance and participation
Typically, no homework	Homework to be undertaken individually, assigned for each session

PAT IMPLEMENTATION

Practical Details

PATs were implemented during Semester Two of the 2008-09 academic year; 40 students enrolled in the relevant module (CHEN30020: Unit Operations), 15 female and 25 male. There were 7 PAT Tutors, 5 male and 2 female. Each PAT group contained 5-6 Tutees, randomly assigned (except to ensure gender balance). One Tutor was assigned to each of the 7 PAT groups for the duration of the PAT series. The post-graduate Teaching Assistant assigned to the module, who

attended all PAT Tutor and Tutee training and who also graded PAT homework, was present during all PAT sessions to monitor attendance and to answer any problem-related questions which might arise.

There were seven 50-minute PATs during the 12-week semester. Homework was associated with each PAT. The first assignment was issued to the students in advance of PAT1; thereafter, new homework was assigned during each PAT. Assignments consisted of examination-type questions selected from the module textbook (McCabe, Smith and Harriott, 2005) or from past examination papers; the link between PAT problems and the examinations emphasised the immediate and practical relevance of the PATs and provided an incentive to students to participate. Worked solutions to homework problems were provided to Tutors in advance; Tutors could also meet with the Module Coordinator to review the problems. PATs were held in a flat-format classroom. PAT groups were arranged at separate tables around the room.

PAT Structure

PATs were developed to facilitate students in assuming more responsibility for their own learning. Thus, the PATs represented a more student-centred approach to learning/teaching (O'Neill and McMahon, 2005) than had previously been implemented with this module. PATs were facilitated by Peer Tutors, who acted as the PAT Chair. Roles were assigned to group members (Reader, Scribe, Questioner, Evaluator, Time-keeper); roles were rotated for each session. There were two distinct parts to each session: Part 1 (Figure 1(a)), in which a previously assigned homework problem was reviewed by the group, and Part 2 (Figure 1(b)), in which a new homework problem was introduced and explored. For a 50-minute PAT, approximately 15-20 minutes was devoted to Part 1; the remaining time was allocated to Part 2.

For both previously assigned homework and new problems, Tutors were charged with supporting the student group in working through the assignments, rather than providing solutions. This was a key feature of the PATs and represented a new departure from traditional tutorial practice, as previously experienced by both Tutors and

Tutees. For homework, students independently undertook the problem explored during Part 2; homework was submitted at the beginning of the next PAT.

The approach used in the PATs could not be described as Problem-Based Learning (PBL) as PATs did not commence with an 'ill-structured problem', a defining feature of PBL (O'Neill and Hung, 2009; Stinson and Milter, 1996; Weiss, 2003); PAT problems were based on the types of well-defined end-of-semester examination questions encountered by students. However, the PATs deliberately mirrored many effective characteristics of the PBL process:

- the two-part ('brainstorm' and 'report') aspect of the Maastricht PBL process (Davis and Harden, 1999) was implemented; however, for the PATs, 'reporting' (on the previously assigned problem) occurred during the first part of the session, while 'brainstorming' (on the newly assigned problem) was confined to the second part of the session;
- to promote student engagement, students were invited to assume different roles during each PAT (e.g., chair, timekeeper, scribe);
- throughout the PATs, students were encouraged to set their own goals, to build on prior knowledge and to learn from the group (Savin-Baden, 1997).

Figure 1(a) Schematic representation of Part 1 of a PAT, dealing with a previously assigned homework problem.

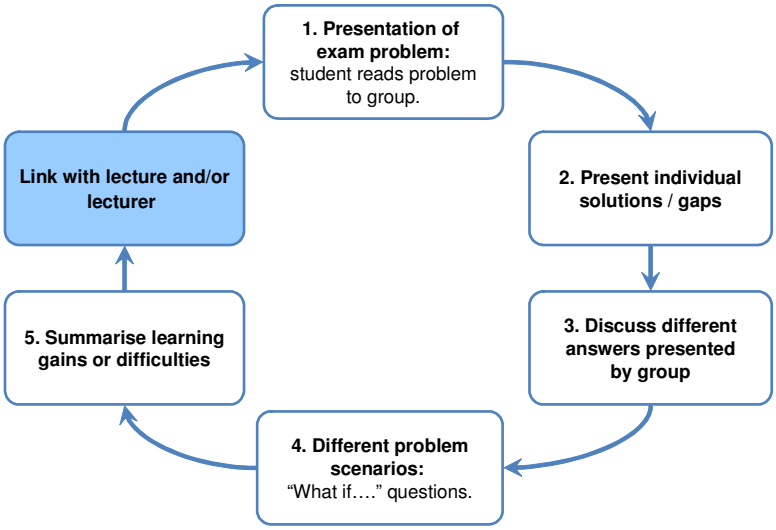
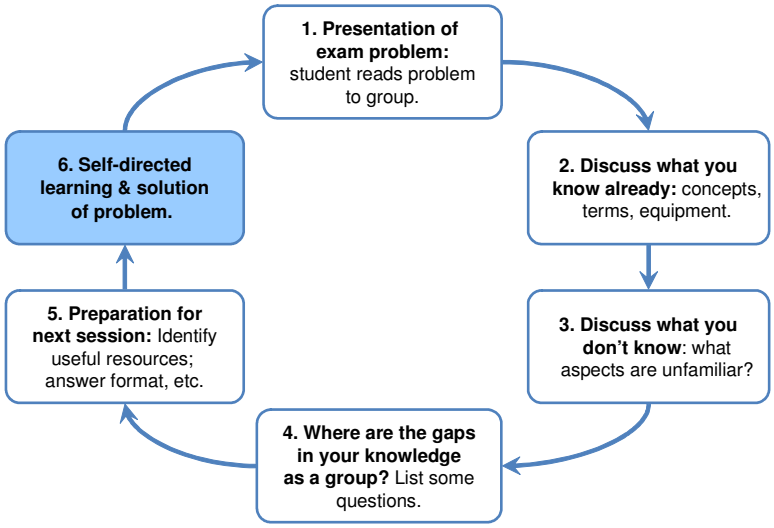


Figure 1(b) Schematic representation of Part 2 of a PAT, during which a new homework problem is introduced and explored by the group



Tutor Recruitment and Training

PAT Tutors were Stage 4 Chemical Engineering students who had taken and passed the Unit Operations module during the preceding academic year. Tutor positions were advertised to Stage 4 students during Semester One; applications (CV and short expression of interest) were invited. Tutors were notified that they would be remunerated for their efforts (at the UCD rate for payment of undergraduate assistants), allowing for 1 hour per PAT, and 0.5 hours preparation per PAT; Tutors were not paid for training. All 7 applicants for the Tutor positions were accepted.

Tutors (and the post-graduate Teaching Assistant assigned to the module) attended a 2.5 hour PAT training workshop at the beginning of Semester Two. The session, which was facilitated by the authors (both Senior Lecturers, one in Chemical Engineering, the other in Teaching and Learning), dealt with: (i) Principles of PAL and PAT; (ii) PAT structure; (iii) Tutor role, responsibilities and expectations; (iv) Supporting teams in solving problems; (v) Directed questioning (Jones, 2007), and (vi) Techniques for silences!

All Tutors had also previously participated in two 2.5 hour workshops on 'Group-Based Problem Solving for Engineers', run as part of a core Stage 4 module. These workshops dealt with effective team work (Oakley, Felder, Brent and Elhajj, 2004) and strategies for effective problem solving (Fogler and LeBlanc, 2008) with reference to engineering applications. The combined training (7.5 hours) offered to PAT Tutors was significantly shorter than the 2-day training period typically offered to PAL leaders (Fleming, 2009). However, PAT Tutors were working in a more controlled environment than PAL leaders, while dealing with a narrower, well-defined range of subject materials and conditions. When questioned at the end of the semester about the degree of pre-PAT training, all but one Tutor rated the appropriateness of the extent of the training as "just about right"; the remaining Tutor rated it as "somewhat" appropriate. In response to questions about support provided during the series of PATs, 5 Tutors rated it as "just about right"; the remainder responded "somewhat". Although the Module Coordinator was available to meet with Tutors at a scheduled time in advance of each PAT, few Tutors availed of this opportunity.

Tutee Training
A 50-minute lecture period during the first week of the semester was allocated to introducing Tutees to the PAT system. During the session, Tutees were allocated to their groups, the principles of PAL and PAT were described, the objectives of the PATs defined and the grading system clarified. Short reading assignments and exercises based on the work of Oakley et al. (2004) were undertaken and the session concluded with the development, by each group, of a short 'Team Expectations Agreement' with reference to PAT participation.

Assessment
The Unit Operations module is primarily assessed via a 2-hour end-of-semester examination (worth 65% of the module grade) and a 1-hour mid-semester test (worth 25% of the grade). The remaining 10% of the grade was allocated to the PATs: 3% for attendance; 3% for participation (evaluated by the Tutor as "did not participate"/"good"/"excellent"); 4% for homework (graded by the post-graduate Teaching Assistant). In grading assignments, emphasis was placed on evidence of individual effort in tackling the problem.

Collecting Feedback
Feedback was collected in 4 distinct ways:

1. At the end of each PAT, Tutors were required to complete and submit a 'Tutorial Review Form' (Appendix 1). This was based on a similar form, developed by Fleming (2008) at the University of Bournemouth and adopted with permission.

2. After the fourth PAT, a group of randomly selected Tutees was invited to participate in an informal focus group, which was facilitated by the module coordinator.

3. At the end of the final PAT, all Tutees in attendance were asked to complete a 'Participant Feedback Form' (Appendix 2). 30 students (75% of the class) submitted forms. Feedback Forms were issued during a PAT session, rather than online, to ensure a higher response rate.

4. At the end of the final PAT, Tutors, as well as the post-graduate Teaching Assistant, who had attended all PATs and who had acted as a substitute Tutor when required, completed a 'Tutor Feedback Form' (Appendix 3).

Participation Rates

Although participation in PATs was voluntary, attendance rates were high: on average, students attended 5.5 of the 7 scheduled PATs; 32.5% of students attended all sessions and only 1 student attended no sessions. On average, students submitted 4.8 of 7 assignments; 35% of students submitted either 6 or 7 assignments, while 25% of students submitted 2 assignments or fewer.

With regard to Tutors, 4 attended all 7 sessions and 3 Tutors attended 6 sessions. If Tutors were absent, groups were combined and/or the post-graduate Teaching Assistant led a PAT group.

RESULTS AND DISCUSSION

Consistency of PATs with good practice in teaching and learning

PATs are consistent with several of the well-established "seven principles for good practice in undergraduate education" (Chickering and Gamson, 1987, 1999):

1. **Encourages contact between students and faculty:** while PATs did not increase contact between Tutees and academic staff, they did provide for cross-class contact. Tutees welcomed the opportunity to "gain from 4th year (Tutors') experiences", while Tutors appreciated "getting to know the 3rd years (Tutees)".

2. **Develops reciprocity and cooperation among students:** academically (based on Irish Leaving Certificate examination results, on which admission to Irish universities is based) UCD Chemical Engineering students are among the highest achievers in the country.[1] However,

[1] On admission to UCD, the cohort of students involved in the PATs had, on average 480 'points' in the Leaving Certificate. Data from

the Leaving Certificate is assessed solely on the basis of individual performance and many of these students do not yet value the group as a resource. Professional success, however, invariably depends on the ability to work effectively as a team member and/or leader. PATs provided an occasion for students to "gain from interacting as a close group" and to "learn from my peers".

3. **Encourages active learning:** PATs were characterised by active learning in the elucidation of solutions to a series of defined problems. In the peer-based learning environment, students felt empowered to "….ask any questions that you wanted without interrupting the class as (you might) in a lecture…" and found Tutors to be "very helpful, not judgemental when asked to explain things again." Tutees reported that Tutors "…didn't provide us with answers…allowed us to figure out each section through discussion."

4. **Gives prompt feedback:** Part 1 of each PAT was devoted to a review of a homework problem introduced and explored during Part 2 of the previous session. Between the two PATs, students were expected to build on that initial group exploration in working, independently, on the homework. By reviewing solutions presented by different members of the group, students received timely feedback on their efforts and they acknowledged its value: "It helps, once you've already had a try, to see where you went wrong or right".

5. **Emphasizes time on task:** in many quantitative subjects, informed practice of problem-solving is key to the development of a deeper understanding of the subject material and of a fluency in applying the relevant problem-solving skills. By providing opportunities for structured problem-solving and rewards for independently undertaken homework assignments, students were

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the Central Applications Office (CAO, 2006) show that only 17.7% of the 50955 Leaving Certificate candidates that year received in excess of 450 points.

encouraged to devote reasonable effort and focused periods of time to the PATs and associated problems. Students recognised the effectiveness of the approach: "…I don't feel under pressure. But we're getting the problems done". When asked to identify "the worst aspect of the PATs", encouragingly, 40% of respondents indicated that there were no negative aspects. However, 20% of respondents cited the small percentage of the module grade awarded, suggesting that it was disproportionately low relative to the time devoted to the assignments. For 2009-10, the contribution of the PATs to the module grade will be substantially increased.

PAT Structure

Imposition of a relatively rigid structure on the PATs was intended to optimise the efforts and associated gains for both Tutors and Tutees. 70% of Tutees and all but one of the Tutors found the two-part structure "very" effective: "Brill(iant) sessions!" and "You don't spend too long on one question - got good start on next week's questions."; the remaining respondents rated it as "somewhat" effective.

All but one of the Tutors found Part 2 (introduction of new problem) more effective than Part 1 (review of previous problem) while the Tutees were more divided in the preferences: 23.33% favoured Part 1, 33.33% favoured Part 2 while the remainder (43.33%) found both parts "about the same". In ranking Part 2 as more effective than Part 1, Tutors highlighted: "Students were interested in developing a solution strategy"; "This allowed the students to think about the future problem to come"; "Getting students to identify and share problems.", while Tutees appreciated that Part 2 "….helps to identify and analyse the steps to solve the problem". Responses from Tutees dissatisfied with Part 1 suggested either PAT time management issues ("Not enough time to fully review homework.") or personal learning styles ("Don't see point in 'post-morteming' when question is done"; "I think more time needed to be spent on reviewing the problem done than introducing the new problem"). For Tutors, difficulties with Part 1 centred on student participation ("Students slow to give feedback on previous assignment"). However, Tutors reported significant improvement in levels of student engagement as the PAT

series progressed: “They worked hard to understand the problem. And there’s a good rapport developing” and “At the end, the students were much more competent in tackling problems and (in) working with one another”.

Key Gains for Students (Tutees)

Learning from others
PATs provided a structured opportunity for students (Tutees) to work together, guided by a Tutor at a slightly more advanced stage in the same academic program. Interaction with and learning from “more knowledgeable others” (Vygotsky, 1978) is a common theme in the pedagogical theory literature (Bruner, 1999, see also Carlile and Jordan, 2005, for overview of key theorists). Whereas Vygotsky emphasises the “knowledgeable other”, Rogoff (1999) supports Piaget's view that the more useful interaction is with peers. In studies related to higher education, Biggs (1999) identifies both active learning and student interaction as key elements in the development of deep learning and advocates the use of peer discussion, peer assessment and group work.

In providing feedback on their experiences of the PATs, Tutee and Tutor responses were very similar in spirit to those of participants and leaders from other PASS/PAL/SI programmes (e.g., Fleming, 2009; University of Wollongong, 2009). Responses to the question “What was the best aspect of the PATs?” revealed that students recognised and appreciated the opportunity to learn from their peers (“What you gain from interacting as a close group and gain from 4th year (Tutor) experience”). These sentiments are combined by a student contribution to a PAT focus group discussion: “It’s great! It’s a small group, so I can ask questions without feeling stupid. And I’m learning from what my classmates have to say.”

Academic gains
The SI literature provides ample evidence of positive and statistically significant effects of peer-assisted learning on student performance (e.g., International Center for Supplemental Instruction, 2009), including SI-related improvements in the performance of Engineering students

(e.g., Webster and Dee, 1998). In the case of the PATs, a full experimental study was precluded for several reasons: (a) without excluding students from the PATs, there was no opportunity for a control group; (b) as class sizes in Chemical Engineering are small (fluctuating between 25 and 40 over the past 5 years), significant class-related variations in performance are common; (c) factors investigated in other studies, such as PAL-associated reductions in drop-out rates are not relevant in Chemical Engineering at UCD, where drop out rates are negligible; (d) in efforts to improve student engagement and performance in this Unit Operations module over the past 5 years, major changes to modes of assessment have been implemented so direct comparison of student scores from successive years is not valid; (e) most importantly, there is no direct mapping between the skills developed by Tutees (effective team work, communication, problem-solving, self-evaluation) through their participation in the PATs and those evaluated in traditional end-of-semester examinations. Accordingly, in this study, emphasis focuses on Tutee and Tutor evaluations of the PATs.

As the PATs dealt specifically with Unit Operations, it was important to determine the students' perceptions of the impact of the PATs on their understanding of the relevant subject material and on their confidence in tackling associated problems. Students acknowledged the success of the PATs in both of these areas: 73.3% of Tutee respondents indicated that the PATs contributed "very much" or "fully" to their confidence in tackling Unit Ops problems; of the remaining respondents, 23.3% responded "somewhat" and only 1 student responded "not at all". When asked for an overall evaluation of the PATs, all but one respondent rated the PATs as "useful" or "very useful". Tutee comments reflect these findings: "(I'm) more confident tackling Unit Ops problems"; "…Learned methodology for solving problems". Tutors expressed supporting opinions: "Practising exam style questions, I believe, gave the students confidence in Unit Ops". Positive responses to the introduction of student-centred initiatives are not uncommon and Lea, Stephenson and Troy (2003) report that participants find such experiences more interesting and more exciting than traditional teaching methods and that they boost their confidence to a greater extent.

When asked which they found more effective, PATs or traditional Tutorials (in which the lecturer typically works through problems), only 10% of Tutee respondents chose traditional Tutorials, 23.7% judged both forms to be "about the same", while the majority (63.3%) indicated that the PATs were more effective: "I think these sessions are more effective since you get to interact and share your opinions".

For Tutees, the direct link between PATs and the module content was important: "It keeps me revising and practicing questions, good motivation"; "Ensured a constant review of course was undertaken". The allocation of marks (10% of module grade) to the PATs was a key motivational force for many students in attending. All but one student indicated that the award of marks was a "somewhat" (46.67%) or "very" (50%) important factor in their decision to participate: "For me, every mark counts"; "Would have attended anyway, but marks were on my mind."

For some students, the relatively small percentage of marks allocated to the PATs was unimportant: "The benefits of attending outweighed marks given". Others, however, felt that the marks allocated to the PATs and, in particular, to the PAT homework assignments, were disproportionately low: "10% awarded to PATs too small"; "Not enough credit given for homework problems". This issue will be addressed for future PAT series, when the percentage of the module grade allocated to the PATs will be increased.

Key Gains for Tutors

Although the PATs were primarily aimed at the Tutees, ancillary benefits were experienced by the Tutors. The Tutors who led the PATs had no prior experience of peer-mentoring/peer-tutoring. Chemical Engineering classes at UCD, as a result of their relatively low student numbers and discipline-specific curriculum, are typically characterised by high levels of informal within-class peer cooperation. Additionally, at all stages, group work is a key feature of the program. However, there is no tradition of cross-class cooperation. For the Tutors, gains were identified in two main areas: academic, reflected in improved understanding of Unit Operations ("I understand Unit Ops better now myself"; "(PATs provided) an opportunity to express and

improve one's Unit Ops skills") and transferable skills (e.g., communication, group facilitation, time-management): "(My) team management skills, I believe, have become better during these sessions"; "I generated good interaction with the students and between the students. They were confident to express and share their ideas".

Transferable skills are essential for all students. For students enrolled in professionally accredited programs, such as Chemical Engineering, the importance of these skills is enshrined by accrediting bodies. For example, the Institution of Chemical Engineers (IChemE, 2008) stipulates that graduates "must have developed and demonstrate ability to integrate transferable skills…that will be of value in a wide range of situations." The professional value of these skills and their development through the PATs was explicitly acknowledged by the Tutors: "Great experience, good for the CV"; "…it is a great way to improve group management and teamwork skills".

Tutor Evaluation of PATs

Tutors were also strongly supportive of the PAT system: 75% of Tutors believed that the PATs were "fully" or "very much" successful in raising student confidence and competency in tackling Unit Ops problems. Although Tutors were remunerated, financial gain was not a factor in their decision to become involved: "Strengthening of leadership/communication skills was attractive. Not interested in the money." All Tutors endorsed the introduction of a for-credit module, offered as an elective to Stage 4 Chemical Engineering students, during future academic sessions, as an alternative to hourly payment for Tutors: "I think this is better than being paid. Tutors might even work harder"; "Yep! It seems far more useful than my current elective".

When asked what aspects of their own performance required improvement, Tutors identified (i) preparation: "I could have prepared better for some problems"; "Make sure you understand the question fully yourself. You will not be helpful otherwise"; (ii) guided questioning: "… don't feel obliged to give away too much of the solution"; "...It's very hard not to just tell solutions. Difficult to coax them towards

it. I got better at it though, I think" and (iii) time management (during PATs): "I sometimes took too long going over the previous week's problem".

Each of these issues will be specifically addressed as part of the elective module ('Peer Assisted Tutoring in Chemical Engineering') to be taken by all Tutors during the coming academic year. On the basis of Tutor responses to variations in group sizes (due either to Tutee or Tutor absences), it was clear that group size was a factor in PAT success: "Large group was harder to control"; "Easier with smaller numbers". For 2009-10, Tutors will be assigned to PAT groups in pairs. The effectiveness of all proposed changes will be evaluated at the end of the coming academic year.

CONCLUSION

The introduction of PATs to the Chemical Engineering curriculum at UCD was successful in achieving its objective of promoting active learning among students enrolled in a Unit Operations module. The PATs attracted high participation levels (in terms of attendance, in-PAT involvement and homework submission) and high levels of student satisfaction (as expressed in feedback forms and in focus group discussions). Tutors indicated an improvement in their own understanding of the subject material while, for both Tutors and Tutees, the PATs provided an opportunity to enhance professionally relevant transferable skills.

In response to the success of this initial series of PATs, the system will be formalised within the Chemical Engineering program for the coming academic year, with Tutors receiving academic credit for their effort through an elective module. This elective module will address several of the issues raised during the current manifestation. The PAT system described was specifically developed for a Chemical Engineering module. However, the approach, in which a group of Tutees, under the guidance of a Tutor from a slightly more advanced stage of the same academic programme, work together on the exploration and solution of discipline-specific problems, is readily adaptable to almost any subject area; it is particularly applicable to quantiatively based subjects.

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APPENDIX 1

Feedback form completed by Tutors after each PAT; adapted, with permission, from similar form prepared for PAL applications (Fleming, 2009).
(Additional space, provided for comments/responses to open-ended questions, has been omitted.)

CHEN30020 Peer-Assisted Tutorials 2008-09 – TUTORIAL REVIEW FORM

Tutor:		Date and Time:	
PAT Group:		No. of Tutees present:	
Tutorial Topic:			

Session Overview:
Describe the session in your own words

Session in General:

Negative Points	Positive Points

Group Learning:

Negative Points	Positive Points

Your Facilitation/Group Management:

Negative Points	Positive Points

Activities used (*e.g.* review notes, brainstorming, general discussion, reference to labs, *etc.*)**:**

Negative Points	Positive Points

Self-Development (how the session influenced your own skills and knowledge)**:**

Negative Points	Positive Points

Please rate the following:

	Disagree				Agree
The session was helpful to the Stage 3 students	1	2	3	4	5
The session was helpful to me	1	2	3	4	5

Issues to raise with Module Coordinator

Other notes, including useful reference materials addressing issues raised above:

APPENDIX 2

Feedback form distributed to Tutees, after the last PAT in April, 2009.
(Additional space, provided for comments/responses to open-ended questions, has been omitted.)

CHEN30020 Peer-Assisted Tutorials 2008-09 – PARTICIPANT FEEDBACK FORM

This year, Peer-Assisted Learning (PAL) was introduced to the Stage 3 programme, through the Peer-Assisted Tutorials (PATs), implemented as part of the CHEN30020 module. The purpose of this questionnaire is to solicit feedback on your experiences of the PATs. Your contributions will assist us in developing and improving this and other PAL-related activities for future years. Your cooperation in completing this questionnaire is very much appreciated.

1. Student information (*for statistical purposes*) Male ☐ Female ☐

2. There were 7 PATs this semester. How many did you attend?
1-2 ☐ 3-4 ☐ 5-6 ☐ All 7 ☐

3. There were 7 PAT Homework Assignments this semester. How many did you submit?
1-2 ☐ 3-4 ☐ 5-6 ☐ All 7 ☐

4. The PATs were intended to provide an opportunity for you, as a CHEN30020 student, to develop your problem-solving skills in Unit Ops, supported by your class mates and by a Peer Tutor. To what extent to you feel that the PATs contributed to your confidence in tackling Unit Ops problems?
Not at all ☐ Somewhat ☐ Very much ☐ Fully ☐

5. To what extent did the PAT sessions (identified by the problem *submitted* during the session) *and* your associated efforts in the homework contribute to your understanding of Unit Ops concepts?

PAT 1: Evaporators	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 2: Gas Absorption	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 3: Backward Fed Evaporation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				

PAT 4: Packed Columns	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 5: Liquid-Liquid Extract	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 6: Batch Distillation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 7: Continuous Distillation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				

6. Each PAT has two parts: (1) Review of the Homework Problem; (2) Introduction of New Problem. Which part did you find more useful?

Part 1 ☐ Part 2 ☐ Both about the same ☐

Comment:

7. How effective is the two-part PAT structure?

Not at all ☐ Somewhat ☐ Very ☐

Comment:

8. The Tutor's role is to guide and support the team in their work, *not* to do the problems. Comment on the overall effectiveness of your Tutor in this regard.

9. What aspects of your Tutor's contribution to the PAT did you find most useful?

10. What advice would you give the Tutor for future PATs?

11. During more traditional Engineering tutorials, the lecturer typically works through problems on the board. Which do you find more effective?

PATs ☐ Traditional tutorials ☐ Both about the same ☐

Comment:

12. Marks were awarded for attendance at PATs. How important was this to you in attending?

Not at all ☐	Somewhat ☐	Very ☐
Comment:		

13. In Semester 2, 2009-10, Stage 4 students may enrol in a 5-credit elective module entitled 'Peer-Assisted Tutoring in Chemical Engineering' and receive credit for their work as Tutors. Is this a module which might interest you?

Not at all ☐	Possibly ☐	Probably ☐
Comment:		

14. What were the best and worst aspects of the PATs?

Best:	Worst:

14. Overall, how would you evaluate the PATs?

Waste of time ☐	Somewhat useful ☐	Useful ☐	Very useful ☐
Comment:			

Thank you for taking the time to participate in this survey!

APPENDIX 3

Feedback form distributed to Tutors after the last PAT in April 2009 (Additional space, provided for comments/responses to open-ended questions, has been omitted.)

CHEN30020 Peer-Assisted Tutorials 2008-09 – TUTOR FEEDBACK FORM

This year, Peer-Assisted Learning (PAL) was introduced to the Stage 3 programme, through the Peer-Assisted Tutorials (PATs), implemented as part of the CHEN30020 module. As a Tutor, you were an essential and invaluable member of the process. The purpose of this questionnaire is to solicit feedback on your experiences of the PATs. Your contribution will assist us in developing and improving this PAL-related activity for future years. Your cooperation in completing this questionnaire is very much appreciated.

1. The PATs were intended to provide an opportunity for CHEN30020 students to develop their problem-solving skills in Unit Ops, supported by their class mates and by you, as their Peer Tutor. To what extent to you feel that the PATs were successful in raising student confidence and competency in tackling Unit Ops problems?

Not at all ☐	Somewhat ☐	Very much ☐	Fully ☐
Comment:			

2. Comment on the success of each of the PAT sessions (identified by the problem *submitted* during the session).

PAT 1: Evaporators	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 2: Gas Absorption	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 3: Backward Fed Evaporation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 4: Packed Columns	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 5: Liquid-Liquid Extract	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				
PAT 6: Batch Distillation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐
Comment:				

PAT 7: Continuous Distillation	Not at all ☐	Somewhat ☐	Very much ☐	Did not attend ☐

Comment:

3. Each PAT has two parts: (1) Review of the Homework Problem; (2) Introduction of New Problem. In your opinion, which part was generally more successful?

Part 1 ☐ Part 2 ☐ Both about the same ☐

Comment:

4. How effective is the two-part PAT structure?

Not at all ☐ Somewhat ☐ Very ☐

Comment:

5. Your role, as Tutor, is to guide and support the team in their work, *not* to do the problems. Comment on your overall effectiveness in this regard.

Comment:

6. With what aspect of your work as a Tutor were you most pleased?

Comment:

7. What aspects of your work as a Tutor require improvement?

Comment:

8. Do you feel that you received sufficient PAT training *before* the PATs?

Not at all ☐ Somewhat ☐ Just about right ☐ Too much ☐

Comment:

9. Do you feel that you received sufficient support once the PATs had started?

Not at all ☐ Somewhat ☐ Just about right ☐ Too much ☐

Comment:

10. What advice would you give to PAT Tutors for future year?

Comment:

11. For 2009-10, Tutors will not be paid but will receive *credit* for their activities (enrolled in a 5-credit elective module). Do you think this is a good idea? Would you have been attracted to this module?

Comment:

12. For 2009-10, it is proposed to assign Tutors in *pairs*. For each PAT, one Tutor would act as 'lead', while the other would provide 'backup'; roles would be rotated for each PAT. Do you think this is a good idea? Would you have found it useful to be one of a pair of Tutors, assigned to a single group?

Comment:

13. From your perspective as a Tutor, what were the *best* aspects of the PATs this semester?

Best:

14. From your perspective as a Tutor, what were the *worst* aspects of the PATs this semester?

Worst:

15. Overall, how would you evaluate your experience as a Tutor?

Waste of time ☐	Somewhat useful ☐	Useful ☐	Very useful ☐

Comment:

Thank you for taking the time to participate in this survey and – in particular – for your efforts as a Tutor this semester!