Research Article

Introduction and Evaluation of Peer-assisted Learning in First-Year Undergraduate Bioscience

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Abstract

Bioscience undergraduates, enrolled on a first-year microbiology module, participated in the introduction of peer-assisted learning (PAL) into the curriculum. The class of 122 students was divided into groups of six to ten, with one volunteer from each group assuming the role of group leader (peer tutor). Group leaders attended a compulsory training session at which they were guided through the tutorial they would lead with their peer group. The primary aim of PAL was to raise students' self-confidence in their problem-solving and numerical skills. Students were provided with the opportunity to practise problem-solving questions from past examination papers and to discuss with their peers their answers and any difficulties they encountered, particularly with regard to any mathematics involved. Students' perceptions of their PAL experience, their group leader's contribution and the training provided for group leaders were evaluated using a questionnaire. The latter revealed that bioscience undergraduates found PAL a highly valuable learning experience. In particular, they found the less formal, comfortable and relaxed atmosphere of the PAL session provided them with greater freedom to ask questions and exerted less pressure on them to answer questions correctly than a more formal staff-led session, as well as assisting them to understand the topics covered.

Keywords: Peer-assisted learning, peer tutoring, evaluation, bioscience, undergraduate

Introduction

Anyone who has ever taught knows that the best way to learn something is to have to teach it to someone else. This fundamental principle underpins the concept of peer tutoring, where 'peers' are generally regarded as being individuals of the same or similar intellectual status and/or social standing.

A variety of peer tutoring schemes exist within UK Higher Education (HE) and, although all are founded on a strong belief in the potent efficacy of peer learning, they differ in many respects, e.g. in terms of their primary objectives, their organisational characteristics, the nature and extent of the student-student interaction, the degree to which the participants are truly 'peers', and the role, if any, of staff co-ordinating the scheme. Falchikov (2001) defines four main categories of peer tutoring, namely:

- same-level peer tutoring, where participants within a cohort have equal status, e.g. in terms of their experience, skills and/or attainment levels;
- same-level peer tutoring, where unequal status is identified and introduced by the co-ordinator, e.g. students may be selected to assume the role of tutor on the basis of their higher level of skills and/or academic attainment;

- cross-level peer tutoring, involving a single institution, where unequal status derives from existing differences between student tutors and tutees (e.g. second- or third-year undergraduates tutoring first-year students). This model forms the basis of the highly successful concept of Supplemental Instruction (SI) which originated in North America (Wallace, 1992; Congos and Schoeps, 1993; Bidgood, 1994).
- cross-level peer tutoring, involving two institutions, e.g. the UK's Community Service Volunteers (CSV) 'Learning Together' programme, in which volunteer undergraduate student tutors support pupils' learning by assisting teaching staff in local schools and colleges (Community Service Volunteers, 2005).

Peer-assisted learning (PAL) represents one of a variety of peer tutoring schemes currently operating within UK HE institutions (Peer-assisted Learning, 2005), in which students, normally within the same class or cohort and at a comparable level of academic development, learn with and from one another (Falchikov, 2001).

A peer tutoring approach to student learning has been adopted by a wide diversity of academic disciplines within HE, ranging from history, law, music and business studies to chemistry, mathematics and engineering (Bidgood, 1994; Houston and Lazenbatt, 1996; Topping *et al*, 1997; Coe *et al*, 1999). It is increasingly integrated into medical education (Houston and Lazenbatt, 1996; Wadoodi and Crosby, 2002), and is used extensively by institutions responsible for delivering teacher-training programmes aimed at either the primary or secondary education sector. For example, Evans *et al* (2001) describe the implementation of peer tutoring in mathematics for students embarking on their first year of a teacher-training course. Despite the widespread recognition of its value to students, its adoption across the HE sector, and publication of a very comprehensive review and practical guide to its use in HE (Falchikov, 2001), there is negligible evidence of any attempt to integrate it into bioscience education, particularly at the tertiary level. This case study attempts to redress this situation by describing how a first-year module was used to introduce a large class of bioscience undergraduates to the concept and practical implementation of PAL, with the aim of encouraging other bioscience teaching practitioners and students to consider adopting this alternative model of teaching and learning. The PAL model described spans Falchikov's definitions for *same-level equal/unequal status* peer tutoring (Falchikov, 2001).

The module selected was one to which the author made a significant contribution; a second-semester, 12-week Level 1 introductory microbiology module which attracts approximately 120 to 140 students annually from the Schools of Biology and Biochemistry (with its eight bioscience first degree programmes), Agriculture and Food Science, and Biomedical Sciences. The teaching and learning methods adopted within the module include three traditional 1-hour lectures and one 3-hour practical class (scheduled for 3-6 pm) per week. The PAL strategy adopted entailed dividing the class into small groups and assigning a peer tutor (or group leader) to each group of peers. It was considered desirable that the peer tutors be (slightly) more knowledgeable and confident than their peer group in relation to the subject material that would be covered in the PAL sessions. Since the students had not been formally assessed on the module content, the decision was taken to apply PAL to a more generic aspect of the module rather than select a specific topic(s) from the

lecture content. As with many bioscience modules there is an emphasis on the development and application of practical and problem-solving skills, some of which inevitably require the students to apply some basic mathematical knowledge and numerical skills. At the end of the module students sit an unseen 3-hour written examination paper which includes a single compulsory 30-minute problem-solving question. The latter requires students to apply some of the skills and knowledge they have acquired primarily from the practical component of the module and to a lesser extent from the more theoretical lecture content. The problem-solving question is scenario-based and structured, often including one or more calculations and/or some graphical or diagrammatic interpretation. Historically, over the past ten years students have exhibited a lack of confidence with some of the more basic numerical skills and mathematical concepts which form part of the practical component of the module (Tariq, 2002a, 2002b), as well as experiencing some difficulties and apprehension with more advanced lecture topics, such as the growth kinetics of unicellular micro-organisms.

Over recent years, students have frequently requested small-group tutorials to provide them with additional support, particularly with the more numerical aspects of the subject and the problem-solving question they will encounter in the examination. However, given the large class size, as well as staff, student, timetabling and other resource constraints it has not proved feasible to provide staff-led tutorials within the formal curriculum. The decision was taken, therefore, to run a small-scale pilot of student-led tutorials using PAL, with a view to extending PAL within the module and across the curriculum if students responded favourably towards this initiative and were willing to assume a greater degree of independence and responsibility for their own learning.

Although students have always engaged in informal PAL to a greater or lesser extent (e.g. through providing help and advice to one another during practical classes, when completing assignments, or during examination revision) formally organised PAL sessions have not previously been included amongst the variety of intervention strategies the School has adopted to support students' learning. The specific objectives of this study were three-fold. The first objective was to plan and implement a formal PAL session that would facilitate students practising their problem-solving and numerical skills, with a view to increasing their confidence in these more generic aspects of the module. The second was to evaluate the students' experience of PAL, since very little, if anything, can be achieved if students fail to recognise the value of this learning support strategy and/or are unwilling to participate fully in its implementation. The third was to determine the feasibility of organising an extended programme of PAL with a large class of first-year undergraduates, from a facilitator's perspective. Due to the limited exposure to PAL the students would have during this pilot, it was *not* the purpose of this study to determine whether or not there was any significant (in statistical terms) improvement in the students' academic performance (e.g. in terms of examination scores) as a result of this intervention; the results of such an investigation would only be valid if a more extensive programme of PAL than that planned for this pilot scheme was implemented, the appropriate research design adopted, and variables, such as the specific content of the problem-solving question, taken into consideration.

Methods

In 2003/2004 the introductory microbiology module attracted 124 Stage 1 (normally first-year) students from eleven bioscience, agricultural and biomedical science undergraduate degree programmes, ranging from biochemistry to zoology. For the purpose of accommodating students in the teaching laboratory during the weekly 3-hour practical session, the class has traditionally been divided into approximately equal halves; with each half assigned to either the Tuesday or Thursday practical class. The only time available to accommodate the planned 1.5-hour PAL sessions would be within the scheduled practical classes, during the last fortnight of the module, immediately prior to the students' revision and examination period. It, therefore, seemed appropriate to use this opportunity to expose the students to a sample of problem-solving questions that had appeared in previous examinations, since this would familiarise students with the type of question they would encounter and in doing so would go some way towards better preparing them for the examination. Due to the large class size, as well as limitations on time and space available for this initiative, it would prove possible to run only a single PAL tutorial for each group of students, since several groups would have to occupy the teaching laboratory at the same time. During the course of the fortnight available, therefore, a single PAL session would be repeated four times (i.e. within the Tuesday and Thursday practical sessions in each week), to minimise the number of groups within the laboratory at any one time and to ensure that every student had the opportunity to attend a formal PAL session.

Introducing the concept of PAL

The success of any new teaching and learning initiative that relies heavily upon active student participation depends to a great extent on how that initiative is presented to the students. In week 5 of the module, therefore, students received a single-sided A4 handout which: (i) provided a brief introduction to the concept and potential benefits of PAL, (ii) outlined how the PAL sessions would be organised (emphasising that success depended upon the students' willingness to participate), and (iii) explained the role of the group leader (the student who would be designated peer tutor for a group). A tear-off section at the bottom of the handout requested each student to provide their name, degree subject, highest mathematics qualification (with grade), and to indicate whether or not they would be willing to assume the role of group leader. In view of the fact that the PAL session would be used primarily to support confidence-building in problem-solving and numerical skills the request concerning students' pre-university mathematics qualifications would enable students to be assigned to groups composed of peers with similar 'mathematics' experiences and facilitate assignment of the most appropriate peer tutor (group leader) to each group. The context, organisation and purpose of the PAL pilot was also explained verbally to each class, since it was important to emphasise to students that individuals with any level and grade of mathematics qualification would be considered for the role of group leader. What was important was that potential group leaders felt reasonably confident handling numbers, were well-organised, patient and willing to help others, and possessed good communication skills (Houston and Lazenbatt, 1996). It was emphasised that the prior attainment of AS- or A2-level Mathematics was not an essential prerequisite for the role of group leader and that those who had achieved a mathematics qualification at

GCSE level (or equivalent) were equally eligible for the role (see Appendix for an explanation of these qualifications).

Assignment to groups and group leaders

Ideally, twenty group leader volunteers were required, ten from each half of the class, so that no more than five peers could be assigned to each group leader. In the event, seven students volunteered from the Tuesday half of the class, while fourteen volunteered from the Thursday class (from which ten group leaders were selected to reflect a range of mathematics qualifications). No additional volunteers came forward from the Tuesday half of the class, despite a further call for group leaders.

Students were assigned to groups and specific group leaders on the basis of their highest mathematics qualifications, so that group members had comparable levels of mathematics experience and attainment, with each group leader normally possessing a slightly higher mathematics grade or qualification than the peers in their group, with the exception of a few groups where several members had attained an A grade in A2-level Mathematics. Wherever possible, this strategy ensured that the students were matched with a group leader who had demonstrated an equivalent or preferably marginally better performance than they in terms of his/her mathematical knowledge and skills, but who had a similar prior level of mathematics experience (e.g. at GCSE-, AS- or A2-level). This was considered important so that students did not feel intimidated by or inferior to their group leader in terms of their mathematical knowledge and skills. For example, a group leader who had attained grade A in GCSE Mathematics was assigned a group of ‘peers’ who had all attained either grade B or grade C at GCSE level. This non-random assignment of students to groups in order to more closely match their prior mathematics experiences was explained to students at the start of the PAL session. Only two students within the class did not possess GCSE, AS- or A2 level Mathematics (although they possessed qualifications equivalent to one of these) and neither volunteered to be a group leader.

Training session for group leaders

All group leaders were required to attend a two-hour training session, which had to be scheduled outside normal teaching time (i.e. on a Wednesday afternoon) due to the diversity and, therefore, constraints of the students’ timetables. Two additional sessions had to be scheduled for three students who were unable to attend the original training due to personal commitments. During the training session group leaders were guided through the structured programme for the PAL tutorial session. They were assigned to small groups, using the same strategy being adopted for the whole class, and asked to attempt and then discuss in their groups two problem-solving questions taken from past examination papers; these same questions would be attempted by their peers in the PAL tutorial session. The author assumed the role of group leader, facilitating the students’ discussion of how they had arrived at their answers. Students were provided with a timetable and structure for the PAL tutorial session they would lead, which provided guidance on how long group leaders should allow for each part of the session (e.g. 30 minutes for peers to answer each exam question, with 15-20 minutes of open discussion between

questions). They were also provided with model answers for each question, with a request that they not distribute these to other students before the PAL sessions, since this might deter their peers from attending; they were assured that the entire class would receive the model answers once all the PAL sessions had been completed. Only at the end of the training session were the group leaders informed that upon completion of the PAL tutorial sessions they would each receive a £15 book token in appreciation of their assistance and commitment of time and effort – this ensured that monetary reward was not amongst the incentives for group leaders' to volunteer for their role.

The PAL sessions

Having organised the class into peer groups and prepared the group leaders for their task, the author's only additional contribution to the actual PAL sessions involved guiding students to their respective groups within the laboratory at the start of the PAL session and providing a brief message of welcome; the groups were located as far apart as possible within the laboratory. Students were informed that the author would sit as far away as possible from the groups, and would take no further part in the proceedings, although if group leaders had any concerns they could approach the author; in the event no-one required this additional support. Each group leader was provided with a pack containing (i) a list of members of their peer group, (ii) a timetable for the session, (ii) photocopies of the two problem questions to be answered (including an additional third question for the group leaders to attempt while their peers were busy attempting their questions), and (iv) copies of an evaluation questionnaire for students to complete at the end of the session, so that the author could gauge student reaction to the PAL initiative.

Results

Facilitating PAL

Organising and managing the students' PAL experience proved relatively straightforward and not an arduous or particularly time-consuming task from the facilitator's perspective. Approximately two hours were spent preparing the materials required (excluding designing the evaluation questionnaire), organising the students into appropriate groups and assigning each a peer tutor. Colleagues assisted in providing some of the problem-solving questions and model answers that would be used. Although two hours had originally been scheduled for the group leaders' training, in the event a total of six hours proved necessary to accommodate the extra-curricula commitments of some students. Finally, six hours were devoted to attending the four 1.5-hour tutorial sessions, although the author did not actively participate in any of the proceedings and was therefore able to concentrate on her own work.

Of the 122 students who signed up for the PAL sessions, 114 (93.4%) attended the sessions and 112 students completed the evaluation questionnaire, giving a return of 98.2%. Due to the smaller number of volunteers for the role of group leader in Tuesday's class, the number of students in each of seven groups was 8 or 9 (including the group leader; total 59), while the number of students in each of Thursday's ten groups was 5 or 6 (total 55).

Figures 1 and 2 illustrate frequency distributions for participating students in terms of (i) their highest mathematics qualification (Figure 1), and (ii) their ages (Figure 2).

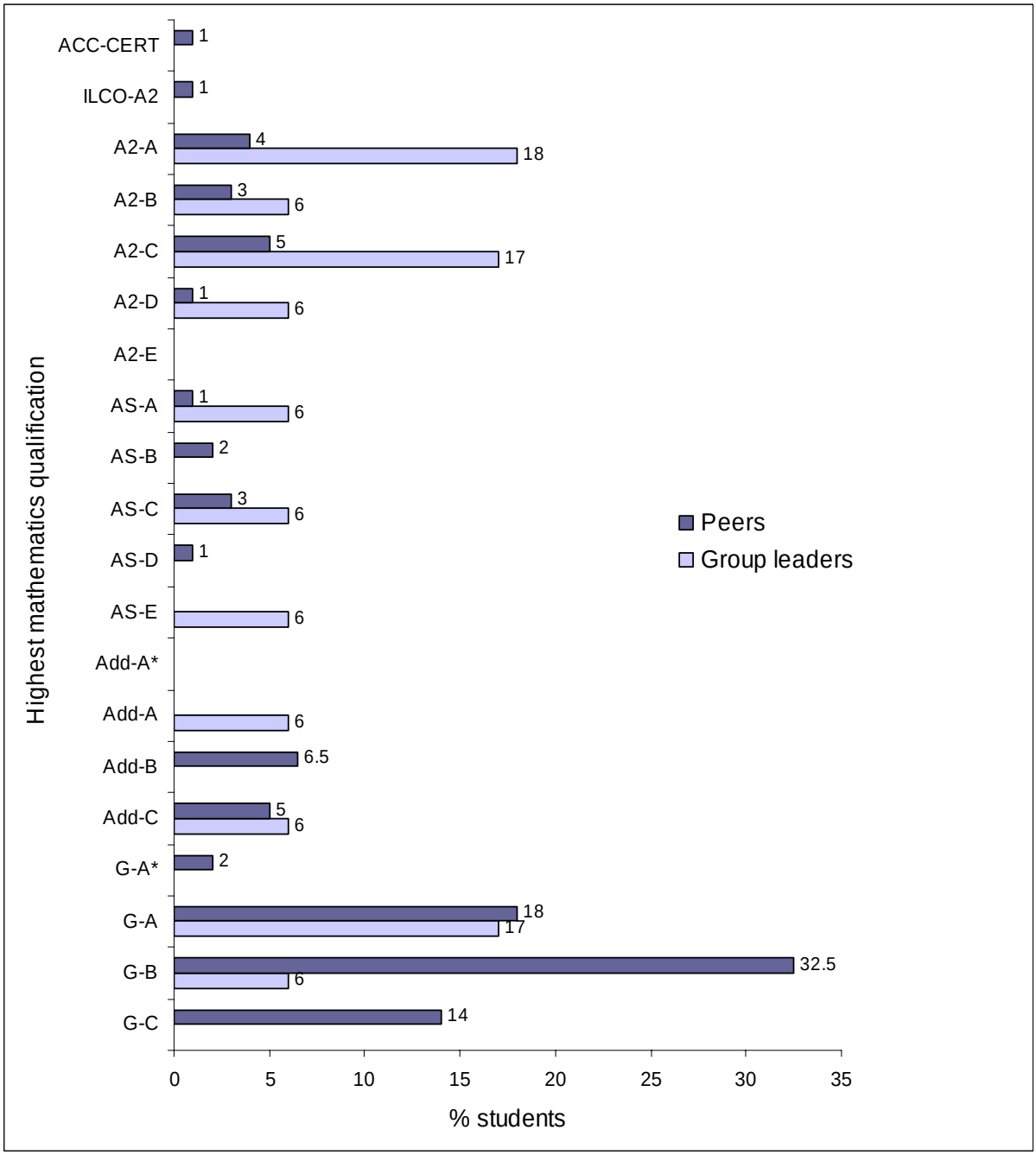

Figure 1 *Frequency distribution indicating highest mathematics qualifications for group leaders (N=17) and their peers (N=96) participating in the PAL sessions. G-C = grade C in GCSE Mathematics; Add-B = grade B in GSCE Additional Mathematics; AS-A= grade A in AS-level Mathematics; A2-C= grade C in A2-level Mathematics; ILCO-A2 = grade A2 in the Irish Leaving Certificate Ordinary Level Mathematics; ACC-CERT = higher education access course certificate (see Appendix)*

Students had attained a diverse range of mathematics qualifications, with 70% having attained pass grades (A*-C) in GCSE Mathematics or Additional Mathematics, and 28% having achieved the higher UK qualifications of AS- or A2-level Mathematics (grades A-E), see Figure 1. Of the remaining students, one had studied mathematics as part of a UK further education foundation

course that facilitates access to HE, while the second student from the Republic of Ireland possessed an Irish Leaving Certificate (analogous to the UK's A-level system of qualifications). Figure 2 reveals that 53% of the class was aged 18-19 years and 39% was aged 20-21 years, with mature students (23-37 years old) constituting only 8% of the cohort. There were some constraints on assigning students to 'peer' groups on the basis of their level of attainment in secondary level mathematics, not least of which was the prior segregation of students into either the Tuesday or Thursday practical class. The latter had been primarily on the basis of the students' degree subjects which inevitably placed constraints on their timetable. No attempt was made to 'match' peer members of a group on the basis of their age.

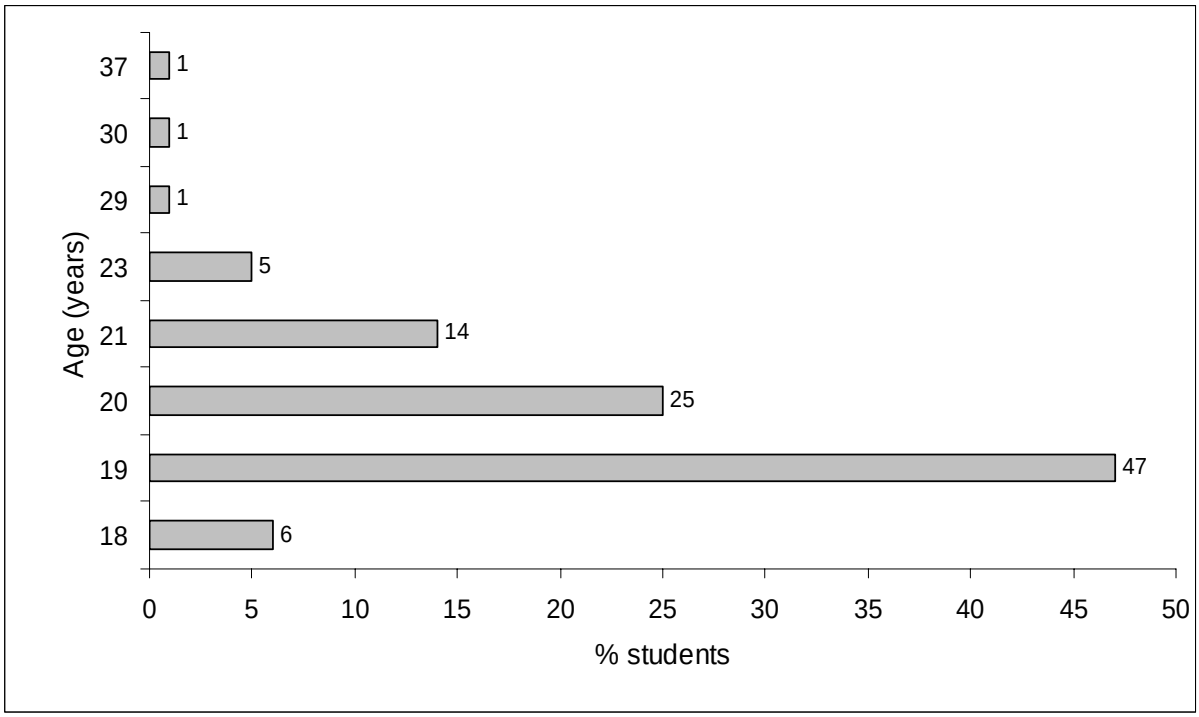

Figure 2 *Frequency distribution illustrating the age profile of students participating in the PAL sessions*

Students' experience of PAL

In order to obtain the students' more personal views regarding the PAL tutorial session, the evaluation questionnaire began with two open-ended questions, with the students' responses subsequently assigned to one of several identified categories. Although students were expected to give only one response some provided more than one.

Question 1: What did you like <u>best</u> about the PAL session?

The rank order of students' responses is presented in Table 1.

Table 1 *What did you like best about the PAL session?*

Response	%
The less formal, comfortable and relaxed atmosphere, with the freedom to ask questions and no pressure to answer correctly	37
It helped in learning and in understanding the topics	19
Being able to discuss with peers the questions and explanations of the answers	17
The use of past paper questions was useful for revision	12
Working in small groups	6
Working at own pace	4
One-to-one/face-to-face help	3
Nothing	2

The top four categories accounted for 85% of the responses. The students' responses indicate that they liked the less formal, comfortable and relaxed atmosphere of the PAL session, believing that it provided them with greater freedom to ask questions and exerted less pressure on them to answer questions correctly than a more formal staff-led session, as well as assisting them to understand better the topics covered.

'It was less formal and more relaxed than a regular teaching session and as a result I felt I learned more.'

'It was led by a student who I found easier to relate to and felt more comfortable asking questions than I would with a lecturer.'

'Not afraid of asking questions or getting answers wrong.'

They valued 'discussing questions with people who had the same level of understanding' and liked the fact that 'examples of exam questions were provided so you could get an idea of what to expect'. Group leaders felt they benefited from 'helping everyone else and discussing common problems', and that the session allowed them 'to further understand problems posed within microbiology'. Only two students felt that the session had nothing to offer them.

Question 2: What did you like <u>least</u> about the PAL session?

The rank order of students' responses presented in Table 2 reinforces the students' generally positive reactions towards their PAL experience with 38% of students indicating that there was 'nothing' they disliked about the sessions.

Table 2 *What did you like least about the PAL session?*

Response	%
Nothing	38
Timing (too late in module, time of day)	28
Nature of work/type of questions	11
Working in a group	7
Too few sample questions and maths topics covered	6
Lack of clarity of some answers	4
Everything – prefer to study of own	2
Not prepared/insufficient discussion/noise distractions in the room/nervousness of group leader	~1% each

However, a significant proportion (28%) of students disliked the timing of the PAL session, either because of 'the time of day' (i.e. because it was scheduled between 4 and 5.30 pm, within existing timetabled practical classes!) and/or its scheduling at the end of the module, immediately prior to their exam revision period – '- a bit earlier on in the course would have been more useful'. This was the first time that many of the students had encountered problem-solving questions and, therefore it is perhaps not surprising that a number felt themselves ill-prepared for the task (11% for the third ranked response). In addition, some group leaders expressed concern at having to explain the answers to more complex questions to peers who clearly expected their group leaders to know the answer to every question they posed. Again, two students disliked everything about the session, preferring to work on their own, rather than with their peers.

The remaining questions were more objective in nature.

Question 3: I found the PAL session ….. (all students)

All students (including the group leaders) evaluated seven aspects of the PAL tutorial sessions and their responses on a five-point semantic differential scale (5 = high, 1= low) are summarised in Table 3.

Table 3 *I found the PAL session ….. (all students)*

	% students								
5-point scale:	5	4	3	2	1		Mean score	*t**	*p*
Enjoyable	17.1	**46.9**	**25.2**	7.2	3.6	Not enjoyable	3.7	7.27	<0.001
Intellectually stimulating	18.9	**52.3**	21.6	5.4	1.8	Dull	3.8	9.83	<0.001
Intellectually easy	9.1	20.9	**41.8**	**25.5**	2.7	Difficult	3.1	0.89	NS
Satisfying	16.4	**43.6**	**30.9**	5.5	3.6	Frustrating	3.6	7.06	<0.001
Valuable	**46.9**	**34.2**	14.4	2.7	1.8	Waste of time	4.2	13.95	<0.001
Confidence-building	**28.8**	**39.7**	23.4	5.4	2.7	Not confidence-building	3.9	9.24	<0.001
A good learning experience	**46.0**	**34.2**	14.4	2.7	2.7	A poor learning experience	4.2	12.89	<0.001

Bold figures indicate percentage values above 25%

** t-test comparison of mean scores with the mid-scale point (3) with levels of significance presented; NS = not significant.*

Scores for six of the seven aspects were in a positive direction (i.e. >3), with 'valuable' and 'a good learning experience' rated the highest, followed by 'confidence-building'. For these six aspects differences between mean scores and the mid-scale point (3) were all highly significant (p<0.001). The seventh aspect concerned the intellectual challenge of the experience. On balance students perceived the PAL session as neither intellectually easy nor as intellectually difficult, although some students clearly found the experience intellectually challenging.

Question 4: By the end of the PAL session I felt ….. (all students)

Scores presented in Table 4 suggest that by the end of the PAL session 74% of students felt more confident and 82% of students more knowledgeable in terms of their problem-solving and numerical skills (i.e. scored 4 or 5), with differences between mean scores and the mid-scale point proving highly significant (p<0.001).

Table 4 *By the end of the PAL session I felt ….. (all students)*

	% students								
5-point scale:	5	4	3	2	1		Mean score	*t**	*p*
More confident	33.0	41.1	21.4	1.8	2.7	Less confident	4.0	11.38	<0.001
More knowledgeable	27.9	54.1	13.5	3.6	0.9	Less knowledgeable	4.0	13.73	<0.001

** t-test comparison of mean scores with the mid-scale point (3) with levels of significance presented; NS = not significant.*

Question 5: Our peer Group Leader was ….. (all students, excluding the group leaders)

Question 5 attempted to gauge students' reactions to their group leaders' contributions. Over 92% of students scored 4 or 5 on all four aspects (Table 5) indicating that they valued highly the group leaders' efforts, finding them supportive, informed, considerate and encouraging. The differences between the mean scores and the mid-point proved highly significant for all four aspects evaluated (p<0.001).

Table 5 *Our Group Leader was ….. (all students, excluding the Group Leaders)*

	% students								
5-point scale:	5	4	3	2	1		Mean score	*t**	*p*
Supportive	56.8	35.8	6.3	1.1	0.0	Unsupportive	4.5	21.71	<0.001
Informed	56.3	35.4	7.3	1.0	0.0	Uninformed	4.5	21.17	<0.001
Considerate	57.9	33.7	8.4	0.0	0.0	Inconsiderate	4.5	22.40	<0.001
Encouraging	56.8	34.7	7.4	1.1	0.0	Discouraging	4.5	21.07	<0.001

** t-test comparison of mean scores with the mid-scale point (3) with levels of significance presented; NS = not significant.*

Question 6: As a Group Leader I found the PAL training session ….. (group leaders only)

In addition to evaluating the PAL session, group leaders were asked to evaluate the training session that had been provided, based on the same seven aspects used in Question 3 (Table 3). Their responses are summarised in Table 6. Scores for six of the seven aspects were rated in a positive direction (i.e. >3), with 'confidence-building' rated the highest, followed by 'valuable' and 'a good learning experience'; the differences between mean scores and the mid-scale point were highly significant (p<0.001) for all six aspects, suggesting the group leaders found the training session a useful preparation for their role in the PAL sessions. In contrast to the results for Question 3, the group leaders' scores for 'intellectually easy' were rated in a positive direction, with the difference between the mean score and the mid-point proving to be just significant

(p<0.05). This is not surprising since these self-selecting students had a high degree of confidence that they could complete the tasks and several had a higher level of academic attainment in terms of their prior experiences, particularly in mathematics, than many of their remaining peers in the class.

Table 6 *As a Group Leader I found the PAL training session ….. (Group Leaders only)*

	% students								
5-point scale:	5	4	3	2	1		Mean score	t*	p
Enjoyable	43.8	43.7	12.5	0.0	0.0	Not enjoyable	4.3	7.46	<0.001
Intellectually stimulating	50.0	43.8	0.0	6.2	0.0	Dull	4.4	6.82	<0.001
Intellectually easy	18.8	18.8	56.2	6.2	0.0	Difficult	3.5	2.24	<0.05
Satisfying	37.5	43.7	18.8	0.0	0.0	Frustrating	4.2	6.33	<0.001
Valuable	62.5	25.0	12.5	0.0	0.0	Waste of time	4.5	8.22	<0.001
Confidence-building	81.2	6.3	12.5	0.0	0.0	Not confidence-building	4.7	9.59	<0.001
A good learning experience	62.5	37.5	0.0	0.0	0.0	A poor learning experience	4.6	13.00	<0.001

** t-test comparison of mean scores with the mid-scale point (3) with levels of significance presented; NS = not significant.*

Overall, the vast majority of students reacted favourably to the PAL initiative. Their additional written comments included:

> *'PAL classes (tutorials) are very useful; would have liked a lot more at the start of the year!'*
>
> *'I think that the peer based learning group is a great idea, not just for maths but also other topics, and could be extended in this and other modules, perhaps with fairly regular meetings.'*

However, a very small minority of students reacted negatively. The following comment from one mature (30 years old) student may in part reflect the fact that the remaining members of her group varied in age from 18 to 23 years and could not perhaps be regarded as her 'true' peers.

> *'Being in a group makes me self conscious and I can't ask for help. I would prefer a one-to-one tutorial with a lecturer involved as I feel I could gain more from this method of teaching. I feel stupid and uncomfortable with my peers in this area of skills and would hate to fail because of it.'*

Discussion

To date there is little evidence in the literature of tertiary level biosciences embracing the concept and implementing formal systems of PAL. This was the first time the School of Biology and Biochemistry had introduced formal peer tutoring of any description into its extensive undergraduate curriculum. The primary reason for doing so was to address the students' growing requests for small-group tutorial support (not only in the microbiology module). Limited staff resources meant that such tutorials could not be staff-led, particularly with the large classes of first-year undergraduates; facilitating the students to help one

another through peer-assisted learning was perceived as a feasible alternative approach. A secondary reason, as far as this pilot study and the module in question was concerned, was the need to try and enhance the students' confidence in terms of their numerical and problem-solving skills (Tariq, 2002a, 2002b, 2003, 2004). Given the reported benefits and success of peer tutoring in a wide diversity of other academic disciplines (Falchikov, 2001) the author felt it appropriate and timely to introduce first-year bioscience undergraduates to this learning strategy. If students responded positively towards this PAL pilot, there would be the potential to extend this method of learning support to other elements of the same module as well as to other modules and levels within the School's undergraduate curricula.

The success of any peer tutoring scheme is dependent ultimately upon the students' willingness to engage fully in the process. The initial challenge, therefore, in implementing PAL lay in encouraging students to volunteer to act as group leaders (i.e. peer tutors), since few, if any, first-year undergraduates had any prior experience of this type of learning strategy. The role of group leader (peer tutor) is not one that should be imposed on individuals, since students assuming this responsibility must be interested, highly motivated, committed to completing the task, and willing to interact positively with their peer group (Wadoodi and Crosby, 2002); enthusiasm and academic ability may be considered of equal importance. Therefore, when introducing the class to the concept of PAL, emphasis was placed on the personal attributes and inter-personal skills potential group leaders should possess, rather than on their academic record, particularly in mathematics, although the latter was clearly a factor in subsequent selection decisions and in the assignment of leaders to particular groups of peers. The closer group leaders were to being 'true peers' in terms of their previous mathematics experience the more readily they might identify with any problems or concerns their peers experienced. Obtaining too few volunteers (as with the Tuesday class) can prove potentially problematic, since it may result in larger group sizes than desirable. On the other hand, if the role of group leader is over-subscribed (as with the Thursday class) then it may become necessary, as in this case, to select the requisite number of peer tutors, remembering to thank those not selected for their expression of interest and for volunteering – their enthusiasm and services may be required at some future date! Practices regarding group size vary, with various ratios of peer tutor:peers (Draper, 2004). For example, Coe *et al* (1999) assigned two group leaders to each group of five to eight members when organising their Peer-assisted Study Sessions (PASS) in chemistry.

The difference between the Tuesday and Thursday classes in the students' willingness to volunteer as group leaders may in part have reflected the fact that students had been assigned to a specific day on the basis of their degree subject and, therefore, timetable constraints. Tuesday's class contained all the biochemistry, biomedical sciences and genetics undergraduates (collectively comprising 71% of the Tuesday class), while Thursday's class contained predominantly biological sciences and marine biology students (comprising 74% of the Thursday class). The remaining degree subjects (e.g. environmental biology, microbiology, molecular biology and zoology) were represented by

relatively small numbers of students and were fairly evenly distributed between the two classes.

It is important that once the group leaders have been selected that they attend one or more orientation or training sessions. These may vary in number and purpose, depending upon the time available and the nature and extent of the proposed PAL experience (i.e. the number and content of the tutorial sessions they will lead and the contribution, if any, of the staff co-ordinator). The training should focus on group leaders' skills (facilitating and interpersonal) as well as the subject-specific content (Wadoodi and Crosby, 2002). In this case one training session was considered sufficient, as group leaders would engage in only one PAL session, the content and structure of which would be clearly defined by the author. It was particularly gratifying that the group leaders viewed the training session in such a positive light and that its primary aim, namely 'confidence-building', was achieved. Improvements in peer tutors' self-confidence is a positive outcome highlighted by Saunders and Gibbon (1998) and by Howman *et al* (2002) who describe the introduction of peer tutoring into the medicine curriculum and provide a valuable and very positive insight into peer tutoring from the peer tutors' perspective.

In view of the fact that this represented the students' first experience of formal peer-assisted learning, their reactions were very favourable and most appeared to enjoy engaging in this manner with their peers, finding the session 'a good learning experience'. They also appreciated the help and encouragement they obtained from their respective group leaders. The study certainly achieved its primary objective, namely to increase the students' self-confidence in some of the more generic components of the module. The fact that on balance students found the content of the tutorial neither intellectually easy nor intellectually too difficult was pleasing in view of the diversity of prior academic achievement and numerical skills competencies found within the cohort. It is important to try and strike the right balance in terms of the academic challenge provided by the task. If the task is too easy high achievers will get bored, while if the task is too difficult there is the risk of disenfranchising the lower achievers (Tariq, 2002a).

One problem when organising PAL for large groups of students is finding appropriate time, space and facilities to accommodate a large number of small tutorial groups. Due to limitations with respect to appropriate accommodation, the PAL sessions in this pilot had to take place in a large teaching laboratory with the three to five groups in each session positioned as far way from one another as possible. Although this was certainly preferable to using a tiered lecture theatre, it was far from ideal and some students found the discussions of nearby groups a distraction. Group leaders had been asked to try and moderate noise levels themselves as it was considered important that the author not intervene in the proceedings, no matter how tempting it was at times. Small tutorial rooms, whilst desirable, are seldom available to cater for large numbers of small groups. In this instance the PAL sessions were timetabled towards the end of the module and used to introduce students to past examination questions to assist them with their revision and exam preparation. However, integrating PAL at regular intervals throughout a module would probably have a greater impact on student learning, since research suggests that distributing

students' study time over several sessions leads to better retention of information than conducting a single study session – a phenomenon known as the spacing effect (Willingham, 2002).

In the UK, institutions vary in their practices regarding rewarding students extrinsically for their participation as peer tutors, with some paying student facilitators while others operate an entirely 'volunteer model' (Draper, 2004). In this case students received a nominal reward in the form of a book token, in recognition of the time and effort they had devoted to the task. However, Wadoodi and Crosby (2002) explain how the rewards for peer tutors may be intrinsic as well as extrinsic, with students gaining a greater understanding of the topic(s) and an altruistic sense of satisfaction from helping their peers. These intrinsic gains were certainly reflected in some of the comments group leaders made in response to Question 1 of the evaluation questionnaire (see above).

For the students, this excursion — however brief — into PAL provided a less formal, and more comfortable and relaxed environment, in which group leaders could ask appropriate questions and provide immediate feedback to their peers, and one in which the latter felt freer to ask questions and under less pressure to answer questions correctly.

Both the training session and the PAL sessions certainly encouraged (often lively) communication between individuals within the groups. The benefits associated with creating a learning environment that enhances 'the student experience' should not be underestimated, particularly when dealing with first-year undergraduates, who are new to (and who often underestimate) the demands of tertiary education. Research by Dixon and Gudan (2000) reveals that PAL can help students integrate in and develop a greater sense of identity with their student cohort; this, in turn, can increase student retention and reduce drop-out rates. The latter are a particular concern within HE in the UK at the present time.

PAL also encouraged the students to become more active and independent learners, assuming greater responsibility for their own learning as well as that of their peers. Students are more likely to look back over their lecture notes and other course material in preparation for a PAL session. For example, the group leaders reported that, in addition to reviewing materials provided in the training session, they had revised their lecture notes and practical worksheets prior to leading the PAL sessions. Introducing first-year undergraduates to distributed PAL early in their curriculum may encourage them to routinely review their lecture notes and read around the topics; some may even organise their own scheme and establish informal peer study groups.

Although the current study provided only limited opportunity for PAL, a further extended study, in which PAL is distributed throughout the module and which adopts a pre-test/post-test research design might reveal to what extent an intervention strategy such as this enhances learning and/or improves students' academic performance (e.g. as evidenced by formative or summative assessment methods). Several studies have revealed that students engaging in PAL perform better in examinations (e.g. Coe *et al*, 1999) and that gains for

group leaders (peer tutors) can be greater than those for their peers (Dixon and Gudan, 2000).

The most obvious advantage to staff is the capacity of PAL to provide an alternative strategy to support small-group tutorials (particularly with large classes) where staffing and other resource constraints preclude staff engaging directly with every student via tutorial contact time. While staff must be prepared to relinquish some 'control' and responsibility for teaching to the students, this is not synonymous with abandoning the students to their own devices. Depending upon what form the PAL will take, establishing a formal and structured scheme of PAL for a large class of students does require some commitment of time and effort. This may involve organising the student groups, timetabling the sessions (unless the scheme operates as an extra-curricula activity) and finding appropriate accommodation where peer groups can meet. It may also prove necessary, particularly in the initial stages and with first-year students, to prepare support materials for the group leaders, and in some, although not all cases, to brief the latter prior to the sessions. The aspirations of staff willing to embark on PAL should extend beyond the students' attainment of higher marks in summative assessments, to developing independent learners, who are more willing to actively explore (with guidance) their chosen discipline. The definition of a successful student learning experience should include much more than the attainment of a good examination grade!

The evidence presented indicates that this excursion into PAL proved highly successful in terms of the students' overall participation and evaluation of the scheme. The vast majority of students taking part would like to see this learning strategy extended beyond problem-solving to other aspects of the microbiology module and even to other modules within their curricula. Although there are advantages to both students and staff in implementing a programme of PAL the logistics need careful consideration. However, based upon the facilitator's experiences, it is certainly feasible to organise an extended programme of PAL, within a system where resource constraints prohibit extensive use of staff-led small-group tutorials, particularly with very large classes. In light of the author's move to another institution, it remains to be seen whether or not colleagues within the School of Biology and Biochemistry will embrace the concept of PAL and support the continuation and extension of this initiative.

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Appendix

The General Certificate of Secondary Education (GCSE) represents the main qualification achieved after two years' study by 16-year-olds at the end of their compulsory secondary level education; the subjects are graded from A* to G, but only grades A* to C allow access to Advanced Level (A-level) study. Traditionally, A-level qualifications were normally awarded to pupils aged 18 years after 2 years' further study of an 'advanced' syllabus (pass grades range from A to E). In 2000, a series of reforms were introduced which aimed to broaden the post-16 curriculum. These reforms included the introduction of Advanced Subsidiary (AS) level and A2 level qualifications. Pupils may 'cash-in' an AS qualification (after one further year of post-16 study) or continue studying the subject for a further year to achieve the higher A2 qualification (equivalent to the traditional A-level).

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