PEER TUTORING IMPROVES STUDENT PERFORMANCE IN AN ADVANCED PHYSIOLOGY COURSE

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Effectiveness of a peer tutoring system developed for an advanced physiology course was assessed in terms of academic performance and perceived value. Forty-five students took the course without the peer tutoring system, and sixty-nine students took the course with peer tutoring. Grades from both groups of students were compared with grades earned in an introductory physiology course. Tutored students were asked how much they valued the peer tutoring. There was a decline in grades received by the students in the advanced physiology course compared with their scores in the introductory physiology course in both tutored and untutored groups. However, the decline in the tutored group was significantly ($P = 0.015$) less than that in the untutored group of students. Tutored students reacted very favorably to the tutoring sessions and expressed a desire to see tutoring expanded to other courses. This was the first demonstration of the effectiveness of peer tutoring in college science teaching. Peer tutoring appears to be effective in enhancing student performance as well as being perceived as beneficial by the students.

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As students move into the more demanding courses of a health professions curriculum, they often have academic difficulty. With other responsibilities, faculty can spend less time with students having academic problems. As a result, new ways to help students in academic trouble must be employed. One such way to help students in academic difficulty is peer tutoring.

Peer tutoring has been shown to be effective in many studies at the primary and secondary school levels (5) and at the undergraduate college level (1). Peer tutoring is used in 75.8% of medical schools studied by Moore-West and Hennessy (11). However, few studies (3, 4, 8, 13–15) have investigated the effects of peer tutoring in the college-level sciences.

Walker-Bartnick and colleagues (15) reported success in a tutoring system in 9 of 10 basic science courses with 84% of tutored students receiving passing grades. In that study, 17 of 18 (94%) tutored physiology students passed their exams. However, the study had no control groups for the tutored students and showed no evidence that these students would have failed without the tutoring system. The study did not investigate the tutees' perception of the tutoring system.

Carroll (4) investigated the use of peer tutoring in two medical school biochemistry courses. His approach used more experienced medical students to act as tutors to facilitate discussion in groups of 18–20 first-year medical students. These tutorial sessions accompanied either traditional lecture methods or a

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highly structured, student-directed educational approach. Effectiveness was determined by surveying the first-year medical students, the peer tutors, and the course instructors for their perceptions of the value of these tutorial sessions. The study showed a general approval by tutees of the tutoring system when combined with the student-directed approach but was less positive when tutoring was combined with the traditional lecture approach. However, the study did not investigate academic performance as a measure of the effectiveness of tutoring.

Saunders (13) reported on a peer tutoring project in engineering in which final-year students tutored first-year students. The outcome measure was a survey of the tutors and the tutored students regarding their perceptions of the value of the peer tutoring. Tutees in the study were very positive about the tutoring and expressed a desire to have it used in more courses. As in the study by Carroll (4), there was no attempt to investigate academic performance as a measure of the effectiveness of tutoring.

Lundeberg (8) reported on the use in basic chemistry courses of a form of peer tutoring called supplemental instruction. Students involved in the tutoring sessions earned significantly higher grades than students in nontutored groups. Students involved in the supplemental instruction responded very positively to the experience. However, students self-selected their involvement in tutored and nontutored groups, and there was no evidence that these two groups of students were equivalent.

Bridgham and Scarborough (3) studied the application of supplemental instruction in first-year medical school courses, including physiology. These investigators compared actual test scores that students received to scores predicted from a stepwise regression model. The regression model was derived from scores in the same courses taught before supplemental instruction was initiated. Results showed a significant improvement in physiology test scores in the first year of the study and a nonsignificant improvement in the second year of the study. The study had no control group per se and presented no evidence to support the validity of the regression model.

Sawyer and colleagues (14) used supplemental instruction to help ''at-risk'' students in first-year medical school courses. They compared the performance of at-risk students who were tutored by second-year medical students with at-risk students in the three years preceding the initiation of the supplemental instruction program. The comparisons were made between the first two examinations in biochemistry, gross anatomy, microanatomy, and physiology. The tutored at-risk students performed better, but not significantly better, on each of the two physiology examinations. The two groups of at-risk medical students were considered comparable because there were no significant differences in their MCAT scores and undergraduate GPAs.

Clearly, the effectiveness of peer tutoring in science courses within professional medical and allied health curricula based on improved performance and tutee acceptance of tutoring has not been clearly demonstrated.

The purpose of this study was to assess the effectiveness of a peer tutoring system developed for a health professions physiology course in terms of both academic performance and perceived value of peer tutoring. There were two principle hypotheses: *1*) health professions students involved in peer tutoring would show significantly smaller decline in grades between their introductory and advanced physiology courses, which were part of a health professions curriculum, than would health professions students not involved in peer tutoring; and *2*) health professions students involved in peer tutoring would have a favorable view of peer tutoring.

METHODS

At the time of this study, students were enrolled as physical therapy students when they entered as freshmen for a five-year bachelor's degree program. During their first two years, students had four introductory physical therapy courses along with their basic science and liberal arts courses. Beginning in their second year, the students in each graduating class were divided into two divisions, and each division of students alternated classroom activities with cooperative education work experiences (12). This pattern of education requires that two different groups of stu-

dents take the same courses. Students began the majority of their professional course work in the third year, with each professional course offered twice each year.

In their second year, students took a basic physiology course as part of the preprofessional anatomy and physiology sequence. This course covered the basic principles of physiology at a relatively elementary level.

Students took the advanced physiology course in either the fall or winter quarter of their third year. The course went into much greater detail in the areas of muscular, neural, and cardiopulmonary physiology. It laid the foundation for the understanding of the pathophysiology of each of those systems and connected the principles of physiology to rehabilitation medicine.

When the peer tutoring system was first established, it began in the winter quarter for this course. Thus, in that year, winter-quarter physiology students had access to the peer tutoring and the fall-quarter students did not. Sixty-nine students were enrolled in the winter quarter that year, and forty-five students were enrolled in the fall quarter. Both groups of students took the same course load consisting of the same four professional courses during this first quarter of their third year of study.

The advanced physiology courses in both quarters were taught by the same faculty member. Both courses had the same number of lecture hours, had the same content, and covered that content in the same order. The faculty member kept the same number of office hours in both quarters and was available at those times and after class to answer questions. This pattern of informal tutoring by the faculty member did not vary between the two semesters.

Fifth-year students in the professional program were selected to be peer tutors on the basis of recommendations from the faculty who taught physiology. The peer tutors were given minimal preparation as tutors. They were given a course syllabus and were required to review material to be covered in the tutoring sessions. Tutors were informed of the importance of the tutoring to the third-year students. Tutors were encouraged to talk with the physiology faculty member when questions arose. The advanced physiology course was not significantly different from the course taken by tutors during the previous year. Tutors were paid a nominal sum at an hourly rate.

Tutoring was done in the laboratory with five tutors on duty during every tutoring session. All students taking the physiology course were invited to participate in the tutoring sessions. Peer tutoring included both review of lecture material and the answering of specific questions posed by the tutees. In most cases, small groups, each led by a tutor, would review the lecture material for each week. When tutors noted that an individual student was having particular difficulty, they would give that student extra attention.

Tutoring sessions were offered once weekly for 2–3 h in the evening. During a 10-week-long academic quarter, tutoring sessions were offered each week, except for the first week and the week after each of two midterm exams, for a total of seven tutoring sessions during the quarter.

Attendance was voluntary but was recorded at every session by having students sign in.

Grades in the advanced physiology course were recorded at the end of the fall and winter quarters. Grades from the introductory physiology course, which the students took as second-year students, were obtained from the students' academic records. Because only the grades and not the final percentage scores from the introductory physiology course were available, the grades were converted for comparison with their grades in the advanced physiology course. Grades were converted to an 11-point scale (Table 1).

Students' perceptions were measured by asking two questions as part of the end-of-term student course evaluation that were answered using a 10-point Likert scale. The questions were distributed during a regular class session of the advanced physiology course so that all students could be surveyed. The two questions asked the students about their perceptions of the value of tutoring sessions (0 on the scale indicated that the tutoring had no value to the student, and 10 on the

TABLE 1
Conversion of grades to a numerical system for comparison of student performance in the introductory and advanced physiology courses

Grade	Numerical Point System
A	11
A−	10
B+	9
B	8
B−	7
C+	6
C	5
C−	4
D+	3
D	2
D−	1
F	0

scale indicated that the tutoring was very valuable) and whether they wished to see the tutoring sessions continued in the future and broadened to include more courses (0 indicated that tutoring sessions should not be continued, and 10 indicated that they should be continued and broadened to include other courses).

The significance of differences in grades and tutee perceptions of the tutoring was determined with the use of the Mann-Whitney *U* test. Correlations between grades in introductory physiology and grades in advanced physiology, between attendance at review sessions and grades in advanced physiology, and between attendance at physiology tutoring sessions and attendance at gross anatomy tutoring sessions taught the same quarter were determined using the Pearson product moment. The significance of these correlations was determined using the Spearman rank correlation coefficient.

RESULTS

Forty-three of sixty-nine students (62%) enrolled in the advanced physiology course attended the tutoring sessions. Students who attended tutoring attended an average of 3.53 tutoring sessions of the total 7 available during the quarter. Students who did not attend tutoring sessions reported that they could not stay on campus at night due to problems with commuting to school or with work schedules.

The tutoring sessions were very popular with those students who attended the sessions. Students who attended the tutoring sessions rated their perceived value of the tutoring sessions at 8.3 (±0.26 SE) on a 10-point Likert scale (range 1–10). These students also expressed strong interest in having tutoring sessions for future courses with an average score of 8.7 (±0.24 SE) (range 4–10). As expected, there was a strong (r^2= 0.865), significant ($P < 0.001$) correlation between perceived value and the desire to have tutoring sessions for future courses.

TABLE 2
Comparison of grades in the introductory and advanced physiology courses for the tutored and untutored students

Course	Tutored		Untutored	
	Mean	SE	Mean	SE
Introductory physiology	6.83	0.28	7.96	0.21
Advanced physiology	6.01	0.19	6.47	0.29
Difference*	0.75	0.24	1.49	0.14

Numerical representation of grades is based on 11-point scale (shown in Table 1) comparing introductory anatomy and gross anatomy courses for tutored and untutored groups of students.

*Significant difference between tutored and untutored groups (P=0.015) by Mann-Whitney *U*-test.

There was a decline in grades received by the students in the advanced physiology course compared with their grades in the introductory physiology course in both tutored and untutored groups. (Table 2). However, the decline in the tutored group was significantly less ($P = 0.021$) than that in the untutored group of students.

Because the introductory physiology grades of the nontutored group were higher than those of the tutored group of students, two possibilities exist that could explain the difference in the declines between the two groups. The first possibility is that tutoring could have preferentially helped C students, and the greater number of C students in the tutored group could have led to a smaller decline in the grades of the tutored group. To test this possibility, the grades of students who received C's in the introductory physiology course were removed from the comparison and only those who received A's or B's were compared between the tutored and untutored groups. There continued to be a significant difference ($P = 0.023$) in the decline in the scores between the tutored (1.378 ± 0.246) and untutored groups (1.932 ± 0.136).

The second possibility is that there was a ceiling effect. Students who had an A in the introductory physiology course cannot show a rise in their grade, and therefore these students cannot contribute to lessening the decline of the grades. The greater number of A students in the untutored group may account for the greater decline in the grades in this group compared with the tutored group. To test whether this was the case, the two groups were compared without the inclusion of the A students. There continued to be a significant difference ($P < 0.001$) in the decline in the scores between the tutored (0.305 ± 0.231) and untutored (1.829 ± 0.144) groups when A students were not included in the group comparisons.

The effect of tutoring on grades in advanced physiology of the tutored students was investigated by correlating the number of tutoring sessions attended to the grade received for the advanced physiology course. The grade in the advanced physiology course was weakly correlated ($r^2 = 0.117$) with the number of tutoring sessions attended, but this correlation was significant ($P = 0.004$).

It could be argued that the more academically prepared students might be more motivated to attend tutoring sessions and, therefore, were more likely to do well in the advanced physiology course. To test this possibility, attendance at the advanced physiology course tutoring sessions was correlated to the student's grade in the introductory physiology course. There was a weak, positive correlation ($r^2 = 0.006$) between the students' grades in the introductory physiology course and their attendance at tutoring sessions, but this correlation was not significant ($P = 0.40$).

In the tutored group, there was a slight, positive ($r^2 = 0.173$) correlation between the students' grades in the introductory physiology course and their grades in the advanced physiology course, and this correlation was significant ($P = 0.002$). However, this correlation was smaller than a similar correlation in the nontutored group ($r^2 = 0.81$; $P < 0.001$).

There is also the possibility that these students would have attended any tutoring sessions, whether they felt they needed to attend or not. To test this possibility, attendance at advanced physiology tutoring sessions was compared with attendance at gross anatomy tutoring sessions held for these same students each week on another night. There was a small ($r^2 = 0.223$) but significant ($P < 0.001$) correlation between attendance at physiology tutoring sessions and attendance at gross anatomy tutoring sessions.

DISCUSSION

This study demonstrated that students benefited from peer tutoring in physiology. Students showed a decline in grades in the transition from the introductory physiology courses to the advanced physiology course. This decline in grades has been attributed to the dramatic increase in the depth of the physiological study in the more advanced course. The grades of tutored students declined less than those of nontutored students when students transitioned from the introductory physiology course in the preprofessional curriculum to the advanced physiology course in the professional curriculum. These results support the first hypothesis, which stated that health professions students involved in peer tutoring would show significantly smaller decline in grades between their introductory physiology course and their advanced physiology course than students not involved in peer tutoring.

Because the grades in introductory physiology of the nontutored group were higher than those of the tutored group, two possibilities exist that could explain the difference in the declines between the two groups: *1*) tutoring could have preferentially benefited C students, and the greater number of C students in the tutored group could have led to the lesser decline in the grades of the tutored group; and *2*) there was a ceiling effect because students who had an A in the introductory physiology course could not show a rise in their grades, and therefore these students could not contribute to lessening the decline of the grades. However, in different analyses, elimination of A or C students from the comparison of tutored and nontutored students did not change the differing performance of these two groups.

Grades of the tutored students in the advanced course were correlated with attendance at the peer tutoring sessions. Grades in the advanced physiology course were also significantly correlated to performance in the preceding introductory physiology course. There

was a negligible, nonsignificant correlation between the students' grades in the introductory physiology course and their attendance at tutoring sessions. This would suggest that both peer tutoring and previous success in physiology course work are both important and mostly independent contributing factors to success in advanced physiology courses.

Attendance at tutoring sessions was not related to previous performance in the introductory physiology course, and student attendance was not strongly correlated to attendance at other tutoring sessions offered for different courses. Apparently, attendance was related to a specific need to better understand the material being presented that week.

Tutoring sessions were very well attended with 88% of the students attending at least one tutoring session and students attending, on average, 3.25 tutoring sessions of the total 7 available during the quarter. Students had a very high perception of the value of these sessions (8.3 on a scale of 10) and desired to have these sessions in future courses (8.7 on a scale of 10). These results support the second hypothesis, which stated that physical therapy students involved in peer tutoring would have a favorable view of peer tutoring.

The impact of tutoring is particularly impressive when the attendance at tutoring sessions is considered. It must be stressed that the average attendance at tutoring sessions was less than one-half of the total number of tutoring sessions offered. Even with this limited attendance, students in the course with peer tutoring performed significantly better than their counterparts who were not tutored.

Previous research (10) has demonstrated that there is greater success with tutors selected for their high intrinsic motivation to be good tutors. College students who needed extrinsic rewards, such as payment, to increase their motivation as tutors reported less improvement in the performance of their tutees (7). The upper-level students eagerly sought to be involved in the tutoring system. They perceived that this would be a good way to review physiology. They were told that there was a small hourly salary for tutoring only after agreeing to be a tutor.

Previous research suggests that tutors who believed that they were selected on the basis of their competence had a more positive attitude toward tutoring than students who were either told that they were selected by chance or not told a reason for their selection (2). It was made clear to the tutors in this study that the selection of tutors was made on the basis of their previous performance in academic courses, particularly physiology, and upon recommendation by the faculty.

DePaulo and colleagues (6) reported that tutee performance was highest when the tutee was a high achiever and was paired with a high-achieving tutor of the same age. They found that helping was greatest and least threatening when students were of similar age and when both were of high ability. Medway (9) reported that there was greater tutee learning when there was less social distance between the tutor and tutee. The difficult course load and, in most programs, the rigorous admissions requirements ensure that both tutors and tutees in a physical therapy program will be high achievers. The tutors were about the same age as the tutees and, hence, there was less social distance.

DePaulo and colleagues (6) also reported that tutee self-esteem was higher when the tutor was perceived as older or more experienced. For this reason, senior students were used to tutor the younger students. The younger students respected not only the basic science knowledge base of the fifth-year students but also the clinical experiences of the senior students. The fifth-year students could assure them that this knowledge was important to their development of clinical skills and clinical problem-solving abilities.

Research has shown that tutees who did the best were tutored by tutors who had high expectations of success from the tutoring sessions (16). The tutors who assumed responsibility for the tutees' success or failure engaged in the most active teaching strategies (10). To encourage this, the tutors in the present study were told how important tutoring is to the third-year student. The tutors understood that peer tutoring was important for the success of the lower-level students.

In summary, peer tutoring appears to be an effective mechanism to improve student performance in ad-

vanced physiology courses. Tutoring is very well received by the tutored students. This is the first clear demonstration of the effectiveness of peer tutoring in basic science courses at the college level.

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