A peer-led supplemental tutorial project for medical physiology: implementation in a large class

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Kibble JD. A peer-led supplemental tutorial project for medical physiology: implementation in a large class. Adv Physiol Educ 33: 111–114, 2009; doi:10.1152/advan.90212.2008.—The purpose of this study was to evaluate the practicality of implementing a peer-teaching program in a large class (≥350 students) of medical students and whether such a program is beneficial. Case-based problems were developed by faculty members to facilitate student problem solving and discussion. Voluntary student enrollment was available during the first week of a semester. Tutorials took place during out of class time and were facilitated by peers from the previous class. Tutors were selected for their outstanding performance in physiology; they were provided with training in facilitation skills and were given a package of model answers. Sixty-eight students enrolled in this pilot program and were organized into groups of ~8 students. On average, students attended four of six tutorials. Posttutorial quiz scores were significantly greater than pretest pretest scores. Surveys showed that students had high expectations at the outset, which were matched with positive perceptions at the end of the program; the use of near-peer tutors was especially well received. Tutors also gave high approval ratings for their experiences. In conclusion, the peer tutoring program was logistically straightforward to implement in a large class and was endorsed by the participants.

peer teaching; collaborative learning; active learning

THE NOTION that students can help each other to learn is a widely accepted premise that has resulted in the use of peer teachers in most medical schools in North America (8). Although one-on-one peer tutoring is perhaps the most common way in which student teachers are used, several medical schools have used more formal systems of peer instruction (2, 4, 5). Supplemental instruction (1) is the most commonly used model when attempting to use peer instruction on a large scale. In its original form, supplemental instruction pairs a “model student” with a group of inexperienced students who work in a cooperative group to pool their knowledge and skills. The student leader is given training in facilitation skills and helps the group to integrate material and acquire successful learning strategies without recitation or giving new content (9). Advocates of supplemental instruction point to documented benefits for students including improved academic performance, reduced attrition rates, and the development of transferable skills (1, 10).

At St. George’s University, 2 or 3 faculty members teach physiology to ≥350 students each semester. There is therefore a need to provide academic support beyond what can be offered in traditional office hours. This problem is compounded by a short supply of upper-class peer tutors because they are studying a challenging second-year curriculum when the physiology course is running. The goal of the present study was to develop a tutorial program that could be used by a large number of students and that made efficient use of student time.

MATERIALS AND METHODS

St. George’s University offers a 4-yr medical program in which basic medical sciences are taught during the first 2 yr. Medical Physiology is taught twice a year to cohorts of ≥350 students. It is a 5 credit hour course, delivered over 18 consecutive weeks, consisting of 75 h of lecture and 12 h of formal small-group teaching. Curricular content is based on the American Physiological Society Medical Physiology Objectives Project. The course runs during the second academic semester, concurrently with Neuroscience, Genetics, Immunology, and Medical Parasitology. Medical Physiology follows Anatomy and Biochemistry and precedes courses that include Pathology, Pharmacology, and Pathophysiology.

The tutorial program consisted of six structured tutorials designed to occupy a small-group discussion for ~90 min. Cases and problems were developed to highlight major concepts in cellular, cardiovascular, endocrine, renal, gastrointestinal, and pulmonary physiology. The problems consisted of a series of questions, each of which was intended to facilitate discussion and collaboration among students. Table 1 shows an example of a case-based tutorial; students worked in groups to achieve a consensus answer for each question before moving on to the next question. A tutorial was scheduled every 2–3 wk to coincide with the body system being taught in the main course; a block of small-group study rooms was reserved on weekends to avoid schedule conflicts with regular classes.

Students were invited to enroll in the tutorial program through general in-class and e-mail announcements during the first week of the semester. Enrollment was registered by an administrative assistant in the university’s Department of Educational Services. Students were provided with a package containing the problems and cases, a description of this study, and a form requesting their informed consent. This study was approved by the Institutional Review Board of St. George’s University.

Before the program began, students were asked to complete the survey shown in Table 2, the purpose of which was to gauge their expectations of peer-led tutorials. The survey was administered again at the end of the final tutorial to assess whether student expectations were met. A short quiz was written to accompany each tutorial; each quiz consisted of four multiple-choice questions of the single best answer type. Quizzes were administered at the start and end of each tutorial. Students were asked not to collaborate and were supervised by tutors during quizzes; answers and discussion were offered immediately after the posttest.

The eight highest-achieving students from the previous semester were identified as potential tutors and were invited to participate by e-mail using a letter that stressed the voluntary nature of their participation. Tutors were initially provided with a description of the program and were invited to attend a 2-h orientation meeting. During their orientation, tutors received a package of written case materials, which included model answers. Most of the orientation was taken up with a workshop on how to facilitate small-group discussion, which was provided by our Faculty Development Office. Tutors were asked...
Survey results comparing student expectations with outcomes

I expect tutorials to improve or increase my:

| Content knowledge of physiology | 3.9 ± 1.0 | 4 |
| Understanding of physiological principles | 3.9 ± 1.0 | 4 |
| Ability to apply physiological concepts | 3.9 ± 0.9 | 4 |
| Interest in physiology | 3.7 ± 1.0 | 4 |
| Attitude toward the usefulness of physiology in medicine | 3.9 ± 0.9 | 4 |

Tutorials improved or increased my:

| Content knowledge of physiology | 4.3 ± 0.8 | 4 |
| Understanding of physiological principles | 4.3 ± 0.8 | 4 |
| Ability to apply physiological concepts | 4.2 ± 0.7 | 4 |
| Interest in physiology | 3.6 ± 0.9 | 4 |
| Attitude toward the usefulness of physiology in medicine | 3.9 ± 0.9 | 4 |

I expect that working in a tutorial group will:

| Help me to identify my strengths and weaknesses in physiology | 3.9 ± 0.7 | 4 |
| Enhance my learning through cooperation | 3.7 ± 0.8 | 4 |
| Enhance my teamwork and communication skills | 3.5 ± 0.8 | 4 |
| Increase positive attitudes toward my peers | 3.8 ± 1.0 | 4 |

Working in a tutorial group:

| Help me to identify my strengths and weaknesses in physiology | 4.1 ± 0.7 | 4 |
| Enhance my learning through cooperation | 4.1 ± 0.9 | 4 |
| Enhance my teamwork and communication skills | 3.5 ± 0.9 | 3 |

Increased positive attitudes toward my peers:

| Worked well in this group | 3.4 ± 0.9 | 3 |

I expect peer tutors to:

| Have adequate knowledge to lead group discussion | 3.7 ± 1.0 | 4 |
| To be acceptable alternatives to faculty members as discussion leaders | 3.9 ± 0.8 | 4 |

Had adequate knowledge to lead group discussion:

| Helped me to identify my strengths and weaknesses in physiology | 4.1 ± 0.7 | 4 |
| Enhanced my learning through cooperation | 4.1 ± 0.9 | 4 |
| Enhanced my teamwork and communication skills | 3.5 ± 0.9 | 3 |

Increased positive attitudes toward my peers:

| Helped me to identify my strengths and weaknesses in physiology | 4.1 ± 0.7 | 4 |

Survey results comparing student expectations with outcomes

To be acceptable alternatives to faculty members as discussion leaders:

| Helped me to identify my strengths and weaknesses in physiology | 4.5 ± 0.6* | 5* |

Additional notes:

- *Significant difference between the pre- and postprogram survey (by Mann-Whitney U-test, P < 0.05).
- To be acceptable alternatives to faculty members as discussion leaders.

Table 1. Example of a case-based tutorial

Case History and Questions (Student Version)

1. Initial history: Jack is an 82-yr-old man with a long history of a heart murmur. He has increasing shortness of breath, especially on exertion (extertional dyspnea), and is undergoing a comprehensive evaluation of cardiac function.

2. Jack’s murmur is a crescendo-decrescendo systolic ejection murmur heard shortly after a normal first heart sound. It is a rough sound that is best appreciated in the second right intercostal space. The intensity increases toward midsystole and then decreases, and the murmur ends just before the second heart sound. What heart valve abnormality does Jack likely have?

3. Based on your conclusions from auscultation, drawn a pressure versus time graph during one complete cardiac cycle for Jack’s left ventricle (add units to the axes to indicate the size and duration of pressure changes).

4. Superimpose a pressure tracing for the aorta on the graph developed in question 3. How does this differ from normal?

5. Jack has an abnormally low pulse pressure. Describe what changes are expected in his systolic and diastolic blood pressure and explain why they are abnormal.

6. Given that Jack has had this heart valve defect for a long period of time, suggest what morphological changes in the myocardium you would expect to see. Comment on his ECG (figure provided to students).

7. Provide an explanation for Jack’s shortness of breath.

Table 2. Survey results comparing student expectations with outcomes

Preprogram Survey | Means ± SD | Medians | Postprogram Survey | Means ± SD | Medians
---|---|---|---|---|---
I expect tutorials to improve or increase my: | 3.9 ± 1.0 | 4 | Tutorials improved or increased my: | 4.3 ± 0.8 | 4
Content knowledge of physiology | 3.9 ± 0.8 | 4 | Understanding of physiological principles | 4.3 ± 0.8 | 4
Understanding of physiological principles | 3.9 ± 0.9 | 4 | Ability to apply physiological concepts | 4.2 ± 0.7 | 4
Ability to apply physiological concepts | 3.7 ± 1.0 | 4 | Interest in physiology | 3.6 ± 0.9 | 4
Interest in physiology | 3.9 ± 0.9 | 4 | Attitude toward the usefulness of physiology in medicine | 3.9 ± 0.9 | 4
Attitude toward the usefulness of physiology in medicine | 3.9 ± 0.7 | 4 | Working in a tutorial group: | 4.1 ± 0.7 | 4
Help me to identify my strengths and weaknesses in physiology | 3.7 ± 0.8 | 4 | Enhanced my learning through cooperation | 4.1 ± 0.9 | 4
Enhanced my learning through cooperation | 3.5 ± 0.8 | 4 | Enhanced my teamwork and communication skills | 3.5 ± 0.9 | 3
Enhanced my teamwork and communication skills | 3.8 ± 1.0 | 4 | Increased positive attitudes toward my peers | 3.4 ± 0.9 | 3
Increased positive attitudes toward my peers | 3.7 ± 1.0 | 4 | Peer tutors: | 4.2 ± 0.7 | 4
Have adequate knowledge to lead group discussion | 3.9 ± 0.8 | 4 | Were acceptable alternatives to faculty members as discussion leaders | 4.5 ± 0.6* | 5*
To be acceptable alternatives to faculty members as discussion leaders | 3.9 ± 0.7 | 4

n = 45 student respondents for the preprogram survey and 35 student respondents for the postprogram survey. Responses were based on a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, and 5 = strongly agree. *Significant difference between the pre- and postprogram survey (by Mann-Whitney U-test, P < 0.05).
An administrative assistant coordinated the allocation of students to tutors and provided a schedule for the participants. Tutors were asked to evaluate the program after the last session using the survey shown in Table 3. Surveys were scored using a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. Survey and quiz data are presented using means ± SD and medians. Differences between pre- and posttutorial quizzes for each individual session were analyzed by Wilcoxon’s nonparametric paired sample test. Paired analysis could not be used to evaluate differences between pre- and postprogram surveys due to differences in student attendance between the first and last tutorial; these data were analyzed using a Mann-Whitney U-test. A 5% significance level was used in all cases.

RESULTS

Sixty-eight students enrolled in the program during the first week of the semester. Forty-five students (66%) completed the pretutorial survey. Students expressed high expectations of the program, including the anticipation that tutorials would augment knowledge, understanding, problem solving, and their enthusiasm for physiology (Table 2). Similarly high expectations were expressed regarding the anticipated benefits of small-group participation and for the knowledge and skills of the peer tutors. All tutorials were delivered as scheduled except in two cases where a tutor was unable to attend and groups were merged to accommodate students. The enrolled students attended four of six tutorials on average; extra students occasionally attended sessions but were not included in this analysis since they did not have an opportunity to give informed consent. Thirty-five students (51%) of the original cohort responded to the posttutorial program survey. In all but one case no differences were noted between the Likert scores before and after the program; students expected peer tutors to be acceptable alternatives to faculty members as facilitators, and they endorsed this statement significantly more strongly at the end of the program.

The overall median score on pretutorial quizzes was 2 of 4, which increased to 3 of 4 when the same quiz was administered at the end of the session. Figure 1 shows a comparison of pre- and posttest performance for individual tutorial sessions. In every case, paired analysis showed a significant increase in student scores on the posttest compared with the pretest.

All eight peer tutors who were invited to participate attended the orientation training session and maintained their participation throughout the semester. Six of eight peer tutors completed the survey shown in Table 3. Tutors agreed that the program was well organized, that their case notes were adequate, and the experience was useful for their own physiology review. The format of sessions was intended to emphasize discussion and collaboration, and tutors agreed that students had worked in collaborative groups. Tutor responses were mixed regarding the level of basic teaching needed during the sessions. They agreed that the program had not impeded their own concurrent studies, and there was universal agreement for recommending others to become a tutor.

**DISCUSSION**

The first goal of this study was to evaluate how difficult the implementation a formal peer support system would be in a large medical physiology class. My initial anxiety was that the program would be overwhelmed with hundreds of enrolled students. This fear proved to be unfounded, with 19% (68 of 354) students choosing the join the program. This level of enrollment is very similar to previous supplemental instruction projects with 22% of students in a study of engineering students (9) and 20% of students in another medical student study (10). The tutorial program was organized in conjunction with our Department of Educational Services, which is normally responsible for scheduling voluntary out of class activities. We required four small study rooms for a 2-h period on a Saturday and Sunday to accommodate the eight study groups. The possibility that programs such as these could be over-

**Table 3. Tutor perceptions of the tutorial system**

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>Means ± SD</th>
<th>Medians</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The tutorial system was well organized.</td>
<td>4.7 ± 0.5</td>
<td>5</td>
</tr>
<tr>
<td>2. The tutorial problems were not too difficult for students.</td>
<td>4.2 ± 0.8</td>
<td>4</td>
</tr>
<tr>
<td>3. The tutor notes provided were adequate for my preparation.</td>
<td>4.8 ± 0.4</td>
<td>5</td>
</tr>
<tr>
<td>4. Students worked in cooperative small groups to solve case problems.</td>
<td>4.0 ± 0.9</td>
<td>4</td>
</tr>
<tr>
<td>5. It was necessary for me to teach students the basic material related to case problems.</td>
<td>3.0 ± 0.6</td>
<td>3</td>
</tr>
<tr>
<td>6. Being a facilitator did not impede my current studies.</td>
<td>4.3 ± 0.5</td>
<td>4</td>
</tr>
<tr>
<td>7. Being a facilitator was a useful personal review of physiology.</td>
<td>4.8 ± 0.4</td>
<td>5</td>
</tr>
<tr>
<td>8. I would recommend being a facilitator to others.</td>
<td>5.0 ± 0.0</td>
<td>5</td>
</tr>
</tbody>
</table>

n = 6 tutor respondents to the survey. Responses were based on a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, and 5 = strongly agree.

**Fig. 1. Pre-and posttutorial quiz scores for individual tutorials.** The x-axis shows tutorial topics and numbers of students (n) who attended the session. Mean pretest scores and paired posttest scores are shown. Median test scores are shown in parentheses. GI, gastrointestinal. *Significant difference between pre- and posttest scores (by Wilcoxon’s paired sample test, P < 0.05).
whelmed will be a real concern for others considering this approach. The largest enrollment encountered in three subsequent iterations of the program was 103 students. In this case, the top 20 students from the previous semester were invited to become tutors, and 16 students accepted. Although no data were collected to shed light as to why students may elect not to join the tutorial program, it seemed that the attraction of the program had a natural limit. It is important to recognize that supplemental instruction is not a remedial program (1), and most students probably feel confident at the outset that they will succeed without additional programs. It may also be the case that the study preferences of many students are not inclined toward group study. The most difficult practical problem posed by larger enrollments in our setting would have been the availability of enough small-group teaching rooms. The present enrollment characteristics of the program make it practical to implement, and the logistics require no faculty input. Indeed, others have successfully asked students to make the practical arrangements for supplemental instruction sessions (5).

The acceptability of peer-assisted learning initiatives has been established by others (3, 4, 5) and was reflected by the positive endorsements from both students and tutors in the present study. Interestingly, students already expected this to be the case before the program started. The similarity of survey responses before and after the program broadly indicate that student expectations were met. This finding is perhaps a function of voluntary enrollment, although similar enthusiasm was expressed when we mandated a different form of peer facilitation in our formal teaching program (6). In the present study, students strongly agreed with the view that peer tutors were acceptable alternatives to faculty members as facilitators. The observation that peer instructors are generally found to be acceptable has been attributed to their cognitive and social congruence with the learners (7).

In traditional supplemental instruction, the study groups typically meet for 1 h/wk to review and discuss the material taught during the week. Supplemental instruction leaders may focus on the integration of existing content, study approaches, and learning skills; the help offered depends on the needs of the group (1). In this study, I decided to provide a higher degree of structure by writing case problems to focus the discussions. The problems did not require any research outside of class materials but were designed to apply what should be known and to solve a new problem as a cooperative group. The idea was to make the most efficient use of student time, particularly for tutors, who had been traditionally difficult to recruit. The tutor survey indicated that the materials provided were adequate for their preparation and that the program had not impeded their concurrent studies. A drawback of this approach is the significant investment of faculty time initially to prepare the tutorial materials.

The second goal was to assess whether the supplemental tutorial program was beneficial. The use of pre- and posttutorial quizzes provided some objective measurement of learning. In every case, the median scores significantly increased in posttutorial quizzes, suggesting that knowledge acquisition occurred. Hurley et al. (5) found a similar immediate improvement in quiz scores; they also included a quiz at the end of the program, which indicated retention of knowledge over time. In the present study, no attempt was made to relate tutorial participation to course grades because the analysis was complicated by having some students registered in an alternative program of study. Many studies (1, 3, 10) have demonstrated improved academic performance with peer learning. There is also accumulating evidence that being a student leader has benefits in terms of improved communication and presentation skills (11) and higher United States Medical Licensing Examination scores (12). Although the potential benefits of participation for tutors were not directly addressed in this study, it was gratifying to note that all six tutors who responded to the survey were unanimous in recommending the program to other tutors.

In conclusion, a structured supplemental tutorial program facilitated by upper-class students is a practical and acceptable way of providing academic support to students in a large class.

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GRANTS

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