Clinically oriented physiology teaching: strategy for developing critical-thinking skills in undergraduate medical students

Reem Rachel Abraham, Subramanya Upadhyya, Sharmila Torke, and K. Ramnarayan
Melaka Manipal Medical College (Manipal Campus), International Centre for Health Sciences, Manipal 576 104, Karnataka, India
Submitted 13 January 2004; accepted in final form 25 March 2004

ABSTRACT

Clinically oriented physiology teaching (COPT) was incorporated in physiology instruction aiming to relate the study of physiology to real-life problems, to generate enthusiasm and motivation for learning, and to demonstrate the vocational relevance of physiology among students by integrating clinical experience with teaching. COPT consisted of two elements: 1) critical-thinking questions (CTQ) and 2) clinical case studies. After a few topics were taught, CTQ and case studies were given as an assignment. Answers were discussed in the next class. Two exams, each of which contained CTQ and recall questions, were conducted, one before (exam 1) and one after (exam 2) the implementation of COPT. Analysis of student performance in the examinations revealed that the students did better on exam 2 ($P < 0.0001$). Feedback from students indicated that this method was useful and challenging.

CRITICAL THINKING IS THE PROCESS of actively and skilfully applying, relating, creating, or evaluating information that one has gathered. Learning by critical thinking consists of various stages of problem-solving processes, with each stage characterized by reasoning skills (6). Developing the ability to think critically is an important element of undergraduate physiology education and is influenced by learning environment as well as by the instructor’s approach to teaching. Good critical-thinking skills are essential for life-long learning. Instead of merely providing knowledge, the medical curricula should challenge students to strive for critical scientific thinking, solving clinical problems, and communicating with the patients (12). The goals of critical thinking are to assess the credibility of information and to work through problems in the best way (7).

Medical students must use critical-thinking skills to relate basic concepts to real-life situations. In the process of becoming an expert clinician, medical undergraduates acquire knowledge not only through listening to lectures and reading recommended textbooks but also through solving scientific problems (15). Research has proven that, when used in conjunction with other teaching methods, lectures create an active learning environment (11). It was reported that medical students had difficulty not only through listening to lectures and reading recommended textbooks but also through solving scientific problems (15). Research has proven that, when used in conjunction with other teaching methods, lectures create an active learning environment (11). It was reported that medical students had difficulty

GROSSLY IMPROVED their exam performance; motivation; learning

METHODS

The undergraduate medical program at Melaka Manipal Medical College (MMMC) Manipal campus, is a five-year, intense academic program. The students are taught preclinical subjects in the first year. The first-year subjects include:- Anatomy, Physiology, and Biochemistry. This study was conducted at the department of Physiology, MMMC, Manipal campus. The first-year curriculum is divided into four blocks as follows:

- Block 1: basic concepts, blood and nerve-muscle physiology
- Block 2: cardiovascular, respiratory, and gastrointestinal physiology
- Block 3: endocrine, reproductive, and renal physiology
- Block 4: central nervous system and special senses

COPT was incorporated in the third block to a class of 136 students. After basic concepts in each system were introduced, students were administered critical-thinking questions (CTQ) and clinical case studies. Case studies were followed by a series of questions, and requests for rationale were given as student assignments. The answers were discussed in the next class. Any misconceptions and doubts were clarified during classroom discussions. This was continued until the end of the block. Two examinations were conducted, one before the incorporation of COPT (exam 1) and one after (exam 2). The examination pattern consisted of CTQ and recall type of questions, both having equal scores. The students’ scores on recall questions and CTQ were determined in both examinations. Also, feedback containing nine items on the Likert scale, from Strongly Agree to Strongly Disagree, were collected from the students. Students were asked to indicate their responses in the appropriate column as shown in Table 1.
Table 1. Students’ feedback on COPT

<table>
<thead>
<tr>
<th>Items</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Uncertain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It motivates me to learn physiology</td>
<td>39</td>
<td>85</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2. It promotes better understanding of the subject matter</td>
<td>52</td>
<td>77</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3. It helps me gain in-depth knowledge about the subject</td>
<td>78</td>
<td>58</td>
<td>6</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4. CTQ helps reduce my misconceptions about the topic</td>
<td>49</td>
<td>71</td>
<td>13</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5. CTQ stimulates my thinking</td>
<td>74</td>
<td>57</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6. CTQ improves my reasoning skills</td>
<td>69</td>
<td>62</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7. This type of teaching helps me relate physiological principles to real-life situations</td>
<td>69</td>
<td>62</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8. I think CTQ and case studies should be included in physiology curriculum</td>
<td>63</td>
<td>55</td>
<td>10</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>9. I prefer this type of teaching to didactic lectures</td>
<td>46</td>
<td>60</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
</tbody>
</table>

COPT, clinically oriented physiology teaching; CTQ, critical-thinking questions.

RESULTS

All scores are expressed as mean percentages. The percentage mean score obtained by the entire class for both recall questions and CTQ in exam 1 and exam 2 are shown in Fig. 1. Statistical analysis was done by comparing the scores of recall questions and CTQ in exam 1 and exam 2 with the Mann-Whitney test. When compared with exam 1, the mean percentage score was increased from 38 to 50% for recall questions and from 33 to 38% for CTQ in exam 2. It was observed that the students’ scores were highly significant in exam 2 compared with those in exam 1 ($P < 0.0001$) in the case of both recall questions and CTQ. Students showed better performance in exam 2 than in exam 1. Even though the percentage mean score was more for recall questions than for CTQ in both exams, a significant increase in the mean percentage score was observed in CTQ between the two exams. A majority of the students felt that CTQ enhance their reasoning skills and remove their misconceptions about a topic.

DISCUSSION

To emphasize the role of understanding and critical thinking in undergraduate medical education, several new methods in teaching and evaluation have been recommended. In this study, we introduced a teaching methodology that was useful for enhancing critical-thinking skills of students. Our results specifically document that the students performed better after implementation of COPT.

The significantly increased performance of CTQ in exam 2 over that in exam 1 may be due to the demand of a greater understanding of the subject matter by the students. Students were informed at the beginning of the block about the testing pattern. Anticipation that a test will require a greater degree of understanding may have changed the students’ intention from memorization to understanding the subject matter. Both examinations engaged the students in active thinking, and COPT promoted active learning in the students.

Knowledge without the ability to apply it is rightly seen as a very poor commodity (5). The concept of problem solving to teaching is not new in education in general or in medical education in particular. Problem solving in medicine generally refers to the ability to use clinical reasoning skills (15). According to De Bono (4), thinking is a skill and therefore teachable. Brookfield (2) characterized critical thinking as a lived activity. Sackett et al. (14) started to teach critical appraisal skills at MacMaster University. COPT tries to create a deep approach in the students as it requires a deep understanding of the subject matter. Research has proved that students who spend more time in independent study tend to adopt a deep approach (16). The assignments administered to the students require them to spend more time in independent study as they require them to study beyond the learning issues (9). During COPT, students are taught to relate basic concepts to everyday experience and to relate evidence to conclusions. These are the features of the deep approach (3).

The instructor also plays a pivotal role in cultivating critical-thinking skills (10). Effective teachers facilitate the development of critical-thinking skills when they implement learning activities that have authentic, real-world contexts and personal relevance to the students. Additionally, well-designed, open-ended questions and investigative activities by the instructor facilitate critical thinking. Instructors promote critical thinking when they pose questions that require explanatory answers that demand that students think before they respond (1). Clinical case studies reflect real-life situations and, hence, promote problem solving in an effective manner (18).

COPT has tried to create an intrinsic motivation in the students for learning. This concept and our results were supported by Seale et al. (8), who reported that assessment had the potential to motivate students and thus influence their learning. Studies have suggested that intrinsic motivation is created when the relevance of the subject matter is the primary driving force.

![Mean scores for Exam 1 and Exam 2](http://advan.physiology.org/)

FIG. 1. Mean percentage scores ($\pm SE$) for recall questions and critical-thinking questions (CTQ) in exam 1 and exam 2. $P < 0.0001$ for recall between exam 1 and exam 2. $P < 0.0001$ for CTQ between exam 1 and exam 2.
force (8). This was made clear to the students when they had to work through the case studies and CTQ.

COPT was well received by the students. The students’ attitude toward medical knowledge had changed, and they reported an increase in their critical-appraisal skills. COPT served as a stimulus for critical-thinking insights. Many students realized the relevance of physiology in medicine and that it was related to and dependent on the context where it was applied. They started thinking of the rapid turnover of information in medicine and the need for lifelong learning. With the incorporation of COPT, learning is facilitated by allowing learning to take place in meaningful contexts by activating prior knowledge and by requiring the students to be actively engaged in the learning process.

REFERENCES