COLLABORATIVE TESTING ENHANCES STUDENT LEARNING

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Examinations and quizzes should be used as learning as well as assessment tools. To achieve this goal, an assessment procedure was developed to enhance as well as assess student learning. Students were tested on four different topics of cardiovascular physiology. Each topic was tested by a different type of quiz (fill in the blanks, single best response multiple choice, short essay, or true/false). The students first completed a quiz individually. Once the quiz was completed individually, the students completed the same quiz in groups. Eighty percent of the score on the quiz was based on the individual results, and 20% of the score on the quiz was based on the group results. The performance on the quizzes was significantly higher ($P < 0.001$) when students completed the quizzes in groups than when they completed the quizzes individually. Results document that completing the quizzes in groups enhances the understanding of the material. In addition, students rated this format superior to the traditional method.

Assessment is the process of collecting information about the quality and quantity of change in a student or group. The parameters assessed can be academic learning, reasoning, skills and competencies, attitude, and work habits. As technology in education evolves to emphasize more cognitive learning, the time devoted to assessment and the research on assessment will become increasingly important (4).

Quizzes and examinations are the most common methods of assessing achievement and assigning grades. Quizzes have several advantages. For example, quizzes facilitate the assessment of learning in a large number of students over a short period of time and over an extensive field of knowledge. Quiz results also provide an account of the quality of teaching (3). There are, however, several disadvantages. For example, feedback from quizzes is delayed and often insufficient. Therefore, the pedagogical value of quizzes is generally low, and the students are often unclear about the correct answer and whether the thought process behind the answer was adequate (6).

The pedagogical value of a quiz should emphasize its instructional merit for both the students and the teacher. Educators often view quizzes simply as a basis for grades. Too often, little emphasis is placed on using quizzes to help teachers teach and students learn. However, quizzes are not only a grading device but also a teaching technique (12). For educators, the process of constructing quizzes helps in putting the course in perspective. Quizzes also provide feedback regarding what students have and have not learned. For students, quizzes provide an opportunity to demonstrate what they have learned and to discover the scope and depth of their knowledge. However, some of the pedagogical value of quizzes is lost due to a lack of immediate feedback. It would be educationally sound for students to discuss the individual questions immediately after completing the quiz. Unfortunately,
minimal feedback characterizes university teaching, especially in large classes (6).

The pedagogical value of quizzes is also reduced because students usually complete the quiz individually. Hence, the focus is on teacher-to-student transfer of learning. In this setting, students work in isolation from classmates and are given individual achievement tests to assess their level of learning. Conversely, group learning settings are superior for student-to-student transfer of knowledge (10, 13). Furthermore, “unassisted” student learning is pedagogically un-sound, since all school learning is assisted and promoted by the instructional efforts of a wide variety of individuals within and outside the school (8). Thus cooperative learning opportunities should enhance understanding.

When students learn with others, they have the emotional and intellectual support that allows them to go beyond their present knowledge and skills and accomplish shared goals (17). In the cooperative learning setting, students become more engaged in learning by discussing material, facilitating understanding, and encouraging hard work. Thus cooperative learning enhances the students’ understanding and ability to synthesize and integrate material (13, 14). In addition, cooperative learning has positive effects on race relations, self-esteem, and a willingness to cooperate in other settings (18).

The effect of cooperative learning on student performance on examinations has been investigated (5). In general, results document that understanding of the material is increased when students complete examinations in groups. Because of these studies, we were interested in using quizzes as a learning tool as well as an assessment tool. We hypothesized that cooperative learning and immediate feedback would enhance students’ understanding of the material. That is, by providing an opportunity to discuss concepts during the quiz, the understanding of the material would increase.

To test this hypothesis, we developed a procedure designed to enhance as well as assess student learning. Specifically, the students first completed a quiz individually. Once the quiz was completed, the students completed the same quiz in groups. Eighty percent of the final score was based on the individual results, and 20% of the final score was based on the group results.

METHODS

Post-Baccalaureate Program. The Post-Baccalaureate Program at Wayne State University School of Medicine is a structured, 10-month (September-July), intense academic program. The program identifies students from underrepresented backgrounds (racial, socioeconomic, and rural) who had originally applied to the medical program but were not selected by the school’s admission committee. These students, however, have shown potential to succeed in medical school.

The program is designed to help students improve their scientific knowledge, academic skills, and personal adjustment. Efforts to improve students’ scientific knowledge involve three basic components: 1) structured courses, 2) subject supplements, and 3) Kaplan Preparation for the MCAT.

Structured course work involves six different subjects: biochemistry, chemistry, embryology, histology, gross anatomy, and physiology. Courses were evenly distributed among three semesters: fall (chemistry and histology), winter (biochemistry and embryology), and spring-summer (gross anatomy and physiology). Gross anatomy and physiology were 6- and 8-week courses, respectively.

The cardiovascular component of the physiology course, presented to 16 postbaccalaureate students, consisted of 14 classes of one hour each. Six different topics were presented (blood vessels, blood pressure, blood flow regulation, microcirculation, cardiovascular reflexes, and cardiovascular integration). Students had four quizzes on the first four topics. They also had an examination at the end on the six topics.

Examination methods. Four different methods of examination were employed for the four quizzes. The first quiz, on blood vessels, consisted of 30 fill-in-the-blank questions; the second quiz, on blood pressure, consisted of 30 single-best-response multiple-choice questions; the third quiz, on blood flow regulation, consisted of 9 short essay questions; the fourth quiz,
on microcirculation, consisted of 30 true/false statements.

The students first completed a quiz individually. Once the quiz was completed individually, the students completed the same quiz in groups. Specifically, students completed the quiz individually for the first 30 minutes. Immediately after completing the quiz individually, the students were assigned to a group of two or three, and the students worked as a team to answer the original questions. Eighty percent of the final quiz score was based on the individual results, and 20% of the final quiz score was based on the group results.

**Data analysis.** The students’ individual and group scores on each quiz were determined. Specifically, the mean percentage ± SE of correct answers on each quiz was calculated for both the individual and group performances. The individual and group scores were compared, when the scores for all types of quizzes were combined, using a Student’s paired t-test (Fig. 1A). A two-way analysis of variance (ANOVA) was used to evaluate differences between the individual and group scores on the four different quizzes (Fig. 1B).

**RESULTS**

All data are expressed as means ± SE. Figure 1A presents the percentage of correct answers for the individual and group performances when the four different quizzes (fill in the blanks, single best response multiple choice, short essay, and true/false) were combined. A Student’s t-test revealed that the group scores were significantly higher than the individual scores (\( *P < 0.001 \)). Specifically, the percentage of correct answers when students completed the quizzes in groups (89 ± 1%) was higher than when the students completed the quizzes individually (83 ± 1%).

Figure 1B presents the results for the individual quizzes when students completed the quizzes individually and in groups. The two-way ANOVA revealed a significant group effect (individual vs. group scores, \( *P < 0.001 \)). Thus the students performed higher for each type of quiz when they worked in groups. Specifically, the percentage of correct answers increased from 82 ± 2 to 88 ± 2 for the fill-in-the-blanks quiz, 90 ± 2 to 96 ± 1 for the single-best-response multiple-choice quiz, 77 ± 1 to 82 ± 1 for the short essay quiz, and 84 ± 2 to 90 ± 2 for the true/false quiz.

**DISCUSSION**

In this study, we introduced an assessment procedure that was useful for enhancing as well as assessing student learning. Specifically, results document that performance on all major types of quizzes (single best response multiple choice, short essay, true/false, and fill in the blanks) was significantly higher when students completed the same quizzes in groups than when they completed the quizzes individually. Interestingly, the increase in group test scores was virtually identical (6%, Fig. 1) for all types of quizzes. The 6% increase was less than expected but greater than that reported for other disciplines (11, 16). At this point, we have no concrete idea as to why test scores did not improve more dramatically. However, the higher performance for the group effort supports the concept that cooperative learning facilitates student learning (13).

The increased performance by the group may be due to a superior understanding of the material. With cooperative learning, students facilitate individual success by working together to solve problems and find solutions. Cooperative interactions promote the exchange of ideas, which enhances connections between present and past learning. When students disagree over answers, the issue must be resolved by group consensus and understanding of the concept. This can be a difficult process, because students must be convinced of an answer they disagree with. These concepts and our results are supported by Hendrickson and colleagues (5), who reported that students’ performance is higher when examinations are completed by teams of two than when they are completed individually. The authors suggested that, by discussing each quiz item, students develop a better understanding of the material and in the process gain more self-confidence. Studies have also shown that groups are more than the sum of their parts and students perform higher academically when they work in groups (8).

Cooperative learning has the additional advantage that students learn academic subject matter (task work) as well as the interpersonal and group skills required to work together effectively (teamwork). Students must...
engage in task work and teamwork simultaneously. Hence, group members learn to provide effective leadership, enhance communication skills, and work toward building trust and conflict management (8). This is important because employment opportunities in the future will require employees to work cooperatively to solve problems and develop solutions. Cooperative compared with individual efforts result in higher

![Bar chart showing percentage of correct answers for individual vs. group performances when the 4 different quizzes (fill in the blanks, single best response multiple choice, short essay, and true/false) were combined. A Student’s t-test revealed that the group scores were significantly higher than the individual scores (*P < 0.001). Specifically, the percentage of correct answers when students completed the quizzes in groups (89 ± 1%) was higher than when the students completed the quizzes individually (83 ± 1%). B: results for the individual quizzes when students completed the quizzes individually and in groups. A two-way ANOVA revealed a significant group effect (individual vs. group scores, *P < 0.001). Thus the students performed higher for each type of quiz when they worked in groups. Specifically, the percentage of correct answers increased from 82 ± 2 to 88 ± 2 for the fill-in-the-blanks quiz, 90 ± 2 to 96 ± 1 for the single best response multiple choice quiz, 77 ± 1 to 82 ± 1 for the essay quiz, and 84 ± 2 to 90 ± 2 for the true/false quiz.]

**FIG. 1.**

A: means ± SE of the percentage of correct answers for the individual and group performances when the 4 different quizzes (fill in the blanks, single best response multiple choice, short essay, and true/false) were combined. A Student’s t-test revealed that the group scores were significantly higher than the individual scores (*P < 0.001). Specifically, the percentage of correct answers when students completed the quizzes in groups (89 ± 1%) was higher than when the students completed the quizzes individually (83 ± 1%). B: results for the individual quizzes when students completed the quizzes individually and in groups. A two-way ANOVA revealed a significant group effect (individual vs. group scores, *P < 0.001). Thus the students performed higher for each type of quiz when they worked in groups. Specifically, the percentage of correct answers increased from 82 ± 2 to 88 ± 2 for the fill-in-the-blanks quiz, 90 ± 2 to 96 ± 1 for the single best response multiple choice quiz, 77 ± 1 to 82 ± 1 for the essay quiz, and 84 ± 2 to 90 ± 2 for the true/false quiz.
achievement, more positive relationships among students and between students and faculty, more positive psychological well-being, and a more constructive classroom learning environment (8).

Some educators may be concerned that less-prepared students will be “carried” by the more industrious ones. This concern may be alleviated by randomly selecting and alternating the group members so that patterns do not develop. However, dividing the class into groups may require forethought. For example, research suggests that group size, abilities, race, sex, and previous experiences can be critical for group success (15). The ideal group size varies with the nature of the task or problem and class size (1, 2, 7, 15). For collaborative testing with a small class, two to three members may be appropriate; for large classes, three to four members may be better. In either case, the idea is to be sure that each group has the academic and creative abilities to complete the task (2). In addition, 80% of the score on the quiz was based on the individual results, and only 20% of the score on the quiz was based on the group results. Finally, current evidence suggests that students feel a responsibility for the group’s success, and group members tend to ensure that everyone is doing their share (12). Therefore, it is unlikely that students will be carried along in the process.

When students complete a quiz individually, questions can arise in the students’ mind regarding whether the thinking behind the answer was correct (9). However, with group quizzes, students have the opportunity to discuss their reasoning for an answer as well as receive immediate feedback on their performance. Group quizzes provide the opportunity to discuss incorrect answers and fill in knowledge gaps and therefore improve understanding of the material. This feedback is very important for learning, especially in large classes.

Students rated this format (individual followed by group performance) superior to the traditional method. Students reported that the group efforts promoted an understanding of the material as well as providing an opportunity to improve their scores. Students also reported that they did not mind the additional time required to complete both the individual and group efforts.

In conclusion, conducting the quiz in groups immediately after the individual quiz enhances students’ understanding of the material (Fig. 1). In addition, this approach provides students with immediate feedback which is an important component for understanding. Finally, cooperative learning may result in higher academic achievement, more positive relationships among students, more positive psychological well-being, and a more constructive classroom environment.

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