COOPERATIVE LEARNING - PART I

Cooperative Quizzes

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When instructors hear the phrase "cooperative quiz," many word-associations come to mind: cheating, freeloading, easy points, etc. If structured correctly, however, cooperative quizzes can serve three important functions: 1) they can facilitate a greater understanding of the subject (e.g., genetics, anatomy and physiology, etc.), 2) they can promote better test-taking skills, and 3) they can be used as a mechanism to foster cooperative groups. The benefits of cooperative learning are well documented (Lord 2001; Johnson & Johnson 1989; Slavin 1991) but most instructors are reluctant to use it as a teaching tool because it requires extra planning, it is not as easy as lecturing, and many believe that it takes time away from delivering content. Cooperative quizzes are not a reliable testing tool because they cannot accurately measure an individual's knowledge, but they are a versatile learning tool that can be used in both the lecture and lab. This paper describes the structure needed for a cooperative quiz, documents how the quizzes can be used in different settings, and compares students' performances on a group vs. individual quiz.

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Theoretical Underpinnings of Cooperative Learning

When students are required to do group work, minimal instructions are often given as to how the work is to be completed. "Work in cooperative groups on this project!" is a phrase that should be avoided in a cooperative classroom; students do not cooperate by default. Therefore, instructors who wish to promote cooperation among students must design and implement lessons with specific parameters. True cooperative groups differ from traditional/informal groups in that five conditions must be met to attain the "cooperative" title (Johnson, Johnson & Smith 1991).

1. Positive interdependence must exist among students. That is, all members of a group must be directly linked to the success or failure of their partners. For example, if one member of the group fails, then all the other members of that group suffer the consequences for that student's poor performance. Positive interdependence encourages and motivates students to monitor and assist other members of their group.
2. Each student must be ultimately responsible for his or her own learning. This condition can be met by administering tests, or other forms of

evaluation, on an individual basis after group work has been completed.

3. There must be face-to-face promotive interaction between all members of the group.
4. All students in the group must properly use interpersonal and small-group communication skills.
5. Group members must talk with each other about how well their group is operating (e.g., what actions of the group are or are not helpful in completing the activities, what processes should or should not be continued, and even the possibility of discontinuing the group if major problems exist). The simplest and most frequently used group processing activity is celebrating by high-fiving each other after a project has been completed.

These skills and processes are not part of a typical biology curriculum; that's why most science instructors refuse to mention, or implement, them in class. But for students living in a world where "The Jerry Springer Show" is wildly popular, many college students need help learning how to function effectively in a small group.

Setting the Stage for a Cooperative Quiz

Prior to implementing a cooperative quiz, the instructor must assign students to groups. Many different methods exist for grouping students (see, for example, Jensen et al. 2002; Johnson et al. 1991), but we have traditionally grouped students randomly on Day 1 to ensure heterogeneous groups. Groups initially consist of three to five students, but smaller groups are usually better than larger groups.

We use cooperative quizzes in three different settings in our anatomy and physiology course: in traditional lectures, in a computer lab, and in our dissection lab. The first quiz is given in lecture during the second week of class and covers Chapter 1 of the text (Shier et al. 2000). Students are notified of the quiz during the first class session, at which time specific directions are given as to which tables, diagrams and lists will appear on the quiz. The quiz starts with each student receiving a copy of the 20-question quiz and an answer sheet. Students are given 5 to 8 minutes to work individually on the multiple-choice quiz; most students easily complete the quiz in this time. After working individually, students move into their groups, where they are given an additional 5 to 10 minutes to compare answers and talk about how they prepared for the quiz. The goals of this quiz are two-fold: first, to introduce students to the style of questions that will be used in the course, and second, for students to begin working in their groups and begin the complex process of learning each others' personalities (e.g., Who was prepared? Who was not prepared? Who finished early? Whom do I trust?). The first quiz of the semester is not a true cooperative quiz because each student must complete an answer sheet; as a result, the students do not have a vested interest in the performance of their fellow group members (i.e., there is no positive interdependence). However, the activity does introduce the idea that students must work together on quizzes.

The second quiz of the semester is a true cooperative quiz. It covers DNA and protein synthesis. This quiz, also given in the lecture setting, establishes the format for cooperative quizzes. Students meet in their groups, where they are given one copy of the questions and one answer sheet per group. Providing only one answer sheet forces students to come to a consensus on each question. This, in turn, promotes interpersonal communication and positive interdependence between group members.

Groups are given approximately 10 minutes to complete the quiz. Many cooperative learning researchers recommend assigning roles, such as a timekeeper, fact checker, recorder, etc., but we have found that to be unnecessary. However, two bonus points are given to groups if the following two behaviors are observed:

1. If the group is sitting in such a way that all students are involved with the quiz. A common phrase in cooperative learning is "knee-to-knee and eye-to-eye," which is impossible in our lecture setting due to the chairs being bolted to the floor, but nevertheless we reward groups for being positioned in such a way that all group members can be engaged in the quiz (e.g., sitting on the floor in a circle).
2. If the following phrases are heard within the group: "What do you think?", "Are we all sure about this answer?" and "How much more time do we have?" Sometimes students will shout these phrases for comic effect, which actually improves the general tone of the classroom and helps students relax.

In the computer lab, where our anatomy and physiology course meets one-hour per week, we use a cooperative quiz to ensure that all students can perform the computer skills required in our activities. The list of skills includes, for example, copying files to a floppy disk, inserting text into a word processing document,

copying and pasting text, locating URLs on the Internet, and using a search engine. The quiz is a performance quiz in that students are required to perform specific tasks on a computer while being evaluated by the instructor. The quiz is given on an individual basis, but group scoring is used. One unique feature to the quiz is that each group can elect one member to be a coach (typically the group's most adept computer user) for the other members of the group while the quiz is in progress. The coach is allowed to verbally help the other group members during the quiz. Prior to the quiz, we use tape to bind the coach's hands; we want the coaches to provide verbal advice but do not want them to touch the keyboard or mouse. (Taping the hands of the coach is comedic in that we use just a small bit of masking tape, but the message of "don't use your hands" is conveyed very effectively.) Due to the wide range of computer skills that students possess, we try to keep this quiz informal by giving students second and third chances on many of the tasks. However, the quiz does successfully communicate what computer skills students will need to succeed in the course.

We use cooperative quizzes each week in our anatomy and physiology dissection lab. A typical activity in lab is the dissection of an eye. At the beginning of the lab, students are given a list of objectives (Figure 1) followed by a brief demonstration of the day's procedures. For most of the time in lab, students work in their groups to complete the dissection and rehearse/practice within their groups. Rehearsing involves students quizzing each other until they've mastered the objectives. When the group feels that they are ready to "test out," they call over the instructor, who then administers the cooperative quiz.

Cooperative quizzes in the lab involve a combination of individual and group questions. Individual questions are administered first and require one student to answer one question without the help of the other group members (e.g., "Mike, what is the function of the occulomotor nerve?"). Group questions require the entire group to agree on one answer for a specific question. For example, the instructor may ask while pointing to the retina, "Identify this structure," after which the group must work to provide one answer. The cooperative quizzes in lab frequently use subsets of a total list of objectives. These subsets are used to help students start learning the larger list of objectives, yet are realistic in that we do not expect our students to master large amounts of content within one two-hour lab period.

Figure 1.
Objectives used for the cooperative quiz covering the dissection of an eye.

Anatomy

All students will be able to identify the following anatomical structures found in an eye:

- aqueous humor
- choroid
- ciliary body and muscles
- cornea
- extrinsic eye muscles
- fovea centralis of macula lutea
- iris and pupil
- lens
- macula lutea
- optic disc
- optic nerve
- retina
- sclera
- vitreous humor

Physiology

All students will be able to answer the following physiology questions about the eye:

- What is the function of the occulomotor nerve?
- What is the function of the optic nerve?
- What is the function of the adipose tissue on the exterior of the eye?

Scoring criteria for group quiz.

Total of 10 questions will be asked and there are five possible points.

There will be six individual questions followed by four group questions.

8 to 10 out of 10 correct = 5 points

6 to 7 out of 10 correct = 4 points

4 to 5 out of 10 correct = 3 points

2 to 3 out of 10 correct = 2 points

Note: Every member of the group receives the same score.

Near the end of the semester we have a "final cooperative quiz" that covers all the anatomical structures discussed in the course. The major goal of this quiz is to help students begin preparing for final exams. (Note: in anatomy and physiology, a basic understanding of anatomy is frequently required before physiological concepts can be understood.) For the final cooperative quiz we first give each student one answer sheet, but let groups work together for the first half (50

questions) of the quiz. The second half of the quiz, which is analogous to the first half, is next completed on an individual basis. The reasons we have each student use one answer sheet, and also have half the quiz administered on an individual basis, are to promote individual accountability and to collect data to compare cooperative vs. individual achievement.

Grading Options

A common mistake when trying to implement cooperative learning is to assign group projects but then grade on an individual basis. If individual grading is used after a cooperative activity, then there is no reason for group members to be concerned with each other's performance and there is no positive interdependence. Some form of group grading must be used to evaluate performance on a cooperative quiz to ensure that all members are concerned with the performance of their fellow group members. Group scoring can be done a variety of ways. For example, the scoring rubric listed in Figure 1 is simple to set up and use in a lab setting. Groups that complete cooperative quizzes in lecture are given only one answer sheet, and the scoring rubric is printed on the same page as the questions (e.g., 18 to 20 questions answered correctly = 10 points, 16 to 17 = 9 points, etc.). All members of the group then receive one common score. Another option for lecture involves having each member of the group complete an answer sheet and then choose to score only one from the group at random, or maybe even choose the highest (or lowest) score and assign that grade to each member of the group.

Individual accountability is frequently a difficult criterion to meet in a cooperative learning environment. Some group members are not prepared for cooperative quizzes; others may be freeloaders on a few quizzes. However, individual accountability is easily achieved in two ways. The first, and most powerful, method is to give individual exams. In our course a student cannot pass the course if he/she maximizes all their group points, but fails the individual exams. However, many students do raise their grades (from a C+ to a B-, for example), because of group work. The second mechanism to ensure individual accountability involves using individual questions during cooperative quizzes when possible.

Philosophy

Cooperative quizzes, and cooperative learning in general, work best in an informal, friendly atmosphere in the classroom and lab. If students are afraid of losing points, afraid of making a mistake, afraid of saying something stupid, afraid of the instructor, afraid of their fellow students, etc., then cooperative quizzes will not work. Cooperative quizzes must be a positive event: students must know that if they are prepared, and perform at a reasonable level, they will be rewarded. Teachers must also recognize that some groups are better than others, and some people get stuck with lousy groups. Because of this we offer "bonus points"

Table 1.
The five elements of cooperative learning and how they are achieved in our class.

Cooperative Element	Description	Implementation in Our Course
Positive Interdependence	Group members are concerned for the learning and performance of their fellow group members.	Group grading: All members of a group receive the same grade on a cooperative quiz.
Individual Accountability	Each individual must ultimately be responsible for his/her own learning.	Using individual questions within cooperative quizzes, such as in the laboratory. Also, the use of larger individual exams.
Face-to-Face Interaction	Knee-to-knee and eye-to-eye.	Students must arrange themselves so that all members can see each other. Never sit 3 or 4 people in a row. Think circular, not lines.
Small-Group Skills	Learn how to work in a team.	Bonus points for key phrases such as "what do you think," "are we all sure about this answer," etc.
Group Processing	Talking about how your group functioned, both positive and negative events, after completing an activity.	Most common is group celebration after completing a quiz. High-five! Also, list things we did well, list things we did not do well, and discuss how can we improve.

for outstanding group members. We award bonus points for doing something good, as opposed to taking away points for not being a productive group member. The use of bonus points further facilitates the overall positive tone of the course. In addition, we also switch groups after the midterm exam (approximately Week 8) to give students a chance to work with a new group.

At the beginning of the semester we typically use short lists of objectives and implement easy cooperative quizzes; most groups receive all the points possible and many even receive bonus points. As the semester continues and group dynamics mature, the difficulty of the quizzes increases and we expect improved academic performance from the groups. We frequently tell our students that the cooperative quizzes represent the easiest points of the course, but the intent of the cooperative activities is to help them learn the course material and begin preparing for larger individual exams.

Comparisons of Individual vs. Cooperative Quiz Scores

Data were collected and analyzed for the final cooperative quiz for four different sections of our anatomy and physiology course. A total of 406 students took the quiz which contained 50 group questions and 50 analogous, individual questions. Students performed significantly better on the cooperative portion of that quiz than on the individual component (Table 2a). On average, cooperative scores were 4.9 points better (out of 50) than the individual portion of the test (Table 2b). Only 10% of the students scored worse on the cooperative portion of the quiz than on the individual portion, meaning that very few students are penalized by the cooperative work. Data here also indicate that group quizzes are not an accurate indication of individual assessment because group performance is significantly better than individual performance.

Conclusions

Hundreds of research studies have documented the effectiveness of cooperative learning in areas such as student retention, attitudes towards science, and critical thinking (Johnson & Johnson 1989; Lord 2001; Slavin 1991). However, many science instructors feel that the use of cooperative learning during quizzes and other assessments leads to invalid measures of students' knowledge and promotes grade inflation. Indeed, our data support the claim that students do better on cooperative quizzes than on quizzes completed on an individual basis. However, we have found that the combination of small cooperative quizzes, and larger individual exams produces an academic environment that is rigorous and which contains many of

Table 2a.
Comparisons of cooperative vs. individual performances.

		Cooperative		Individual	
Term	n	Mean	Std. Dev.	Mean	Std. Dev.
Fall 99	91	46.8	2.3	44.4	5.7
Spring 00	148	47.5	2.3	42.2	4.8
Fall 00 - 1	137	47.7	2.2	42.1	4.7
Fall 00 - 2	30	47.8	2.3	41.3	5.9
Totals	406	47.5	2.5	42.6	4.8

(T-value = 20.3, p <0.0001, d.f. = 405)

Table 2b.
Comparison of cooperative vs. individual performances.
Difference Range (Cooperative Score — Individual Score)

Term	n	-6 or less	-5 to -1	0 to 5	6 to 10	11 to 15	16 or higher
Fall 99	91	2	20	47	19	2	1
Spring 00	148	0	10	84	37	8	9
Fall 00 - 1	137	0	8	73	40	10	6
Fall 00 - 2	30	0	1	16	6	5	2
Totals	406	2	39	220	102	25	18
%	100%	0.5%	9.6%	54.2%	25.1%	6.2%	4.4%

Mean Difference = 4.9, Std. Dev. = 4.9

Note: Negative scores indicate that a student performed better on the individual portion of the quiz whereas positive scores indicate better performance on the cooperative portion.

the positive outcomes of a cooperative classroom (e.g., increased student-student interactions, increased student-teacher interactions, etc.).

Some science instructors take pride in the severity of their biology courses and use exams and quizzes to show students just how difficult biology can be. This philosophy is not consistent with good teaching or the use of cooperative quizzes. Instructors who use cooperative quizzes, and cooperative learning in general, must be open to ideas such as bonus points, students talking in class, unconventional assessments, and many other nontraditional classroom activities. The early stages of using cooperative learning are frequently difficult; there will be frustrating days when the effort required to design and implement cooperative learning does not seem worthwhile and the temptation to revert to traditional teaching methods, most notably lecture, will be strong. However, as teachers become increasingly adept with cooperative quizzes, they also become more efficient and effective at facilitating student learning.

There are many ways to incorporate cooperative learning into a biology course. Some cooperative lessons require large amounts of preparation and lead to frustration by instructors and students, especially when both are learning how to use and structure cooperative groups. However, we have found cooperative quizzes to be the simplest, and quickest, mechanisms to stimulate a cooperative classroom.

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