

# Cooperative and Active Learning in Undergraduate Biological Laboratories at FIU-- Implications to TA Teaching and Training

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**Abstract:** There were several changes in the laboratory teaching program in the Biological Sciences at Florida International University (FIU) between 1993-1994. The underlying goal was the improvement of the amount of material learned and retained by the student, but these changes showed little positive improvement. It was deemed necessary for FIU to incorporate a completely different, well-researched approach. At the time of these implemented changes, it became apparent that Teaching Assistant (TA) training and development necessitated a restructuring that would involve the instructor on a more cognitive and interactive level with the students. Therefore, the goal for FIU was to prepare the TAs with a general pedagogical construct that would require a higher level of instructional and collaborative training in order to help improve student learning and retention of materials presented in the laboratory teaching program. The five basic constructs of cooperative learning were employed and the results proved to be of significant benefit to both the TAs and the students in their classes.

**Key words:** cooperative learning, active learning, positive interdependence, individual accountability, face-to-face promotive interaction, collaborative skills, group processing laboratory instruction, biology

## INTRODUCTION

Cooperative Learning (CL), a pedagogy that has been used extensively in various settings in higher education, has demonstrated its value in learning and retention (Angelo and Cross, 1993; Astin, 1993; Cooper et al., 1990; Goodsell et al., 1992; Johnson et al., 1991; McKeachie, 1986). CL is instruction that involves students working in teams to accomplish a common goal (Johnson et al., 1991). The CL method was utilized by FIU in training TAs in order to help improve student learning and retention.

### The Basic Elements of Cooperative Learning

Cooperative Learning is more than group work or group assignments. There are five basic constructs that are important foundational elements to consider when developing this pedagogy (Felder and Brent, 1994; Cooper, 1990). The first basic element of cooperative

learning is positive interdependence. This occurs when there are mutual goals, joint rewards, shared resources, and assigned roles. The second basic element of cooperative learning is face-to-face promotive interaction among students. This interaction exists when group members communicate their ideas to one another in order to learn and accomplish a task (Johnson et al., 1991). The third basic element of cooperative learning is individual and group accountability. Two levels of accountability must be structured into cooperative lessons. The group must be accountable for achieving its goals—this accountability is accomplished by having a small fraction (5-10%) of the overall average based upon group performance. Each member is accountable for his or her share of the work. Individual accountability is more important in the assessment of grades and is responsible for the remaining percentage of students' grades after any

"group" grade has been factored in (usually 90-95%). Usually, there is only a group portion to students' grades as a bonus. For example, if all members of a group get an "A" on a quiz, all members of that group get five bonus points added to their quiz grade as a reward for functioning well as a group. The fourth element of cooperative learning is interpersonal and small group skills. Groups cannot function properly if students do not use the required leadership, decision-making, trust building, communication, and conflict-management skills. The fifth basic element of cooperative learning is group processing. Group processing exists when group members analyze their performance in achieving goals and maintain effective cooperative relationships.

### **The Importance of Groups and Roles**

Group functioning is an essential and natural element of the college laboratory experience. Cooperative Learning maximizes group learning benefits by ensuring that students function in a face-to-face promotive environment to achieve certain goals. Although no system is foolproof, the groups formed use principles deemed apt in decreasing the chances of negative group interactions. The main principle is to ensure a diversity of backgrounds in the group, be it cultural, ethnic, academic, or breadth of experience (Johnson et al., 1991).

It is helpful to have students initially fill out 3x5 cards with some basic background information including name, age, sex, major (if applicable), year in college, ethnic origin, and their personal strengths so the instructor can determine group constituency in the following meeting. There should never be only one female in a group, all females, or no females. Studies have shown that women's ideas and contributions are often devalued or discounted in mixed gender teams, and the women take passive roles in group interactions, to their detriment (Felder et al., 1994; Heller and Hollabaugh, 1992). The same rule applies to minority students (Felder et al., 1994; Heller and Hollabaugh, 1992).

Groups should be designed to be as heterogeneous as possible without placing one female or one minority student in a group. Students should not be grouped with their friends because past experience has shown that prior friendships detract from overall positive interaction. Once groups are assigned, the other critical step is to define and assign roles. It is also helpful to change roles periodically to help keep all students actively engaged.

### **TA Training Prior to the Implementation of CL**

Prior to the implementation of cooperative learning at FIU, the training of teaching assistants involved weekly lab meetings. During those meetings, the TA coordinator would go over key issues regarding what was planned for teaching that week. Teaching

assistants with no prior teaching experience had an opportunity to ask questions during that time. These questions focused on the material to be covered rather than on how to teach that material; this was due to the fact that most new teaching assistants have little confidence in their laboratory teaching ability.

### **Implementation of CL into TA Training**

In 1995 CL and Active Learning (AL) techniques were incorporated in the laboratory instruction curriculum of the Biology department at Florida International University by a few volunteer TAs (Angelo and Cross, 1993). Initially, only some CL exercises were intermixed with traditional lecture format. Students responded positively to the TAs who were providing a change of pace from teaching their labs through lecture alone to actively involving their students through the use of CL. Students enjoyed labs more and began to see a connection between their labs and the lecture course. Therefore, it became apparent that the department could no longer justify standing in front of the TAs and lecturing about teaching, safety, or anything else in the traditional paradigm if students preferred and learned more in an interactive and cooperative environment.

In 1996 the department began using CL and AL techniques in the actual training of TAs. For the first time at FIU, all TAs were required to attend a two day training workshop. During this workshop, the TAs were taught about teaching techniques such as active and cooperative learning. The TAs were taught the techniques of CL by experiencing CL themselves. For example, the TAs filled out 3X5 note cards, which were used to place them into CL groups. They were assigned group roles and completed tasks just as they would have their students do. The results of the entire process were extremely helpful for all involved. The training helped the TAs understand how they were expected to conduct their labs as well as created a support system for the new TAs.

TAs were taught how to assess individuals and groups by making and administering quizzes and practicing questioning before being allowed to move to the next task, checking assigned work. In their training, TAs practiced doing "one-minute-papers" after the completion of each task or section. The point was to examine the use of group processing to maintain the skills necessary to keep the group functioning properly. The "one-minute-papers" allow students to express their feelings about what they learned, including the "muddiest point," and to comment about the functioning of their group.

### **Incorporating CL into Teaching Biology Labs**

At FIU four roles are defined that have been helpful in teaching in biological laboratories. Other types of laboratories may want to define their own according to context. The "Recorder-Checker" is

responsible for ensuring that the data from all experiments performed in lab are recorded, that any drawings, sketches, graphs and/or tables are made and that the questions in the lab manual pertaining to that week's lab are answered. The "Protocol Manager" ensures that everyone is following the tasks step-by-step, and that everyone in the group can relate what they are learning to the questions in the lab manual and to those given by the instructor. The "Maintenance Manager" ensures that the supplies and equipment needed for the lab are in place to perform the tasks, the group is practicing good lab hygiene, and the group is functioning in a cooperative manner. The "Encourager" motivates the group to begin, continue, and finish each task, ensures that the group can relate the procedures of the tasks to the objectives of the lab, assists the group with seeing the "big picture" (tying previous lab concepts to the present), and determines that the group has performed all tasks completely and correctly.

Assigning roles is especially important from a standpoint of student empowerment in a laboratory classroom. For both science and non-science majors, the first college laboratory experience can be overwhelming and discouraging. There are procedures to follow, microscopes to set up, chemicals to mix, samples to prepare, and many other tasks to perform, while continuously answering questions. In a two-person interaction, communication about respective responsibilities is fairly simple (i.e. You do this and I will do that). In a group of three or four, however, the dynamics change and having more people to do the work only increases the stress level due to the additional task of organizing the responsibilities of several people. Defining and assigning the four roles from day one minimizes this stress and allows even otherwise reticent students to take ownership in accomplishing tasks at hand.

Although roles can be very useful, there are several pitfalls to avoid. The first is that students may focus on their roles too much and forget that the goal is for everyone to get an overall understanding of what is happening in the lab. It is important to stress to students that having assigned roles does not mean they have no responsibilities beyond their own roles. It is in students' interest to ensure that the duties of each student's role are being carried out, because, in doing so, they increase their own potential (Johnson et. al., 1991). Notice that the duties assigned to each task begin with "ensuring." In other words, students must ensure that the duties assigned to their roles are performed; they do not necessarily need to have to do the tasks themselves. Students are told that it is every group member's responsibility to make sure that all members of the group keep up with the material and perform their tasks and roles. Students need to be reminded that they are interdependent and will benefit from helping each other. Certain roles require more

work; therefore, it may be necessary, or desirable, to ask another individual for help. As with all aspects of the laboratory environment, students need to be carefully monitored and guided, especially at first, as they learn to work cooperatively.

An important role for the laboratory instructors using CL is to monitor and evaluate group functioning (Johnson, et. al., 1991). A great tool is associating a "thought" question with each task. Pro-actively, the TAs can pick any group member and ask a higher-order or methodology question and then evaluate each response. In doing so, they determine if the students are cognizant of the information and are functioning as cooperative groups. If instructors desire specifically to evaluate roles, they might ask a group member what has been done or is being done to fulfill his/her role. They might also ask one group member what another group member has done to fulfill her or his specifically assigned role.

The performance of each individual is assessed independently by quizzes and lab practicals, and the results are returned to the individual in order to ascertain who needs more assistance, support, and encouragement in learning. Our goal with CL is to improve the performance of the individual.

Individuals (independently and secretly--from the other members of the group) need to describe which actions of the members are helpful and detrimental. The instructor uses this information to implement strategies and make decisions about which behaviors to continue or change. Assessment of group processing skills is accomplished by having students write their analysis of their group's functioning in a "one-minute-paper" that is filled-out and returned at the end of every laboratory period. The instructor uses this information to decide which functioning skills and behaviors require modification and which are being used adequately.

In order to incorporate these roles into biology laboratories at FIU, TAs needed to be trained to implement these roles themselves. The initial training was carried out during the 2 day training workshop of TAs. During that workshop, TAs were assigned group roles as part of their training providing them with a sense of what implementation those roles would be like for the students. The roles of "Recorder-Checker", "Protocol Manager", "Maintenance Manager", and "Encourager" were discussed previously. Additional training of the TAs was provided during the weekly lab meeting held for individual lab exercises. TAs were required to carry out lab procedures in a group setting similar to what their students would be expected to do.

## CONCLUSIONS

The results of using Cooperative Learning in teaching and training in the Biology Department at FIU have been very positive. Responses from instructors indicate that students are more engaged and participatory in the learning process. There has been

an increase in the cognitive level of the material communicated, learned, and assessed by the students. Students have shown an increase in their ability to devise and practice scientific experimentation. Critical thinking skills have improved. TAs find that teaching and feedback are more rewarding. The failure rate has dropped and grade averages have improved. TA evaluations have also improved dramatically.

The TA's responses to being trained in a cooperative and active format have been very favorable. They are better prepared to perform CL than if it were simply explained to them. They also fare better at learning and retaining the information that is covered in orientation. Much less repeating of concepts and information throughout the semester is necessary, allowing for more material to be covered in greater detail. A more enthusiastic and well-prepared teaching staff is another positive outcome of TA training with CL and AL. The general feeling among the TAs is that there is much more collaboration, mentoring, and assistance, which makes for a positive attitude in the laboratory.

The implementation of CL into biology laboratories not only enhanced the overall lab experience, but especially helped shy and quiet students or students from minority groups to fit in with the rest of the students in lab. The students became highly invested in their groups and their group roles.

For example, many students began to work outside of class in their CL groups. They studied together for lab and lecture exams as well as for other course exams. They valued working together as a team to help each other learn. The students wanted to have their professors incorporate CL into their lecture classes. Students expressed that labs were more fun, that the biological concepts made more sense, and that they worked harder because they not only wanted to learn, but they wanted all of their group members to learn too.

In essence, training the TAs at FIU in CL and AL techniques and then implementing these practices in the laboratory environment helped to accomplish FIU's ultimate goal of improved learning and retention by biological laboratory students. FIU has continued with these practices and continues to see positive learning and retention gains for TAs and students alike. Whereas new TAs benefit greatly from using CL in biological laboratories at FIU, implementing CL has also had an impact on TAs with previous teaching experience. CL has made labs more organized and students more engaged in the material covered. Using CL during students' first college lab experience, allows them to experience science as scientists (working cooperatively), while at the same time making labs more meaningful and enjoyable, which allows students to continue to be successful in future lab experiences.

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