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COOPERATIVE LEARNING IN SIMULATION

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ABSTRACT

Traditionally, class periods have meant that students listen to a professor lecture for about an hour. Cooperative learning can replace some of that lecture time with methods designed to get students actively involved during the class period. In this article, I highlight some methods of cooperative learning and suggest ways of integrating it into simulation study. Detailed examples are given on cooperative learning in a simulation course where GPSS/H is used for simulation modeling. Student feedback and results using the new methods are briefly discussed.

1 INTRODUCTION

In the typical college classroom it is likely that the professor is most actively engaged during the class time because she is walking about, expressing ideas in her own words, organizing, justifying, elaborating, and asking questions. The principles of *cooperative learning* (CL) are designed to get the student involved transferring some of these activities to the them. Cooperative learning strategies are designed to motivate the students' interest and help their retention of key ideas by encouraging them to participate in discussions.

Much of the literature on CL strategies and benefits focuses on non-engineering courses (see e.g., Brufee (1993), Sharan (1990), and Slavin (1993)). Mourtos (1997) and Smith and Waller (1995) have written on the subject for technical courses. In this article, I highlight a technique that has students work together in small informal groups throughout the class period to discover and explore the concepts for themselves. Examples are given on ways of integrating this technique into simulation courses where GPSS/H is used for simulation modeling.

I started using CL in my undergraduate simulation course in the Winter of 1995. Although formal assessment has not yet been a part of my activities, I have observed that students develop stronger thinking and problem-solving skills over the term. Other professors have given me feedback that they are also carrying over a higher level of preparedness into later courses.

2 COOPERATIVE LEARNING AND THE LECTURE

The cooperative learning lecture is likely to be quite a departure from what students are traditionally used to. In order for it to work well, the students should understand what they are about to embark upon and "buy-in" to it. Therefore, my course syllabus includes a brief overview of the CL philosophy and why I believe in it. I discuss this approach with my students at the beginning of each term. (Now, after using it for several terms, I find that they have some idea of what to expect from the student grapevine.) Given this information, they have a choice in whether they want to actively participate or just "watch". A part of the participation involves coming to class prepared (the reading assignments and exercises needed for each meeting are specified on the syllabus). If they chose to participate they indicate so on an information card (that also asks for their name, email address, computer experience, and photo). Those who participate record their cooperative learning work on an index card and submit it at the end of each class period. The cards are not specifically graded but they are used to gauge their level of preparation and involvement. At the end of the term, students who participate earn a bonus of up to five percentage points on their total course score.

A cooperative learning strategy that works well during the class period is the use of small informal groups of students assembled periodically to examine, experience, try, discuss, and understand the topic. The groups are considered "informal" because they are formed spontaneously (Stanford (1977)). For example, I may ask the students to work with the per-

son on their right/left or randomly pair them up as they come in the room (depending on the size of the class). A schematic on how the cooperative learning class proceeds in a one hour period is shown in Figure 1 (adapted from Smith and Waller (1995)).

The class meeting begins with an advanced organizing activity designed to focus their attention on the session topic. The activity may involve collecting thoughts to contribute to a group discussion on an opening question based the reading or exercises assigned for the day. The topic is further investigated with three "mini-lectures." The class concludes with a discussion wherein all of the students contribute to a summary of the main points. The figure conveys that the lecture is transformed from being an isolated one-dimensional effort to a building-block in developing an understanding of a topic.

The group development work is usually subdivided into a minute or so to think about the question or exercise independently followed by a few minutes to work in the group. The advantage to this approach is that it gives the individual an opportunity for formulate a contribution to the group's work. Furthermore, they feel they *should* make a contribution since they were given the time. While the groups are at work, I circulate around the room to coach and encourage them in their work. At the end of this step, I ask groups to volunteer their responses. In some of the literature, this approach is termed *think/pair/share* (see, e.g., Davidson, et al. (1992) and Sharan and Sharan (1992)).

Many educators express three frequent responses to this CL approach. One is an uneasiness about "giving up control" of their classrooms. The second is that it sacrifices the amount of material that can be "covered" in a course if class time is turned over to student work. The third is a feeling that they aren't fully doing their job unless giving a polished lecture (Monk (1983)). It's true that some of the spotlight is relinquished to the students during the class but I think they are left with a greater impression when they are the ones doing some of the thinking and talking in class. I have found that we can investigate the same topics as those my course contained before introducing CL plus gain the benefit from student involvement. However, designing the cooperative learning class takes a significant amount of preparation time because it requires careful development of the student activities in addition to developing the lecture component.

3- EXAMPLES OF COOPERATIVE LEARNING ACTIVITY IN A SIMULATION CLASS

Choosing an appropriate text is important in the CL method. Rabow, et al. (1994) indicate that text with shorter sections help facilitate the class segments. In my undergraduate simulation course, we use *Introduction to Simulation Using GPSS/H* (Schriber (1991)). Many of the chapters in this text fit nicely into one class session and most contain case studies that naturally lend to CL activities. Examples of two class sessions are given below.

Chapter 2 of Schriber's text introduces the topic of entity management in simulation. Figure 2 shows copies of the overhead transparencies used in the class session on this topic. Students who have prepared the reading for the class session can quickly address questions 1 - 3. The first lecture component then focuses on why we need to keep track of transactions and how simulation software accomplishes this task. Questions 4 and 5 in the first group development activity lead to a general discussion of the role of distributions on in simulation modeling. Questions 6 and 7 in the second group development activity lead to understanding of the particulars of creating transactions and reporting on their movement in GPSS/H.

Chapter 6 introduces single server modeling. It includes the text's first case study on modeling a manufacturing system wherein widgets are assembled and heat treated in an oven (the single server). Students are required to read and prepare a written summary of each case study in the text before the class meets. Figure 3 shows the material used in the class session. The advanced organization activity in this example leads to a discussion of queueing disciplines and the nature of servers. The first group development activity flows into an investigation of modeling the single servers. The second group development activity prepares us to delve into issues stemming from the case study. The theme of the mini-lectures after a case study is often what other issues would the president of the company be concerned about and how would we address them using simulation as a decision-making tool.

It is important that the questions or exercises be clearly stated. I have developed files for cooperative learning activities associated with each chapter of Schriber's text that can be downloaded using the URL given in Section 5. To reiterate, the student's responses on these activities are not directly graded (rather their overall effort earns bonus points at the end of the term as discussed in Section 2). The goal is to engage the students during the class meeting

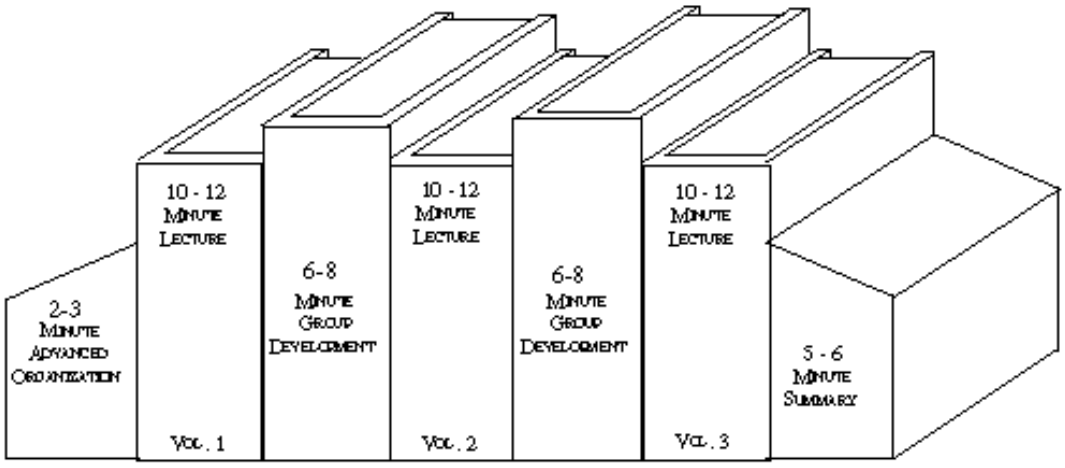

Figure 1: The cooperative learning lecture is divided into segments that promote active involvement on the part of the students.

Advanced Organization Chapter 2	**Group Development** Chapter 2	**Group Development** Chapter 2
1. What name is given to units of traffic in GPSS/H?	**4. What is the difference between an arrival time and an interarrival time?**	6. Under what condtions will a .lis file be created in GPSS/H?
2. In a model, can more than one unit of traffic move at at time?	**5. How can a sample from a 0-1 uniform distribution be converted to a general uniform distribution?**	7. Which columns are reserved for tables in the recommended GPSS/H format?
3. What three conditions may force a unit of traffic to stop moving?		8. For what reasons might a block statement be assigned a label?

Figure 2: Cooperative Learning Activities on Entity Management

Advanced Organization Chapter 6	**Group Development** Chapter 6	**Group Development** Chapter 6
1. Give definitions for queue and queueing system.	4. Explain Why True or False: Waiting time is typically determined by sampling from a distribution.	6. In Case Study 6A, assume there is never any delay in the use of the oven. Carry out manual calculations to determine how many widgets the system can produce in 40 hours.
2. Give an example of an OLOS queueing system in which the server is a thing and an example in which a server is a person.	5. Explain Why True or False: Service time is typically determined by sampling from a distribution.	
3. Why would a unit of traffic be denied access to a server?		

Figure 3: Cooperative Learning Activities on Single Server Modeling

and it's okay if responses are imperfect or incomplete. Using the index card reinforces an informal environment and eliminates preoccupation with correcting their work after discussing it in class.

4- FEEDBACK AND RESULTS

In general, student learning is difficult to evaluate. Reviewing the student's index cards at the end of each lecture, however, provides daily and immediate feedback on the their comprehension of the day's topic. Any gaps can be addressed during the next class period. Additionally, I have often gained insight on how to modify my lectures when I introduce the topic for the next term.

I have not conducted a formal assessment of CL in my course. However, at the end of each term, I ask the students to provide open feedback on using CL and to specifically respond to the following two statements using *strongly agree*, *agree*, *neutral*, *disagree*, or *strongly disagree*:

- It was valuable to me to have a few minutes throughout each class to think independently about new ideas.
- It was valuable to me to have a few minutes throughout each class to discuss new ideas with a partner/group.

Nearly all of my students have responded favorably to CL measures. Several students have personally thanked me for the methods used in my class. On a recent evaluation, one student wrote: "I really appreciate the way Dr. Nembhard conducted the class interactively as opposed to just lecture and she encouraged the learning process by having us think and discuss. [Her approach] makes a big difference in student's ability and motivation to learn." Furthermore, based on feedback from other faculty, they are carrying over advanced preparation habits to other classes.

5- SUMMARY

The goal of using cooperative learning in the classroom is to make the student stronger through interaction and communication around the process of academic inquiry. Students improve their thinking and problem-solving skills.

Designing cooperative learning classes takes significantly more preparation time than conventional lectures. In this article, I give examples of CL activities used to support two simulation classes. All of the activities used in my simulation course can be downloaded from the web site
http://www.eng.auburn.edu/∼nembhard/learn.html.

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