Collaborative Learning Enhances Critical Thinking

Anuradha A. Gokhale

The concept of collaborative learning, the grouping and pairing of students for the purpose of achieving an academic goal, has been widely researched and advocated throughout the professional literature. The term "collaborative learning" refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for one another's learning as well as their own. Thus, the success of one student helps other students to be successful.

Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but also promotes critical thinking. According to Johnson and Johnson (1986), there is persuasive evidence that cooperative teams achieve at higher levels of thought and retain information longer than students who work quietly as individuals. The shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Totten, Sills, Digby, & Russ, 1991).

In spite of these advantages, most of the research studies on collaborative learning have been done at the primary and secondary levels. As yet, there is little empirical evidence on its effectiveness at the college level. However, the need for noncompetitive, collaborative group work is emphasized in much of the higher education literature. Also, majority of the research in collaborative learning has been done in non-technical disciplines.

The advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork within the workforce. Workers need to be able to think creatively, solve problems, and make decisions

---

Anuradha A. Gokhale is an Associate Professor at Western Illinois University in the Department of Industrial Education and Technology, and is currently a Visiting Associate Professor at Illinois State University.

as a team. Therefore, the development and enhancement of critical-thinking skills through collaborative learning is one of the primary goals of technology education. The present research was designed to study the effectiveness of collaborative learning as it relates to learning outcomes at the college level, for students in technology.

Purpose of Study

This study examined the effectiveness of individual learning versus collaborative learning in enhancing drill-and-practice skills and critical-thinking skills. The subject matter was series and parallel dc circuits.

Research Questions

The research questions examined in this study were:

1. Will there be a significant difference in achievement on a test comprised of “drill-and practice” items between students learning individually and students learning collaboratively?
2. Will there be a significant difference in achievement on a test comprised of “critical-thinking” items between students learning individually and students learning collaboratively?

Definition of Terms

Collaborative Learning: An instruction method in which students work in groups toward a common academic goal.

Individual Learning: An instruction method in which students work individually at their own level and rate toward an academic goal.

Critical-thinking Items: Items that involve analysis, synthesis, and evaluation of the concepts.

Drill-and-Practice Items: Items that pertain to factual knowledge and comprehension of the concepts.

Methodology

The independent variable in this study was method of instruction, a variable with two categories: individual learning and collaborative learning. The dependent variable was the posttest score. The posttest was made up of “drill-and-practice” items and “critical-thinking” items.

Subjects

The population for this study consisted of undergraduate students in industrial technology, enrolled at Western Illinois University, Macomb, Illinois. The sample was made up of students enrolled in the 271 Basic Electronics course during Spring 1993. There were two sections of the 271 class. Each section had 24 students in it. Thus, a total of forty-eight students participated in this study.

Treatment

The treatment comprised of two parts: lecture and worksheet. Initially, the author delivered a common lecture to both treatment groups. The lecture occurred simultaneously to both groups to prevent the effect of any extraneous variables such as time of day, day of week, lighting of room, and others. The lecture was 50 minutes in length. It was based on series dc circuits and parallel dc circuits. Next, one section was randomly assigned to the “individual learning group” while the other section was assigned to the “collaborative learning group”. The two sections worked in separate classrooms.

The same worksheet was given to both treatment groups. It was comprised of both drill-and-practice items and critical- thinking items. The full range of cognitive operations were called into play in that single worksheet. It began with factual questions asking for the units of electrical quantities. Next, the questions involved simple applications of Ohm’s law and Watt’s law or power formula. The factual questions and the simple application questions were analogous to the drill-and-practice items on the posttest. The questions that followed required analysis of the information, synthesis of concepts, and evaluation of the solution. These questions were analogous to the critical-thinking items on the posttest. When designing the critical-thinking items it was ensured that they would require extensive thinking. Both sections had the same treatment time.

Individual Learning

In individual learning, the academic task was first explained to the students. The students then worked on the worksheet by themselves at their own level and rate. They were given 30 minutes to work on it. At the end of 30 minutes, the students were given a sheet with answers to the questions on the worksheet. In case of problems, the solution sheet showed how the problem was solved. The students were given 15 minutes to compare their own answers with those on the solution sheet and understand how the problems were to be solved. The participants were then given a posttest that comprised of both drill-and-practice items and critical-thinking items.

Collaborative Learning

When implementing collaborative learning, the first step was to clearly specify the academic task. Next, the collaborative learning structure was explained to the students. An instruction sheet that pointed out the key elements of the collaborative process was distributed. As part of the instructions, students were encouraged to discuss “why” they thought as they did regarding solutions to the problems. They were also instructed to listen carefully to comments of each member of the group and be willing to reconsider their own judgments and opinions. As experience reveals, group decision-making can easily be dominated by the loudest voice or by the student who talks the longest. Hence, it was insisted that every group member must be given an opportunity to contribute his or her ideas. After that the group will arrive at a solution.

Group Selection and Size

Groups can be formed using self-selection, random assignment, or criterion-based selection. This study used self-selection, where students chose their own group members. The choice of group size involves difficult trade-offs. According to Rau and Heyl (1990), smaller groups (of three) contain less diversity; and may lack divergent thinking styles and varied expertise that help to animate collective decision making. Conversely, in larger groups it is difficult to ensure that all members participate. This study used a group size of four. There were 24 students in the collaborative learning treatment group. Thus, there were six groups of four students each.

Grading Procedure

According to Slavin (1989), for effective collaborative learning, there must be “group goals” and “individual accountability”. When the group’s task is to ensure that every group member has learned something, it is in the interest of every group member to spend time explaining concepts to groupmates. Research has consistently found that students who gain most from cooperative work are those who give and receive elaborated explanations (Webb, 1985). Therefore, this study incorporated both “group goals” and “individual accountability”. The posttest grade was made up of two parts. Fifty percent of the test grade was based on how that particular group performed on the test. The test points of all group members were pooled together and fifty percent of each student’s individual grade was based on the average score. The remaining fifty percent of each student’s grade was individual. This was explained to the students before they started working collaboratively.

After the task was explained, group members pulled chairs into close circles and started working on the worksheet. They were given 30 minutes to discuss the solutions within the group and come to a consensus. At the end of 30 minutes, the solution sheet was distributed. The participants discussed their answers within the respective groups for 15 minutes. Finally, the students were tested over the material they had studied.

Instruments

The instruments used in this study were developed by the author. The pretest and posttest were designed to measure student understanding of series and parallel dc circuits and hence belonged to the cognitive domain. Bloom's taxonomy (1956) was used as a guide to develop a blueprint for the pretest and the posttest. On analyzing the pilot study data, the Cronbach Reliability Coefficients for the pretest and the posttest were found to be 0.91 and 0.87 respectively.

The posttest was a paper-and-pencil test consisting of 15 "drill-and-practice" items and 15 "critical-thinking" items. The items that belonged to the "knowledge," "comprehension," and "application" classifications of Bloom's Taxonomy were categorized as "drill-and-practice" items. These items pertained to units and symbols of electrical quantities, total resistance in series and parallel, and simple applications of Ohm's Law. The items that belonged to "synthesis," "analysis," and "evaluation" classifications of Bloom's Taxonomy were categorized as "critical-thinking" items. These items required students to clarify information, combine the component parts into a coherent whole, and then judge the solution against the laws of electric circuits. The pretest consisted of 12 items, two items belonging to each classification of Bloom's Taxonomy.

Research Design

A nonequivalent control group design was used in this study. The level of significance (alpha) was set at 0.05. A pretest was administered to all subjects prior to the treatment. The pretest was helpful in assessing students' prior knowledge of dc circuits and also in testing initial equivalence among groups. A posttest was administered to measure treatment effects. The total treatment lasted for 95 minutes. In order to avoid the problem of the students becoming "test-wise", the pretest and posttest were not parallel forms of the same test.

Findings

A total of 48 subjects participated in this study. A nine item questionnaire was developed to collect descriptive data on the participants. Results of the questionnaire revealed that the average age of the participants was 22.55 years with a range of 19 to 35. The mean grade point average was 2.89 on a 4-point scale, with a range of 2.02 to 3.67.

The questionnaire also revealed that eight participants were females and 40 were males. Nineteen students were currently classified as sophomores and 29 were juniors. Forty-five participants reported that they had no formal education or work experience in dc circuits either in high school or in college. Three students stated that they had some work experience in electronics but no formal education.

The pretest and posttest were not parallel forms of the same test. Hence, the difference between the pretest and posttest score was not meaningful. The posttest score was used as the criterion variable.

At first, a t-test was conducted on pretest scores for the two treatment groups. The mean of the pretest scores for the participants in the group that studied collaboratively (3.4) was not significantly different than the group that studied individually (3.1). The t-test yielded a value ($t=1.62$, $p>0.05$) which was not statistically significant. Hence, it was concluded that pretest differences among treatment groups were not significant.

The posttest scores were then analyzed to determine the treatment effects using the t-test groups procedure which is appropriate for this research design. In addition, an analysis of covariance procedure was used to reduce the error variance by an amount proportional to the correlation between the pre and posttests. The correlation between the pretest and the posttest was significant ($r=0.21$, $p<0.05$). In this approach, the pretest was used as a single covariate in a simple ANCOVA analysis.

Research Question I

Will there be a significant difference in achievement on a test comprised of “drill-and-practice” items between students learning individually and students learning collaboratively?

The mean of the posttest scores for the participants in the group that studied collaboratively (13.56) was slightly higher than the group that studied individually (11.89). A t-test on the data did not show a significant difference between the two groups. The result is given in Table 1. An analysis of covariance procedure yielded a F-value that was not statistically significant ($F=1.91$, $p>0.05$).

Research Question II

Will there be a significant difference in achievement on a test comprised of “critical-thinking” items between students learning individually and students learning collaboratively?

The mean of the posttest scores for the participants in the group that studied collaboratively (12.21) was higher than the group that studied individually (8.63). A t-test on the data showed that this difference was significant at the 0.001 alpha level. This result is presented in Table 1. An analysis of covariance yielded a F-value that was significant at the same alpha level ($F=3.69$, $p<0.001$).

Table 1
Results of t-Test

Item Classification	Method of Teaching	N	Mean	SD	t	p
Drill-and-Practice	Individual	24	11.89	2.62	1.73	.09
	Collaborative	24	13.56	2.01		
Critical-thinking	Individual	24	8.63	3.06	3.53	.001***
	Collaborative	24	12.21	2.52		

Discussion of the Findings

After conducting a statistical analysis on the test scores, it was found that students who participated in collaborative learning had performed significantly better on the critical-thinking test than students who studied individually. It was also found that both groups did equally well on the drill-and-practice test. This result is in agreement with the learning theories proposed by proponents of collaborative learning.

According to Vygotsky (1978), students are capable of performing at higher intellectual levels when asked to work in collaborative situations than when asked to work individually. Group diversity in terms of knowledge and experience contributes positively to the learning process. Bruner (1985) contends that cooperative learning methods improve problem-solving strategies because the students are confronted with different interpretations of the given situation. The peer support system makes it possible for the learner to internalize both external knowledge and critical thinking skills and to convert them into tools for intellectual functioning.

In the present study, the collaborative learning medium provided students with opportunities to analyze, synthesize, and evaluate ideas cooperatively. The informal setting facilitated discussion and interaction. This group interaction helped students to learn from each other’s scholarship, skills, and experiences. The students had to go beyond mere statements of opinion by giving reasons for their judgments and reflecting upon the criteria employed in making these judgments. Thus, each opinion was subject to careful scrutiny. The ability to admit that one’s initial opinion may have been incorrect or partially flawed was valued.

The collaborative learning group participants were asked for written comments on their learning experience. In order to analyze the open-ended informal responses, they were divided into three categories: 1. Benefits focusing on the process of collaborative learning, 2. Benefits focusing on social and emotional aspects, and 3. Negative aspects of collaborative learning. Most of the participants felt that groupwork helped them to better understand the material and stimulated their thinking process. In addition, the shared responsibility reduced the anxiety associated with problem-solving. The participants commented that humor too played a vital role in reducing anxiety.

A couple of participants mentioned that they wasted a lot of time explaining the material to other group members. The comments along with the number of participants who made those comments are described in Table 2.

Table 2
Categorical Description of Students' Open-Ended Responses Regarding Collaborative Learning

A. Benefits Focusing on the Process of Collaborative Learning
Comments (# of responses):

Helped understanding (21)
Pooled knowledge and experience (17)
Got helpful feedback (14)
Stimulated thinking (12)
Got new perspectives (9)

B. Benefits Focusing on Social and Emotional Aspects
Comments (# of responses)

More relaxed atmosphere makes problem-solving easy (15)
It was fun (12)
Greater responsibility-for myself and the group (4)
Made new friends (3)

C. Negative Aspects of Collaborative Learning
Comments (# of responses)

Wasted time explaining the material to others (2)

Implications for Instruction

From this research study, it can be concluded that collaborative learning fosters the development of critical thinking through discussion, clarification of ideas, and evaluation of others' ideas. However, both methods of instruction were found to be equally effective in gaining factual knowledge. Therefore, if the purpose of instruction is to enhance critical-thinking and problem-solving skills, then collaborative learning is more beneficial.

For collaborative learning to be effective, the instructor must view teaching as a process of developing and enhancing students' ability to learn. The instructor's role is not to transmit information, but to serve as a facilitator for learning. This involves creating and managing meaningful learning experiences and stimulating students' thinking through real world problems.

Future research studies need to investigate the effect of different variables in the collaborative learning process. Group composition: Heterogeneous versus homogeneous, group selection and size, structure of collaborative learning, amount of teacher intervention in the group learning process, differences in preference for collaborative learning associated with gender and ethnicity, and differences in preference and possibly effectiveness due to different learning styles, all merit investigation. Also, a psycho-analysis of the group discussions will reveal useful information.

References

Bruner, J. (1985). Vygotsky: An historical and conceptual perspective. *Culture, communication, and cognition: Vygotskian perspectives*, 21-34. London: Cambridge University Press.

Bloom, B. S. (1956). *Taxonomy of educational objectives, handbook 1: Cognitive domain*. New York: Longmans Green.

Johnson, R. T., & Johnson, D. W. (1986). Action research: Cooperative learning in the science classroom. *Science and Children*, 24, 31-32.

Rau, W. & Heyl, B. S. (1990). Humanizing the college classroom: Collaborative learning and social organization among students. *Teaching Sociology*, 18, 141-155.

Slavin, R. E. (1989). Research on cooperative learning: An international perspective. *Scandinavian Journal of Educational Research*, 33(4), 231-243.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). *Cooperative learning: A guide to research*. New York: Garland.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Webb, N. (1985). Student interaction and learning in small groups: A research summary. *Learning to Cooperate, Cooperating to Learn*, 148-172.