Comparison of computer assisted cooperative, competitive and individualistic learning: An example of Turkey

Burak Feyzioğlu*, Hüsamettin Akçay, Esin Şahin-Pekmez

Dokuz Eylul University, Buca Fac. of Edu., Dep.of Chemistry Edu. Izmir, Turkey.

e-mail: husamettin.akcay@deu.edu.tr

Abstract: Computer assisted instruction / learning (CAI/CAL) brings with it the possibility that student introduction with computers may result in less interaction with teachers and classmates. This possibility is increased when individualistic assumption guides CAI. In a cooperative learning situation, when one student achieves his or her goal, all others with home he or she is cooperatively linked achieves their goals. In a competitive learning situation when one student achieves his or her goal, all others with home he or she is cooperatively linked failed to achieves their goals(Johnson&Johnson,1975). In the last decade, the community working on computer assisted learning has started considering a different type of learning as an alternative to traditional ones. These are especially collaborative of cooperative learning and competitive group cognition.

There is this agreement among the researchers as to whether the instructional use of computers with affect students' achievement. The basic positions are that the individualistic use of computers rises student achievement (Kulik,Bangert&Williams,1983) and that the computer is a vehicle that delivers instruction but thus not in an of itself affect student achievement (Klark,1983). Since cooperatively structural learning tends to promote higer achievents than do competitive and individualistic learning situations (Johnson&Johnson, 1981). If the computer increases student achievements in individualistic learning situations, it may be hypothesized that computer-assisted individualistic instruction may promote higer achievement than computer-assisted competitive or cooperative instruction.

The first aim of this study is to clarify this issue. For this purpose the effect of computer assisted collaborative (CACL), and individualistic learning (CAIL) in chemistry teaching on students' achievement and attitudes towards chemistry were carried out. The methods were applied to the sample of first year prospective chemistry and prospective science teachers when they were taking the course of general chemistry. A computer software program (Active Chemistry Education Package) was designed for both methods for the topic of chemical bonding. Additionally, worksheets were designed specifically for computer assisted collaborative learning environments. All prepared teaching materials were based on 7E model. As a result of this study it was found out that both CACL and CAIL have positive

effects on students' achievement and attitudes. However, significant differences were found in favor of CACL.

Key words: Computer assisted learning, cooperative learning, collaborative learning, computer assisted individualistic learning, chemistry education, 7E model.

Introduction

The amount of studies on computer assisted collaborative learning (CACL) has dramatically increased during the last decade. There have been numerous studies aimed at investigating the effects of CACL on students' achievement. Many studies on small group computer-based instruction, published in the late eighties and the early nineties, indicated at least some positive impact on students' learning (Anderson et. al., 1995; Hativa, 1988; Hooper, 1992; Mevarech et. al., 1991; Shlechter, 1990).

Co-operative learning is an instructional technique whereby students work together in small fixed groups on a structured task (Cooper, 1995). Recent research on the role of collaboration in learning has tried to find deeper theoretical frameworks that could better guide the developing of technology-aided learning environments. A distinction between co-operation and collaboration which is based on different ideas of the role and participation of individual members in the activity is conceptually central in this review. Co-operative work is accomplished by the division of labor among participants. It is an activity where each person is responsible for a portion of the problem solving, whereas collaboration involves the mutual engagement of participants in a coordinated effort to solve the problem together.

Deutsch (1949) compares three categories of situations in which learners can interact in the learning task:

- cooperative learning (or 'collaborative learning'): each pupil's goal-oriented efforts contribute to others' goal attainment.
- competitive learning: each pupil's goal-oriented efforts frustrate others' goal attainment.
- individualistic learning: there is no link between the goals of the different pupils; each of them is concerned with her own result and not with the results of others.

Collaborative learning has always existed, getting both positive and negative critiques (Slavin, 1995). A positive point is that learners are more concerned with correcting their errors in group work, that they seldom produce errors in their mutual corrections nor integrate errors made by other learners, that their discourse is more open to negotiation of sense and to self-repair. Yet, the following point is sometimes mentioned as an example of negative effect:

if the discrepancy in cognitive capacities of the interlocutors is too important, then collaboration can be useless or even harmful to the learning process; besides, working in a group becomes relatively difficult for the more advanced learners (especially if they are not used to it).

Collaboration is considered to be essential for promoting successful learning and has been implicated to education by various different means. Characteristics of collaborative classroom that there needed to involve share knowledge among teachers and students, shared authority among teachers and students, roles of teachers as mediators, and heterogeneous grouping of students.

Collaborative learning presents an environment in which a student interacts with one or more collaborating peers to solve a given problem, mediated by the collaborative learning system. The interactions among students can be monitored and controlled by the system.

There are experimental studies and implemented systems available in the literature to emphasize the effectiveness of collaboration. A study on *Constructive Interaction* by Naomi Miyake (1986) confirms that in the learning process the bulk of *Constructive Criticisms* occur while learning in collaboration. The results of the study showed that about 80% of *self-critiquing* (reflection) took place during collaborative learning compared to 20% which took place when students were learning alone. Self-critiquing is one of the major contributors to the effectiveness of learning. This research showed that the learners might have missed the opportunity for better understanding if they had not collaborated.

A technologically sophisticated collaborative learning environment could provide advanced support for facilitating advancement of learning as well as transformation of the participants' epistemic states through a socially distributed process of inquiry. On the other hand, a co-operative group does not automatically improve the construction of higher order cognitive skills and complex knowledge structures. In order to increase the possibilities for mutual understanding and task-related social interaction, interaction tools are needed that are adequately related both to the new concepts to be learned and to the previous experience and knowledge of the students (Katz & Lesgold, 1993). There should be flexible methods available for the students, to help them externalize their preliminary ideas and make their thinking processes transparent to other people. Using computers for this purpose as a learning tool is an alternative. Interaction with computer and collaborative working methods could encourage students towards mutual reflections.

Crook (1996) has widely analyzed how computers can facilitate collaborative learning in schools. He makes a distinction between interacting around and through computers. He claims

that a traditional classroom situation has little effect for successful collaboration. Jarvela et. al. (1999) suggested that the capabilities of computers can be used as mediating tools which help students to focus their attention on mutually shared objects. So far, many different program types like databases, spreadsheets, math programs, simulations, multimedia authoring tools, etc. have been successfully used as tools to promote collaborative and co-operative learning (Amigues and Agostirelli, 1992; Brush, 1997; Eraut, 1995; Lehtinen and Repo, 1996).

Typically, collaborative learning systems concentrate on refining and integrating the learning process and the subject knowledge of the students with the help of the collaborating partners. The promise of collaborative learning is to allow students to learn in relatively realistic, cognitively motivating and socially enriched learning contexts, compared to other tutoring paradigms such as Socratic learning, discovery learning, integrated learning, etc. For instance, a student might *discuss* the strategies to solve a given problem in a problem-solving domain like trigonometry or *practice* the colloquial usage of a foreign language in a computer-aided language learning system. With CACL, students can discuss these strategies with a group of students who can advise, motivate, criticize, compete, and direct towards better understanding of the subject matter (Kumar, 1996). Additionally, Lehtinen and Rui (1996) believe that CACL is one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology.

A review of existing literature also showed that computer-supported learning is not necessarily beneficial relative to individual learning (O'Malley and Scanlon, 1990; Del Marie Rysavy and Sales, 1991) and very little attention has been paid to the affective aspects of computer-supported collaborative learning. Successful collaboration was found by Blaye et. al. (1991) who stated that children working as pairs were more likely to succeed than children working alone. In contrast, Messer et. al. (1992) found that peer interaction did not facilitate learning on a balancing task, and in fact, inhibited learning.

Methods

Data were collected over a term of 2005-2006 academic year by applying an achievement test to 114 first year undergraduate students in the department of both chemistry and science education in Turkey. The distribution of the students according to their departments and groups is presented in Table 1 below.

Table 1. Distribution of the participants according to their departments and groups.

	Chemistry Education	Science Education	Total
Control Group	15	45	60
Experiment Group	13	41	54
Total	28	86	114

The Teaching Materials and the Data Collection

The both CACL and CAIL materials were prepared as an active teaching methods using 7E constructivist method (Eisenkraft, 2003). Firstly, possible misunderstandings about chemical bonding were found out from the literature. Secondly the content of the teaching materials was determined and developed. According to 7E model the stages of the teaching materials are stated below:

Elicit: Some animations about chemical bonding are presented to the students and they are asked to make and write their own explanations about the animations on the computer. The aim of doing this is to make students realize what they know and find out their prior knowledge.

Engage: Analogies, experiments, animations or concept maps are used in this page in order to capture students' attention and motivate them.

Explore and explain: In this stage students are oriented to an activity according to their first decision in the elicit stage. The purpose of this stage is to make students to test that their knowledge is true or not and give opportunity to make explanations.

Elaborate: Students are asked to apply their knowledge, to solve problems, and to make predictions or to hypothesize. It allows students to consolidate the knowledge.

Evaluate: In this stage students evaluate themselves with some multiple choice questions.

Extend: Students have some projects to do in this stage and they are also presented some daily life examples.

Additionally, apart from computer programs worksheets were prepared as an extra activity for CACL.

In order to find out the differences between the levels of students' understanding before and after applying different methods (CACL and CAIL), a scale was developed. A*chievement Scale (AS)* was performed to find out the students' readiness to chemical bonding, before they were taught in this study, and to compare the students' pre and post performances and to find out whether there was a significant difference between students' successes related to methods

used. The questions in the scale were about chemical bonding in the first year undergraduate level. Firstly, a content table was prepared then with the help of the table the learning outcomes were determined, and for each learning outcome a question was prepared. The number of the items was 24 (as a pilot a 33-item draft test was done with the sample of 119 students, and the factor loads were calculated. As a result, 9 questions were eliminated). Then the Cronbach α reliability coefficient was found 0,88). The questions were prepared as a "two tier type". The questions were divided into two parts. In the first part there were multiple-choice questions. Students were required to answer the questions and select the right explanation which came just after the multiple choice question. The aim of doing this was to find out whether the students truly understand the topic or not.

Attitude scale towards chemistry (ASTC) was developed in order to find out students' attitudes towards chemistry, laboratory activities, science and scientific methods (cronbach α reliability coefficient was found 0,88).

Application of the Scales

This experimental research design was partially taken from Campbell and Stanley's (1963) pre and post-test control group model. Before the test, the students were divided into two groups; control group (CG) and experiment group (EG). After applying the pre-test the topic (chemical bonding) was taught to the control group (CG) by using the CAIL and at the same time the experiment group (EG) was treated CACL.

Analysis of the Data

The data collected in this study were analyzed by using SPSS/PC version 10.0 statistical program; two different t-tests were performed: Paired Samples t-test was conducted to determine whether there was a significant difference between pre-test and post-test results in each group (departments of chemistry and science students). Independent Samples t-test was performed to identify whether understanding levels of all students in CGs and EGs and to find out whether a significant difference arise between groups as result of the methods used. Significance level was decided by taking p values into consideration; $p>0.05$ meant there was not a meaningful difference, $p<0.05$ meant there was a meaningful difference.

Results

Results of in Groups Analysis of AS

Pre and post-test results taken from CG and EG in each department were analyzed separately. Differences in levels of students' understanding between pre and post-test results in each CG and EG, in each department for AS was presented in Table 2.

Table 2. Pre and Post Tests Results of AS.

Dep.	Group		N	X	SD	δ	t	P
CHEMISTRY EDU.	CG	Pre-test	15	7,4000	2,19740	,56737	-- 13,464	,,000*
		Post-test	15	14,9333	1,16292	,30026		
	EG	Pre-test	13	8,0769	2,13937	,59336	-- 15,819	,000*
		Post-test	13	20,1538	2,26738	,62886		
SCIENCE EDU.	CG	Pre-test	45	7,8000	2,42712	,36181	-- 24,476	,000*
		Post-test	45	18,5556	2,01760	,30077		
	EG	Pre-test	41	7,6341	2,36385	,36917	-- 27,225	,000*
		Post-test	41	20,8049	1,92639	,30085		

As can be seen from Table 2, there were statistically significant differences between pre and post-test results in all CGs and EGs in each department for AS. That means that there were significant differences between students' prior knowledge and knowledge gained after they were taught the topics, either by a CAIL or by CACL. When we look at the mean values in all CGs and EGs, it is seen from the table that the differences between pre and post-test mean values of EGs are higher than those of CGs. In other words, achievement levels of students in EGs who received the topic through the CACL used were higher than students taught the topics through CAIL in CGs.

Results of Between Groups Analysis of AS

The results of pre-tests of all CGs and EGs, and post-tests of all CGs and EGs were compared to see whether the methods used in this study were affected students' achievement. The results of between groups analysis are presented in Table 3.

Table 3. Results of Between Groups Analysis

Test	F	P
Pre-test	1,365	,801
Post-test	0,617	,000*

As it is understood from the table that there was no significant difference between the pre-test results (p=0.801). In other words, both control and experiment groups were selected from students with similar knowledge level before the study. On the other hand, as a result of the study it is seen from the table that post-test results were significantly different (p=.000<0.05) depending on the methods used. Table 4 below shows the mean values of each group.

Table 4. Mean values of pre and post-test results of both groups.

Group	Mean Values	
	Pre-test	*Post-test*
CG	7,629	17,981
EG	7,740	20,648

As can be seen from the table, whereas the mean value of the test results of CG who received the topic by CAIL increased by 135% (from 7.629 before the treatment to 17,981 after the treatment) EG's value increased by166% (from 7.740 to 20.648).

These results implicates that students who were taught the topic by using CACL method were more successful than those who received the topic through CAIL method.

Results of in Groups Analysis of ASTC

Differences in attitudes of students' towards chemistry between pre and post-test results in each CG and EG, in each department for ASTC was presented in Table 5.

Table 5. Pre and Post Tests Results of ASTC

Dep.	Group		N	X	SD	δ	t	P
CHEMISTRY EDU.	CG	Pre-test	15	70,400	10,11223	2,61097	-- 16,076	,000*
		Post-test	15	103,000	8,83984	2,28244		
	EG	Pre-test	13	77,1538	8,40482	2,33108	-- 10,786	,000*
		Post-test	13	108,6154	5,99359	1,66232		
SCIENCE EDU.	CG	Pre-test	45	69,0889	7,85326	1,17070	-- 26,477	,000*
		Post-test	45	102,1333	7,33485	1,09341		
	EG	Pre-test	41	71,7317	8,12104	1,26829	-- 22,600	,000*
		Post-test	41	107,3171	6,25076	,97620		

As can be seen from Table 5, there were statistically significant differences between pre and post-test results in all CGs and EGs in each department for ASTC.

Results of Between Groups Analysis of ASTC

According to the table 6 below, before the treatment there were no significant differences between groups but after the treatment it can be seen that depending on the methods used there was significant difference.

Table 6. Results of Between Groups Analysis of ASTC

Test	F	P
Pre-test	1,367	,037
Post-test	0,61	,000*

This significant difference can also be seen when examining the mean values of the groups (Table 7).

Table 7. Mean values of pre and post-test results of both groups for ASTC.

Group	Mean Values	
	Pre-test	*Post-test*
CG	70,129	102,963
EG	73,037	107,629

Conclusion

Results of this study shows that computer assisted collaborative learning method is more effective on students' achievement (for the subject of chemical bonding) than computer assisted individualistic learning method. CACL has also the same effect on students' attitudes for chemistry. The findings are valid either in groups or between groups. The main difference between the learning methods was students' sharing of their ideas in which students think more critically. For example Ames (1984) has stated that in a co-operative setting there is a valuing of effort within the achievement of co-operation. Thus the focus is directed on group performance over and above any individual characteristics (Issroff et.al, 1997). These claims have become valid with this study at least for a specific subject of chemical bonding.

Many field studies about the effects of co-operative learning on students' achievement, have been done in every major subject, at all grade levels. Like the result of this research shows there is a growing consensus among researchers about the positive effects of co-operative learning on students' achievement (Slavin, 1997; 1995). There are, however, still many open questions and much disagreement about why and under what conditions this kind of learning effects students' achievement positively (Slavin, 1997; Webb & Palincsar, 1996). Group learning refers to instructional methods whereby students are encouraged or required to work together on learning tasks. It is widely agreed that we should distinguish collaborative

learning from the traditional 'direct transfer' model in which the instructor is assumed to be the distributor of knowledge and skills. Unlike the teacher-centered models the principles of collaborative learning are based upon a learner-centered model that treats the learner as an active participant.

The results of this study are the same with some major studies by Alavi (1994), Bruckman and De Bonte (1997), Brush (1997), Enyedy et al. (1997), Graves and Klawe (1997), Hmelo et al. (1995), Silverman (1995). However, Messer et al. (1992), Seymour (1994), and Kupperman et al.(1997) found that peer studies had no significant difference when CACL and CAIL compared.

Rysavy and Sales (1991) published a review in which they summarized the results of 13 studies on co-operative computer-based instruction (published between 1982 and 1988). They discussed the findings related to achievement and motivation. In ten of these studies the achievement of students was explored and in six of them, the computer-based co-operative condition resulted in better learning, whereas in four studies there were no significant differences. Motivation was considered only in two studies and both reported positive effects.

In their study in 1992, Light and co-workers conducted an experimental study, in which 120, 11- and 12-year-olds worked on a computer-based problem-solving task couched in an adventure game format. The scenario drew upon elements of a familiar children's story/song and a contemporary TV advertisement aimed at children. The task was a specially designed computer based route-planning task. As a result of this experiment, there was some significant advantage for pairs over the individual in the second session of the three sessions. However, there was no advantage at individual post-test.

What is not clear is that under what conditions CACL type learning method is effective. It is understood that making generalization, that CACL is always effective, is not possible at that point. However, every researcher can make their own criticism. We believe that in our study the main difference between EG and CG was students sharing alternative ideas and making decisions when constructing concepts in their cognitive structures. Although both learning methods had been prepared basing on a constructivist method as a result one of them was more effective in terms of students' understanding. The main point that should be stated from that finding is that even if constructivist method is used the teaching method (technique) matters. The findings have also showed that when constructing concepts, working in peers was more effective than working alone.

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