An Assessment of the Effectiveness of Cooperative Learning in Introductory Information Systems

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ABSTRACT

This study presents results from a field experiment investigating the efficacy of cooperative learning on individual students in an undergraduate introduction to information systems class. Statistical analysis of the data indicates that cooperative learning did not have a positive effect on individual student learning. This result is in contrast to effective individual learning outcomes associated with cooperative techniques reported in the education literature on cooperative learning. Furthermore, in completing a project, cooperative project groups did not have significantly higher project scores than individual students who undertook the project.

Keywords: Cooperative Learning, Team Learning, Teamwork, Assessment, Introduction to Information Systems

1. INTRODUCTION

Cooperative learning (CL) is a popular instructional technique. A recent search of the ERIC education database provided over 6,000 citations associated with this subject. There is great appeal to the concept that students can help each other learn. For a detailed introduction to the techniques of CL, see Johnson, Johnson, & Smith (1998a) and Millis & Cottell (1998). For a review of the learning theory supporting cooperative approaches and the associated research literature, see Slavin (1996).

This technique is also being applied in information systems (IS) classes. This study presents results from an assessment of the learning effectiveness of CL as applied in an undergraduate introduction to IS class. Following this introduction, the body of the study is divided into four sections. The second section provides background material on CL and the manner in which it has been applied in IS instruction. The third and fourth sections describe the research methodology of the assessment and present the results. The final section provides a discussion of conclusions based on the results.

2. BACKGROUND

This background section provides a brief review of the essential characteristics of CL and then examines the manner in which CL has been employed within IS.

2.1 Cooperative Learning

CL is defined as "the instructional use of small groups so that students work together to maximize their own and each other's learning" (Johnson, Johnson & Smith 1991, p. 3). CL structures the small group activity of students in terms of the five critical elements illustrated in Table 1.

There is evidence that this pedagogy is relatively effective in producing individual learning outcomes as compared to the broad alternatives. According to Johnson, Johnson, & Smith (1998b), "Between 1924 and 1997, over 168 studies were conducted comparing the relative efficacy of cooperative, competitive, and individualistic learning on the achievement of individuals 18 years or older. These studies indicate that cooperative learning promotes higher **individual achievement** (emphasis added) than do competitive approaches ...or individualistic ones..." (p.31).

Table 1: Elements of the Cooperative Learning Model

Element	Description (Johnson, Johnson & Smith 1998b)
PI: Positive Interdependence	Each student perceives that he or she is linked with others in a way that the student cannot succeed unless the others do.
F2FPI: Face to Face Promotive Interaction	Students help, assist, encourage and support each other's efforts to learn in a face to face manner.
IA: Individual Accountability	The performance of each student is assessed.
SS: Social Skills	Students are taught social skills and they are used appropriately.
GP: Group Process	Students take time to identify ways to improve the process members have been using to maximize their own and other's learning.

The learning theories upon which the effectiveness of CL is based relate to implementation of the CL model elements. Figure 1 illustrates Slavin's (1996) model that synthesizes various learning theory perspectives on the manner in which CL results in enhanced learning. In view of PI (i.e. group goals), the student is motivated to learn and to encourage and help others in the group to learn. F2FPI is the process of assisting others in the group to learn. The student interaction associated with F2FPI drives one or more cognitive processes. Notable among these processes is elaboration – putting material into one's own words. Elaboration provided by one student to another is a win/win situation. Elaboration not only enhances the learning of the student who receives the explanation, but also deepens the understanding of the student providing the explanation (McKeachie 1999. p. 164). These cognitive processes produce enhanced learning.

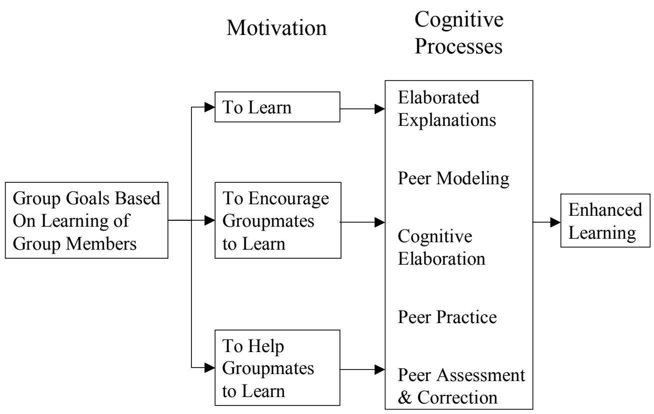

Figure 1: Learning Theory & Cooperative Learning

IA enters Slavin's synthesis in two ways. First, achievement (enhanced learning) is measured at the level of the individual student. According to Johnson, Johnson & Smith (1998b), "The purpose of cooperative learning is to make each member a stronger individual in his or her own right. Students learn together so that they can subsequently perform better as individuals" (p. 30). Slavin (1992) distinguishes between individual achievement and group outcomes by pointing out "Learning is a completely individual outcome that may or may not be improved by cooperation … learning is completely different from 'group' productivity. It may well be that working in a group under certain circumstances does increase the learning of individuals in that group more than would working under other arrangements, but a measure of group productivity provides no evidence one way or the other on this" (p. 150). Second, on the basis of research evidence, Slavin (1996) asserts that there is a linkage between IA and PI. "Use of group goals or group rewards enhances the achievement outcomes of cooperative learning, if and only if the group rewards are based on the individual learning of all group members." (p. 45). That is, the incorporation of individual learning outcomes into the structure of PI for the group is a necessary condition for positive achievement via CL.

Finally, having students engage in unstructured F2FPI does not insure that the requisite cognitive processes will occur. Therefore, process skills such as SS and GP must be taught to the students. SS and GP are mediating elements that increase the likelihood of appropriate cognitive processes. SS include leadership, decision-making, communication, and conflict management. Many students have never worked cooperatively in learning situations and need training in these skills to be successful. Correspondingly, GP must also be taught in order to ensure that groups focus on how well they are achieving their goals and identifying ways in which they might improve.

2.2 Cooperative Learning in Information Systems

Within IS education the context in which application of cooperative learning arises has profoundly influenced the learning objectives of the instructors that employ it.

In response to the demands of global competition and the increasing use of knowledge to create products and services, organizations have been moving toward a form of work that organizes employees into teams rather than a rigid management hierarchy (Naisbitt & Aburdene 1990). Within the IS function in organizations, the use of systems development teams is established practice. The importance of teams has spawned a Business (Pelled, Eisenhardt, & Xin 1999) and IS (Janz 1999) research literature focused on the determinants of team performance in organizations.

Employers translate the importance of teams into a desire for certain skills in employees (Van Slyke, Kittner & Cheney 1998). Business and IS educators have responded to this need by embracing teamwork or interpersonal skills as important process skills to be addressed in Business (McKendall 2000) and IS (Fellers 1996b; Johnson & Moorehead 1998) instruction. Incorporating teamwork into IS courses is typically done via a group project. At the present time it is most often done informally with no teamwork training, and less often accompanied by explicit team structuring and/or instruction in teamwork skills. The goal is to develop the student into a more productive and more positive team member and hence lead to more effective teams.

Consequently, in IS cooperative learning is largely viewed as a pedagogy that complements the development of teamwork and associated skills. Focus on group process skills as a dominant IS instructional objective sharply contrasts with the objective of individual cognitive achievement espoused in the education literature on cooperative learning. The education literature views the development of teamwork skills as a mediating factor in pursuit of individual achievement.

Table 2 provides a synopsis of six key articles in IS education that involve elements of the CL model. The first article provides an early statement of the CL model as it relates to education in IS, but does not incorporate assessment. The remaining five articles all incorporate some form of comparative assessment.

Table 2: Key Journal Articles on the Use of CL Elements in IS Education – by Year of Publication

Article: Lead Author & Year	Contribution	Application Level	Implementation of CL Model	Assessment Results
Wojtkowski (1987)	Early exposition of CL & relevance to IS	MBA		
Keeler (1995)	Computer Anxiety & Relation to CL	Undergraduate IS & Computer Literacy	F2FPI, SS, GP	Positive & Significant effect on student grade
Alavi (1995)	IT enabled CL	MBA	F2FPI	Positive & Significant effect of IT enabled CL on Critical Thinking as compared with non-IT enabled CL
Fellers (1996a)	Very complete exposition of CL and relevance to IS	MBA	PI, F2FPI, IA, SS, GP	No significant effect on student perceptions
Mennecke (1998)	Role assignment to Team Members	Undergraduate Introduction to IS	F2FPI, SS	Significant and positive effect on student perceptions and on group project grades
Van Slyke (1999)	Teamwork Training	Undergraduate Systems Analysis and Database	F2FPI, SS, GP	Significant and positive effect on student perceptions

The synopsis provides several insights into the use of CL within IS. First, CL has been applied at various levels in IS education. Second, Fellers study is the only one implementing all elements of the CL model. In particular, it is the only study that employs PI and IA. Third, since the mid-90's, assessment has focused on student perceptions as a dependent variable and not on individual student cognitive achievement. Specifically, assessment in recent studies tends to be undertaken in terms of actual or perceived team success, and in terms of individual attitudes toward working in teams. That is, the emphasis is to develop teamwork skills and a positive attitude toward that type of work mode.

An exception is the study by Keeler & Anson (1995). They conducted a field experiment assessing learning performance in cooperatively and traditionally structured class sections of a computer literacy course offered from an information systems perspective. Keeler & Anson hypothesize that cooperative learning will also serve to ameliorate computer anxiety and therefore enhance individual learning in comparison with the traditional alternative. Their analysis shows significant positive treatment effects in terms of student grade, and a partition of the sample indicated that students in the treatment group with high initial anxiety achieved higher grades than their traditional counterparts. However, there was no significant treatment effect on anxiety reduction between the beginning and end of the course. These findings are further limited by incomplete implementation of the CL model, the omission of significant covariates, such as grade point average, and use of bivariate statistical techniques.

3. RESEARCH METHODOLOGY

In view of the emphasis on process skills and team performance, the IS education literature related to cooperative learning is notably lacking in comparative studies focused on individual cognitive outcomes. Fellers (1996a) recognized this lack of attention, and called for (1) further studies assessing the effectiveness of CL as compared with other pedagogical models, and (2) performance measures in addition to student surveys. Since there were no comparative studies in IS at the introductory level that focused on individual achievement and incorporated PI and IA, the author undertook to conduct a quasi-experiment in that context. An examination of the methodology of this experiment is subdivided into three parts; the characteristics of the experiment itself, a description of the data set arising from the experiment, and a description of the statistical method employed on the data set that includes a statement of the research hypotheses.

3.1 Characteristics of the Experiment

The experiment involved three sections of an introductory IS course. The experimental design was a posttest-only design with nonequivalent groups (Cook & Campbell 1979). This course is taught by Information Systems faculty and is typically taken by second year pre-business students. It has a computer literacy course as a prerequisite. It requires a project involving end user software development in a microcomputer database and/or spreadsheet. In one section (sec. 5), the students experienced a formal cooperative learning environment that extended to all components of the class. In a second section (sec. 6), the students experienced an environment in which a portion of the course, a project, was cooperative. In a third section (sec. 7), there was no formal cooperation. All three sections were taught during the same academic term by the same instructor and were administered the same tests.

The tests were divided into two components. The first half of each test focused on IS literacy. The second half focused on IS software. In order to insure test validity, care was exercised in mapping the specific course objectives into test questions and software problems. Students were administered the tests by the instructor in a computer classroom and they completed the tests strictly on an individual basis.

Project activities were concentrated in the last third of the semester. These activities were based on systems development activity that occurred earlier in the semester. Early in the semester, students developed components of a simplified transaction processing system using Microsoft Access. The instructor provided the system design and components were constructed via exercises. The project itself involved the solution of a decision problem relevant to the functional area associated with the transaction processing system. In addressing the decision problem, students were required to develop a decision support tool using Microsoft Excel. The students queried the transaction processing system to provide initial data for the decision support tool. Analysis was undertaken within the tool in terms of simple models of the decision problem. Analytical outcomes, in the form of tables and charts, were transferred from Excel to Microsoft Word. These tables and charts provided supporting evidence for a recommended solution to the decision problem. The Word document, as a report, included the supporting evidence, the recommendation, and a narrative describing the analytical process that led to the recommendation.

The cooperative treatment adhered to the key elements of cooperative learning. The instructor formed the cooperative learning and project groups (Johnson, Johnson & Smith 1998a). There were two goals employed in forming the groups. Groups of three or four students were formed such that they were heterogeneous in terms of student demographic characteristics (i.e. ethnicity, age, and gender -- see Millis & Cottell 1998), and academic ability (i.e. grade point average: GPA -- see Persons 1998). On the other hand, in order to facilitate group meetings outside class, the groups were formed so that they were homogeneous in terms of student schedules and other commitments identified by the students.

Each student subject to cooperative treatment received a document outlining learning group responsibilities and guidelines. An early activity for each group was to develop a group contract. The contract has two purposes. First, it defines agreed-upon ground rules according to which the group would function. In this regard the contract also had to include a disciplinary process for group members who were not abiding by the rules. Second, it identifies the group role to be undertaken by each group member. These roles were meeting leader, meeting coordinator, learning facilitator, and account manager. In a cooperative environment, the role of the learning facilitator is especially important. If the group partitions learning tasks among the members, it is the responsibility of the learning facilitator to make sure that what was learned by one group member is communicated to the others.

To foster positive interdependence within the group, all members of a group were awarded test bonus points based on the test performance of individuals within the group (Fellers 1996a). This is one way in which group rewards may be based on individual learning – the link between IA and PI. The number of bonus points was directly related to the average test score of the two lowest group performers on each test. This provided the group a positive incentive to focus their help on those group members who needed it most. Consequently, test results for individual group members were reported back to the group in order to identify those group members who required help from their peers.

In order to further accentuate individual accountability within the group, each group member evaluated themselves and their fellow group members during the semester. These intragroup evaluations were incorporated into the class grading structure (Reif & Kruck 2001).

Table 3: Class Section Treatment by Test

Test	*Cooperative treatment*	*No cooperative treatment*	*Observations (N)*
Test 1 & 2	Section 5	Sections 6 & 7	69
Test 3	Sections 5 & 6	Section 7	69
Test 1 & 2 & 3	Section 5	Section 7	46

Over the course of the semester, treatment group membership changed. Table 3 summarizes the section membership of the treatment and non-treatment groups in relation to the three tests that were administered. Section 5 of the course experienced a cooperative treatment over the entire semester. Section 7 had no formal cooperative aspects over the entire semester. Section 6 had no formal cooperative aspects prior to the administration of the second test. Following the second test, cooperative groups were formed in section 6 in order to undertake work on the project. Consequently, comparison of treatment versus non treatment individual test performance may be undertaken for (1) all tests as between sections 5 and 7, or (2) for tests 1 and 2 between section 5 and sections 6 plus 7, or (3) for test 3 between sections 5 plus 6 and section 7.

3.2 The Experimental Data Set

In view of the experimental design, the experimental and treatment groups may not be equivalent in terms of the confounding effect of variables, other than treatment, that influence learning outcomes. In order to isolate the effect of cooperative treatment on learning outcomes it is necessary to identify and measure these confounding variables (i.e. covariates), and to incorporate them in a multivariate analysis.

Relevant covariates fall into two groups; those that are believed to influence learning in a wide variety of subject areas and those that are peculiar to specific subjects. Covariates also differ in terms of their measurement. Some are readily measured using well-understood scales or categories (e.g. academic ability – GPA), and others are social or attitudinal in nature and therefore require the development of validated instruments for measurement purposes (e.g. computer anxiety). In this study covariates were limited to student characteristics that were directly available or could be obtained without the use or development of validated instruments, and which were either generally accepted as predictive of learning or were believed to be significant for learning in computer-related disciplines.

The set of covariates that were employed included GPA, age, amount of time devoted to the subject matter of the class, gender, and ethnic status. GPA is a widely employed measure of academic ability. Age is taken to represent the experience, maturity or discipline the student may bring to bear on the subject matter. The time devoted to the subject matter was measured in two ways. Student attendance was recorded for each class session. Furthermore, each student logged his or her study time outside class and self-reported these data to the instructor on a weekly basis. Gender is a demographic characteristic related to attitudinal and other factors that influence computing performance (Charleton & Birkett 1999) and cooperative behaviors (Busch 1996). Ethnic status represents a demographic characteristic that reflects racial differences. In view of peer support, research on CL has indicated that it is especially effective with minority students (Ravenscroft 1997).

There were 69 students who completed the class and who had a complete data set. There were 23 of these students in each section. Table 4 provides details on the characteristics of the resulting data set. Table 5 provides descriptive statistics on the learning outputs and Table 6 provides descriptive statistics on the covariates. All tabular values are rounded to two decimal places of accuracy.

As indicated in Table 6, a large majority of subjects in all three sections were in the WHITE category. Furthermore, there were no non-WHITE subjects in section 5. Therefore, WHITE was not employed as a covariate in the subsequent analysis

Table 4: Characteristics of the Data Set

Category	Variable	Description
Learning Outputs	Project Score	100 points maximum
	Test Score	350 points maximum - 100 Test1, 100 Test2, 150 Test3
	IS Concepts	200 points maximum: Multiple choice on Information Systems Concepts - 50 Test1, 50 Test2, 100 Test3
	IS Software	150 points maximum: Written answer to software problems in a specific business context - 50 on each test
Covariates	GPA	Beginning Grade Point Average on a four point scale
	Age	In years
	Male	Categorical variable coded 1 for Male, 0 for Female
	White	Categorical variable formed from Preferred Ethnic Background and coded 1 for White, 0 for Asian, Black, & Hispanic
	Attendance	Maximum 29 - Number of classes attended
	Study Time	Average weekly study time outside of class in hours

Table 5: Individual Learning Outputs – Descriptive Statistics

Tests	Minimum	Maximum	Maximum Possible	Mean	Standard Deviation
Test1Plus2	65.00	188.00	200	144.25	21.90
Test1Plus2IS	32.00	94.00	100	69.45	11.60
Test1Plus2Soft	33.00	98.00	100	74.80	12.88
Test3	50.00	140.00	150	103.62	17.34
Test3IS	46.00	94.00	100	73.91	9.36
Test3Soft	4.00	50.00	50	29.71	10.29
TestTotal	115.00	328.00	350	247.87	36.72
TestIS	78.00	184.00	200	143.36	18.95
TestSoft	37.00	148.00	150	104.51	20.98

Table 6: Covariate Descriptive Statistics by Section

Section		GPA	Age	Attendance	StudyTime	MALE	WHITE
5	Mean	3.00	20.74	28.04	6.08	0.52	1.00
	Std. Dev.	0.60	2.99	1.58	2.48	0.51	0.00
6	Mean	3.00	23.22	27.00	6.86	0.61	0.96
	Std. Dev.	0.50	6.65	3.10	2.94	0.50	0.21
7	Mean	2.90	20.52	28.26	6.35	0.57	0.91
	Std. Dev.	0.49	1.38	1.10	2.41	0.51	0.29
Total	Mean	2.97	21.49	27.77	6.43	0.57	0.96
	Std. Dev.	0.52	4.40	2.15	2.60	0.50	0.21

3.3 Statistical Method and Research Hypotheses

When the research design does not provide adequate control for the confounding effect of covariates, statistical control is achieved by including one or more covariates as independent variables in a multiple regression along with a categorical variable coded to identify the treatment and non-treatment groups. The dependent variable in the regression analysis is a continuous variable that is the outcome of interest (i.e. response variable) in the experiment – in the case of this experiment it is a measure of learning output. When a multiple regression procedure is used in this manner it is referred to as analysis of covariance (Kleinbaum et al 1998).

The purpose of the procedure is to produce an accurate estimate of the regression coefficient associated with the categorical variable defining the treatment and non-treatment groups. This coefficient represents an adjusted mean difference in the response variable between the treatment and non-treatment groups where the adjustment accounts for the linear effect of the covariates. The categorical (i.e. dummy) variable is coded such that a positive coefficient value indicates the mean response (i.e. learning output) of the treatment group exceeds that of the non-treatment group.

However, this regression procedure will not produce an accurate estimate of the adjusted mean difference if there is an interaction between the covariates and the experimental treatment as they influence the dependent variable. In other words, interaction is present if the relationship between the treatment and the response variable is different at different values of a covariate. One way to reduce the likelihood of interaction between the covariates and the treatment is to observe/measure the covariates before the experiment. A second approach is to statistically test for the existence of such an interaction effect prior to undertaking the regression procedure. The covariates GPA, age, and MALE were all measured prior to the experiment. However, Attendance and Study Time were measured during the experiment. In order to determine whether interaction was present, all of the covariates were tested for interaction with the treatment variable. This was done for all regression models. In no instance was there evidence of a statistically significant interaction.

The results of research on CL in higher education, as presented in the education literature, strongly support the hypothesis that CL has a positive effect on individual student achievement. It is logical to extrapolate those results to the IS discipline, and examine whether or not the evidence supports such an extrapolation. Therefore, subsequent analysis will examine the following hypothesis:

H1: Application of the elements of the CL model will produce a significant increase in the achievement of individual students in the undergraduate principles of Information Systems as compared with students who have not experienced the application of these elements.

This hypothesis will be examined in terms of the mean difference between the experimental and control groups, and in terms of the mean difference adjusted for covariation.

In view of the importance attached to the development of teamwork skill and effective teams within Business education in general, and IS in particular, a second hypothesis will be tested. The literature on application of CL in IS (See Section 2.2) indicates that IS educators have adopted a subset of CL elements as a means to enhance the teamwork skills and attitudes of IS students.

The logical outcome of the development of such skills and attitudes would be more effective teams. Mennecke and Bradley (1998) compared the project grades of student teams who had received relatively modest SS training (i.e. the assignment of team roles) with student teams who had not received such training. These authors found a significant and positive treatment effect on team project grades. The data set available from the quasi-experiment presented in the current study allows examination of another hypothesis. Namely, that project grades of cooperative teams (where team roles have been assigned) should exceed project grades for students who undertook the project on an individual basis.

H2: Application of the elements of the CL model will produce a significant increase in the project performance of student project teams in the undergraduate principles of Information Systems as compared with the project performance of individual students who do not have team support.

Since analysis relevant to this hypothesis will compare group outcomes with individual student outcomes, this hypothesis will only be examined in terms of the mean difference between the project scores produced by student groups and the project scores produced by individual students.

4. RESULTS

The examination of results will be subdivided in terms of the research hypotheses. Results bearing on the first hypothesis will be examined under the heading of individual effectiveness. The second hypothesis will be examined under group effectiveness.

4.1 Individual Effectiveness

The individual effectiveness variable, test score, is made operational in three different forms corresponding to the three approaches to treatment group membership (see Table 3). Moreover, since the tests were composed of two parts, the first part being IS literacy and the second part IS software (see section 3.1 and Table 5), examination of individual effectiveness will be undertaken in terms of literacy plus software, in terms of literacy, and in terms of software. In order to contrast the difference between results adjusted for covariation and results not adjusted, in each case a test for unadjusted mean difference will be presented along with the multivariate analysis.

IS Literacy and Software: Tables 7 and 8 show the results of the individual effectiveness analysis with respect to learning outputs that included IS literacy and software in total.

Table 7: IS Literacy & Software – Mean Difference

Learning Output	Treatment Mean	Control Mean	Mean Difference	t	p (2-tailed)
Tests 1 and 2	139.65	146.54	**-6.89**	-1.24	**0.22**
Test 3	102.54	105.78	**-3.24**	-0.73	**0.47**
All Tests: Sec. 5 & 7	239.00	249.48	**-10.48**	-0.95	**0.35**

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Table 8: IS Literacy & Software – Regression / ANCOVA

Variable	Coefficient	Std. Error	t	p*	Tolerance
Tests 1 and 2: Adj. $R^2 = 0.58$, F = 32.48, df = 3/65, p = 0.00					
(Constant)	6.40	24.04	0.27	0.79	
Treatment Group	**-9.07**	3.64	-2.50	**0.02**	0.99
GPA	30.73	3.28	9.36	0.00	1.00
Attendance	1.79	0.80	2.23	0.03	0.99
Test 3: Adj. $R^2 = 0.56$, F = 17.93, df = 5/63, p = 0.00					
(Constant)	12.14	22.36	0.54	0.59	
Treatment Group	**-3.64**	3.03	-1.20	**0.24**	0.95
GPA	24.12	2.73	8.84	0.00	0.96
Age	-0.82	0.35	-2.33	0.02	0.82
Study Time	1.06	0.58	1.82	0.07	0.86
Attendance	1.19	0.69	1.72	0.09	0.89
All Tests Sections 5 & 7: Adj. $R^2 = 0.69$, F = 33.81, df = 3/42, p = 0.00					
(Constant)	-99.51	66.00	-1.51	0.14	
Treatment Group	**-13.71**	6.26	-2.19	**0.03**	0.98
GPA	49.95	6.10	8.19	0.00	0.91
Attendance	7.22	2.44	2.96	0.01	0.91
* 2 - Tailed					

A noteworthy feature of Table 7, that is also present in other individual effectiveness results, is that the control mean exceeds the treatment mean. This presents an issue of statistical hypothesis testing in regard to the research hypothesis. The focus of the issue is the manner in which p (the probability of rejecting a true null hypothesis of zero mean difference – also called the significance level of the test) is calculated. As stated, the research hypothesis would allow for a one-tailed test in the positive tail of the t distribution. However, a more conservative approach in the sense that it makes it more difficult to reject the null hypothesis, and hence accept the research hypothesis, is to calculate p in terms of a two-tailed test. Furthermore, in terms of this experiment, there is no a priori reason to assume that the experimental treatment ***must*** lead to either an increase in learning output or no change. Therefore, in this table and in those that follow, p will be calculated in terms of a two-tailed test. As a consequence of the symmetry of the t distribution, in the presence of a negative mean difference, calculating p in this manner also permits examination of whether the treatment mean is significantly less than the control. In Table 7, if a standard significance level such as 0.05 is assumed, the mean differences are negative but not significant.

The goal of the multivariate analysis is to derive an accurate estimate of the regression coefficient associated with the Treatment Group variable. In the process of identifying covariates to include in the analysis, two criteria are pertinent to accuracy; confounding and precision (Kleinbaum et al 1998). Therefore, starting from the complete set of covariates, whether or not a covariate was retained was based on the impact removal of the covariate had on the Treatment Group coefficient and on the standard error of that coefficient. The statistics displayed in Table 8 and in subsequent multivariate results, are the outcome of this choice process. In no instance did the outcome of this process result in the removal of a covariate that was statistically significantComparison of tables 7 and 8 indicates that the impact of the treatment effect remained negative, but in two of three cases the inclusion of covariates produced an increase in the absolute value of the adjusted mean difference sufficient to make it statistically significant using a two-tail test. The multivariate regression model was highly significant in explaining variation in Test Score. The explained variation ranged between 56% and 69%. The tolerance statistic estimates the proportion of the variation of that variable that is ***not*** explained by its linear relationship with other independent variables in the model. With tolerance estimates close to one, there is no evidence of multicolinearity.

IS Literacy: Tables 9 and 10 display the results of the individual effectiveness analysis with respect to IS literacy as the learning output.

Table 9: IS Literacy – Mean Difference

Learning Output	Treatment Mean	Control Mean	Mean Difference	t	p (2-tailed)
Tests 1 and 2	66.35	71.00	**-4.65**	-1.59	**0.12**
Test 3	73.00	75.74	**-2.74**	-1.15	**0.26**
All Tests: Sec. 5 & 7	136.61	145.57	**-8.96**	-1.68	**0.10**

These results parallel those where learning output included both IS literacy and software. The mean differences in Table 9 are negative and not significant. On the other hand, the adjusted mean differences in Table 10 are negative and significant at the 0.05 level in the same two out of three cases.

Table 10: IS Literacy – Regression / ANCOVA

1. ***Variable***	Coefficient	2. ***Std. Error***	t	p*	Tolerance
Tests 1 and 2: Adj. $R^2 = 0.51$, F = 18.88, df = 4/64, p = 0.00					
(Constant)	-9.20	15.40	-0.60	0.55	
Treatment Group	**-5.11**	2.09	-2.44	**0.02**	0.98
GPA	14.19	1.89	7.50	0.00	0.98
Age	0.54	0.23	2.32	0.02	0.93
Attendance	0.96	0.47	2.05	0.04	0.95
Test 3: Adj. $R^2 = 0.31$, F = 16.39, df = 2/66, p = 0.00					
(Constant)	46.61	5.49	8.49	0.00	
Treatment Group	**-3.71**	1.99	-1.86	**0.07**	0.99
GPA	10.03	1.81	5.56	0.00	0.99
All Tests Sections 5 & 7: Adj. $R^2 = 0.58$, F = 21.75, df = 3/42, p = 0.00					
(Constant)	66.64	10.60	6.29	0.00	
Treatment Group	**-11.65**	3.54	-3.29	**0.00**	0.99
GPA	23.76	3.32	7.17	0.00	0.99
IS Time	4.20	1.41	2.99	0.01	1.00
*2-tailed					

In Table 10, IS Time is included as a covariate rather (total) Study Time. The student self-report regarding time spent outside of class was subdivided between time spent on IS literacy and time spent on software. Since the comparison between sections 5 and 7 involved all tests over the course of the semester, it was possible to incorporate this measure as a covariate. A corresponding measure pertinent to only part of the semester, for tests 1 and 2 or only test 3, was not easily assembled from the student data and hence was not considered in the covariate set.

IS Software: Tables 11 and 12 display the results of the individual effectiveness analysis with respect to IS software as the learning output.

Table 11: IS Software – Mean Difference

Learning Output	Treatment Mean	Control Mean	Mean Difference	t	p (2-tailed)
Tests 1 and 2	73.30	75.54	**-2.24**	-0.68	**0.50**
Test 3	29.54	30.04	**-0.50**	-0.19	**0.85**
All Tests: Sec. 5 & 7	102.39	103.91	**-1.52**	-0.23	**0.82**

In the case of software, the mean difference results in Table 11 are similar to the mean difference results for both learning components and for IS literacy alone. The mean differences are negative but not significant.

However, the multivariate results are different. While the adjusted mean differences remain negative, in no case are they significant.

Table 12: IS Software – Regression / ANCOVA

Variable	*Coefficient*	**Std. Error**	*t*	*p**	Tolerance
Tests 1 and 2: Adj. R^2 = 0.48, F = 16.98, df = 4/64, p = 0.00					
(Constant)	19.56	17.59	1.11	0.27	
Treatment Group	**-4.10**	2.39	-1.72	**0.09**	0.98
GPA	16.67	2.16	7.72	0.00	0.98
Age	-0.67	0.26	-2.53	0.01	0.93
Attendance	0.77	0.54	1.45	0.15	0.95
Test 3: Adj. R^2 = 0.53, F = 20.04, df = 4/64, p = 0.00					
(Constant)	-29.44	13.59	-2.17	0.03	
Treatment Group	**-0.34**	1.85	-0.19	**0.85**	0.95
GPA	13.45	1.66	8.13	0.00	0.98
Attendance	1.06	0.41	2.58	0.01	0.94
Age	-0.47	0.20	-2.31	0.02	0.93
All Tests Sections 5 & 7: Adj. R^2 = 0.69, F = 34.60, df = 3/42, p = 0.00					
(Constant)	-133.89	38.40	-3.49	0.00	
Treatment Group	**-2.98**	3.64	-0.82	**0.42**	0.98
GPA	27.78	3.55	7.83	0.00	0.91
Attendance	5.56	1.42	3.93	0.00	0.91
*2-tailed					

These results do not support H1. As opposed to increases in achievement, the individual effectiveness analysis indicates that individuals subject to cooperative treatment on average have lower test scores than individuals not subject to such treatment. Furthermore, using the t statistic in a two-tailed test, the adjusted mean difference is negative and statistically significant in several cases. This negative effect appears most pronounced on achievement in IS literacy.

Table 13: Mean Difference – Group Versus Individual Project Scores

Learning Output	Group Mean	Individual Mean	Mean Difference	t	p (2-tailed)
Project					

Score	84.73	79.83	**4.90**	1.01	**0.32**

4.2. Project Effectiveness

Between sections 5 and 6 there were fifteen project groups. Twenty four projects were completed by individual students in section 7. Table 13 presents the result of an analysis of mean difference between group and individual project scores. These results indicate that cooperative groups did have a higher mean project score than project outcomes for individuals. However, the mean difference is not statistically significant. These results do not support H2.

5. CONCLUSION

In summary, statistical analysis of the experimental data indicates that cooperative treatment as applied to an introductory course in IS:

- had a pervasive negative impact on individual student learning outcomes,
- in some cases had a statistically significant negative impact on overall individual learning outcomes and those related to IS literacy, and
- did not have a significant positive impact on project performance when compared with individual student project performance.

One explanation for these results is that the implementation of elements of CL was inadequate. Some details of that implementation are presented in this study. The manner in which these elements were implemented could no doubt be improved. However, at what point does the effectiveness payoff occur? Is cooperative learning a robust pedagogy with respect to individual learning outcomes, or is it fragile? Results reported in the education literature strongly suggest that it is robust. Ravenscroft (1997 p. 190) emphasizes this by pointing out the "remarkable" lack of consistent research showing achievement decrements with cooperative learning and how "noteworthy" significant negative effects would be. More assessment studies in IS are needed to address this issue. Furthermore, if the results are not positive, careful attention needs to be paid to the potential cause(s). If cooperative learning is fragile in IS, it should clearly be handled with care.

What might be potential sources for such fragility? In answering this question it may be useful to distinguish between student teams in an academic environment and business teams in an organizational environment, and relate this distinction to the elements of CL (See Table 1). There are significant differences between student and business teams (Jones 1996; Stephens 2001). They differ in terms of their experience and therefore their degree of sophistication in process skills. With respect to the CL model these are SS and GP. Attention to development of these skills in students has been a recent focus in both business and IS instruction (see Section 2.2). Process skills as employed within CL serve to mediate enhanced learning outcomes at the individual level. In this experiment the extent to which student process skills were developed may not have been sufficient.

There are also differences between student teams and business teams in terms of incentives for behavior. Jones (1996) points out that longevity with the company, personal connections that precede and supersede a particular team, and a personal history of accomplishment are some of the incentives in a business environment that lead to team commitment and that are not as evident in academic settings. In an academic context these incentives are largely implemented in terms of the evaluation structure of the class. Students must not only have the skills necessary to succeed in groups, they must also be motivated to contribute to the group. With respect to the CL model, this is where PI and IA come into play.

Slavin (1996) asserts that associating group success with individual learning is a necessary condition for achieving positive results with CL. This may present a problem as significant as the development of process skills. In this experiment, test bonus points may not have provided a sufficient incentive for the necessary group learning behaviors to occur. The more able students must be motivated to assist the less able students via elaboration, and the less able students must be motivated to exert effort to receive and learn from that assistance.

In circumstances where the group activities involve a collective product (e.g. an IS project), lack of adequate motivation can also lead to "free ridership" (Kerr & Bruun 1983). A student rides free when he/she does not do their best work or exert maximum effort in the group on the belief that he/she will not individually suffer negative consequences as a result. Bartlett (1995) identifies the free-rider problem as the biggest negative cost associated with cooperative learning, and effectively addressing it as the key to success for the technique. This also is a potential cause for negative effectiveness results. Since a free rider may not have participated in vital learning experiences, test outcomes over that material would tend to be lower as compared to similar students undertaking course materials on an individual basis who are unable to ride free. The existence of free riders and the burden that is placed on those students that actually bear the cost of producing the collective product on behalf of the group may be one source of an inverse relationship between student ability and satisfaction with CL (Baldwin, Bedell, & Johnson 1997). While peer pressure reinforced by the group contract and intragroup evaluations are intended to address this problem, they depend critically on the willingness of students to objectively evaluate their peers and the timeliness (Jones 1996) of this feedback.

However, implementing class evaluation structures that provide strong incentives for students to assist their peers introduces additional risk into the relationship between student effort and reward. For example, while this experiment employed test bonus points as an incentive (i.e. no down-side risk for a student), a stronger evaluation structure might require that a student's test score be based on the average of the scores received by the group members, or by the test score of a randomly selected single group member. In this context there would be much greater motivation to assist peers, but there may also be significant down-side risk for more able students. Roberts (2001) refers to such strongly motivational, but individually risky, evaluation structures as the "socialist" model of assessment. In this regard, it is noteworthy that in Table 2, Fellers (1996a) was the only study implementing PI. Such structures may be another source of a negative relationship between student ability and satisfaction with CL. Consequently, instructors may be unwilling to implement them (Roberts, 2001).

In order to determine whether further process skill development or stronger incentive structures are required for CL to produce significant positive effects on individual learning outcomes in IS instruction, further research involving comparative analysis that focuses directly on those types of interventions is needed. However, regardless of whether the results presented in this study stemmed from problems with process skills, incentives, or other factors, they suggest that until a robust implementation of CL is achieved, instructors in IS may face goal conflict in terms of instructional objectives. The cooperative treatment did have a positive impact on collective project work, although it lacked significance. If group project experience is specified as a dominant instructional objective in IS, should instructors be willing to accept some negative effects on individual learning as a trade-off? The answer to this question would depend on the curriculum level at which the technique is being applied. These results suggest that instructors should reconsider the implementation of cooperative techniques in lower-division IS classes intended to promote core competencies. It might be best to foster the development of these core competencies on an individual basis. Once these core competencies are in place, learning group skills in a cooperative context in upper-division classes would take place on a firmer foundation.

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