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Effect of Group Learning on Academic Performance: A Pilot Study for Com-Based Classes

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EFFECT OF GROUP LEARNING ON ACADEMIC PERFORMANCE: A PILOT STUDY FOR COMPUTER-BASED CLASSES

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Abstract

This project investigates the effect of group learning on academic performance for computer-based courses. The independent variables include group learning, current grade point average, major field, gender, and ethnicity. The dependent variable is the grade for the computer-based course. The subjects are students from two computer-based courses in two semesters. Two courses in the first semester have individual-based learning while the same two courses in the second semester have group-based learning. A series of multiple regression models are used to explore the relationship in the entire data set, data subsets of female/male, and major/non-major. The results suggest a significant group learning effect on academic performance. For all students, the most significant factors are current GPA and group learning. Controlling the factors of gender and major, we found that female and non-major students benefit more from group learning than other students. This finding provides some support to the social approval and competence theories stating that students with strong needs for social approval from their peers and low level of competence tend to achieve more in a group learning environment. In addition, we could not find any significant non-linear effect of current GPA on course grades among the regression models.

Keywords: Group learning, gender, classroom, grade, ethnicity

Introduction

The effect of group learning on academic performance has been the subject of many research studies. Some studies find positive effect of group learning on students' fast grasp of difficult concepts, sense of support system, enhancement of self-image, and high quality of work accomplished (Winter 95, Smith 95, Dobos 96, Heller 92, Wissglass 93, Lou 96, Towns 00, Lepine 01, Kumpulainen 99). On the other hand, there are also studies showing insignificant differences between individual and group learning (Daniels 94), or inconclusive results on the effect of group learning (Prado-Olmos 93, Nelson 96, Brush 97, Smith 95, Rosser 98). Most of the inconclusive results are due to the contingency effect from different composition of the groups (such as academic preparation, gender, ethnic origins, learning style, group dynamic, etc.), different task nature, and different task environment.

Scalia and Sackmary (96) investigated classroom group activities in a technology-oriented environment. Their results indicated students' high satisfaction for the quantity of information received from team members, the contributions of group members to the discussion, and the final group work, but low satisfaction for the decision making process. Daniels (94) identified the need for social approval as a significant factor for group learning. Students with strong need for social approval tend to be good group learners. McInerney *et al.* (97) concluded that students' prior competence in the task affects the learning result of group activities. When group members have the same level of competence, they can communicate and perform more effectively. However, mixed-ability groups have the most positive effect on individuals with lower level of competence. The literature indicates that group learning can be an effective alternative to traditional individual learning but the effect of group learning can be subject to many factors and their interaction. Thus, there is the need to identify factors that can induce group productivity in different situations. Section 2 of this research report describes the objective and experimental procedure of the project. Section 3 presents statistical models and analytical results. The last section concludes the report and suggests further research directions.

Objective and Experimental Procedure

This research project has the objective of revealing the effect of group learning on two computer-based classes being taught by the investigator. The two courses are Accounting Information Systems and Knowledge-Based Information Systems. The two courses have individual learning as the major learning approach as well as the common characteristic of being heavily loaded with computer concepts and system techniques. The study attempts to shed light on the applicability and effectiveness of group learning for computer courses.

This research project defines group learning as a learning approach, which relies on students' interaction in a group setting to acquire knowledge and problem solving skills. Students' interaction includes different types of communication (e.g., questioning, explaining, arguing, etc.) for knowledge delivery. There are five independent variables including group learning (Group), grade point average (GPA), major field (Major), gender (Gender), and ethnicity (CA: Caucasian, OR: Oriental, AA: African American, IN: Indian, HI: Hispanic). The dependent variable is a student's final grade from the two courses under investigation. Students in the course of Accounting Information System do not have Management Information Systems (MIS) as their major. Students in the course of Knowledge-Based Information Systems have MIS as their major. The investigator adopted the group learning approach as the teaching method for the two courses in one semester, from which we collected students' information and performance data. Then we compared the results with the students in two equivalent classes without the group learning method from a previous semester. In order to ensure the comparability of the classes, the textbooks, examination contents, quiz contents, and homework assignments are all the same. The only difference in the controlled classes is the presence of in-class group exercises. For classes without in-class group exercises, the instructor used the problems from the exercises as examples during lectures to reinforce the understanding of those topics.

The teaching method of group learning approach was administered as follows. At the beginning of the semester, students were informed of the in-class group exercise as a grade component. Students were allowed to form their own groups of not more than 4 students. In-class group exercises were unannounced, and were given to students randomly throughout the semester. All students in the same group received the same grade for an in-class group exercise. In-class group exercises are of problem solving type, which are designed to practice and reinforce difficult technical concepts and skills presented in class. The topics for in-class group exercises include normalization for relational database, mapping from entity-relationship diagrams to relational tables, identification of internal control problems, cost-benefit analysis, risk calculation for internal control problems, and value of perfect information. These are important topics for quizzes and examinations. Students were allowed to consult the investigator (i.e., the instructor), their books, and notes during in-class group exercises. An in-class group exercise was given only after relevant and necessary concepts and information were presented in class. The time allowed for an in-class group exercise ranged from 15 to 30 minutes. The investigator minimized lecture time by covering only the necessary information for in-class group exercises. It is expected that much of the learning result will be accomplished through the group dynamic during in-class group exercises. Students' final grades and all independent variables from the two controlled courses (i.e., having group learning activities) were collected at the end of the semester. Similar variables were also compiled from the same courses in a previous semester, which did not have group learning activities.

Statistical Models and Analytical Results

Multiple regression models are adopted to explore the relationship between the five independent variables (Group, GPA, Major, Gender, and Ethnicity) and the dependent variable (Grade). All variables except GPA and Grade are nominal. For the variable of Group, 0 indicates having no group activity, and 1 indicates having group activity. For the variable of Major, 0 indicates non-major (non-MIS students), and 1 indicates major (MIS students). For the variable of Gender, 0 indicates female, and 1 indicates male. For the variable of Ethnicity, 5 dummy variables including CA (Caucasian), OR (Oriental), AA (African American), IN (Indian), and HI (Hispanic) are used. For the 5 dummy variables, 0 indicates not being in that ethnicity group, and 1 indicates being in that ethnicity group. GPA and Grade are continuous variables. The data set has 139 students in total, which has 61 female and 78 male; 45 major and 94 non-major; 71 with group learning and 68 without group learning; and 76 Caucasian, 39 Oriental, 11 African American, 5 Indian, and 8 Hispanic.

In order to verify the assumptions of regression model, we checked the normality of the variables GPA and Grade. Figure 1 (omitted) shows the normal probability plot and histogram for the variable Grade, and Figure 2 (omitted) shows the same for the variable GPA. Since the normal probability plots present roughly straight lines, the assumptions for regression models are not violated. Tables 1 through 9 present the regression equations, p values for individual independent variables, p values for F ratios, and the adjusted R^2 values for different regression models in this project. Since the variable HI (Hispanic) is highly correlated with other variables, it was excluded from the regression analysis for all students.

Table 1 shows the regression models for all students in the data set. We built different regression models using different subsets of the independent variables. There are 5 models with 1 independent variable (models 1.1 – 1.5), 10 models with 2 independent variables (models 2.1 – 2.10), 2 models with 3 independent variables (models 3.1 – 3.2), 1 model with 4 independent variables (model 4.1), and 1 model with 5 independent variables (model 5.1, the full model). Among all models, model 2.1 is the model with all independent variables being significant at $\alpha = 0.1$ and a relatively high adjusted R^2. Model 2.1 has Group and GPA as the two independent variables. The coefficients for Group and GPA are both positive indicating the higher the cumulative GPA, the higher the course grade, and there is a positive association between group learning activities and course grade. However, the effect of GPA is more significant than group learning activities on Grade. As a diagnostic tool for the goodness of fit of the regression model, the plot of standardized residual vs. the predicted grade for model 2.1 is given in Figure 3 (omitted). Figure 3 shows a random distribution of the data points, which confirms a well-fitted model.

Table 2 shows the regression models for male students. All models with α level of 0.01 or less have GPA as the significant factor. Group and Major do not have significant effect on Grade for the male subset.

Table 3 shows the regression models for female students. Model 3.1 has a relatively high value of adjusted R^2 and all independent variables being significant at $\alpha = 0.1$. For female students, GPA, Major, and Group are significant factors for Grade. GPA and Group have a positive whereas= Major has a negative correlation with Grade. The results reveal the phenomenon of non-major female students with group learning activities being able to achieve higher grade.

Table 4 shows the regression models for major students. Model 2.3 has a high adjusted R^2, and independent variables GPA, CA, AA, and IN are significant at the α level of 0.1. For major students, Caucasian, African American, and Indian students with high GPA tend to have high course grade.

Table 5 shows the regression models for non-major students. Model 1.1 has GPA as the significant factor, and model 1.3 has Gender as the significant factor.

Tables 6 and 7 (omitted) show the regression models using GPA^2 as one of the independent variables. The purpose of using the higher order GPA variable is to test whether group learning activities have a more positive effect on students with high GPA than other students. The results indicate that models using GPA^2 have similar adjusted R^2 to models using GPA.

Tables 8 and 9 (omitted) show the regression models using $GPA^{1/2}$ as one of the independent variables. The purpose of using the lower order GPA variable is to test whether group learning activities are more effective on students with low GPA than other students. The results indicate that models using $GPA^{1/2}$ have similar adjusted R^2 to models using GPA. The above results show that GPA does not have significant non-linear relationship with the dependent variable Grade.

Conclusion

We performed a preliminary study of the effect of group learning activities on students' performance for computer-based courses. For all students, GPA and group learning activities are the two significant variables to determine student performance. The results of controlling Gender show that GPA is the only significant factor for male students whereas GPA, group learning, and Major are significant factors for female students. The results of controlling Major show that for major students, Caucasian, African American, and Indian students with high GPA tend to have good performance whereas for non-major students, GPA and Gender are significant factors. To explore non-linear effect of GPA on performance, we built regression models using GPA^2 as well as $GPA^{1/2}$ as one of the independent variables. We cannot identify non-linear relationship between previous GPA level and future performance. Overall speaking, to answer the research question we have in this project, i.e., whether group learning activities have significant effect on students' performance in computer-based classes, we can offer a tentatively positive response. Multiple regression analyses confirm that GPA is the most significant factor, followed by group learning activities as another significant factor for the entire data set. The group learning factor is especially strong for female and non-major students. This study supports the effectiveness of group learning on the delivery of technical concepts and skills in computer-based courses. To generalize the results, further studies can increase the sample size, include other independent variables such as learning behavior and group dynamics, and apply the study to courses in different disciplines.

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Table 1. Regression Equations for All Students

	Regression Equation	p value for Individual Factor	p value for F	R-sq (adj)
1.1	Grade = 2.57 + 0.197Group	Group: 0.196	0.196	0.5%
1.2	Grade = 2.7 + 0.133CA - 0.272OR - 0.264AA - 0.16IN	CA: 0.688; OR: 0.432 AA: 0.524; IN: 0.752	0.183	1.7
1.3	Grade = - 0.336 + 1.07GPA	GPA: 0.0	0.0	29.4
1.4	Grade = 2.81 - 0.258Gender	Gender: 0.091	0.091	1.4
1.5	Grade = 2.69 - 0.064Major	Major: 0.696	0.696	0.0
2.1	Grade = - 0.493 + 0.242Group + 1.08GPA	Group: 0.058 GPA: 0.0	0.0	30.7
2.2	Grade = - 0.2 - 0.152Gender + 1.05GPA	Gender: 0.242 GPA: 0.0	0.0	29.6
2.3	Grade = - 0.336 + 1.09GPA - 0.183Major	GPA: 0.0 Major: 0.184	0.0	29.8
2.4	Grade = - 0.31 + 1.04GPA + 0.129CA - 0.143OR - 0.002AA + 0.223IN	GPA: 0.0 CA: 0.644; OR: 0.626 AA: 0.996; IN: 0.607	0.0	29.2
2.5	Grade = 2.72 + 0.184Group - 0.248Gender	Group: 0.225 Gender: -0.248	0.115	1.7
2.6	Grade = 2.59 + 0.195Group - 0.057Major	Group: 0.201 Major: 0.724	0.408	0.0
2.7	Grade = 2.82 - 0.032Major - 0.255Gender	Major: 0.843 Gender: 0.099	0.237	0.7
2.8	Grade = 2.51 + 0.256Group + 0.21CA - 0.191OR - 0.304AA - 0.173IN	Group: 0.106 CA: 0.527; OR: 0.581 AA: 0.46; IN: 0.732	0.115	2.9
2.9	Grade = 2.73 - 0.071Major + 0.129CA - 0.278OR - 0.2714AA - 0.13IN	Major: 0.668 CA: 0.698; OR: 0.422 AA: 0.514; IN: 0.8	0.115	2.9
2.10	Grade = 2.81 - 0.288Gender + 0.199CA - 0.225OR - 0.214AA - 0.153IN	Gender: 0.059 CA: 0.545; OR: 0.513 AA: 0.601; IN: 0.761	0.27	1.1
3.1	Grade = - 0.364 + 0.234Group - 0.138Gender + 1.06GPA	Group: 0.068 Gender: 0.284 GPA: 0.0	0.081	3.5
3.2	Grade = 2.72 + 0.183Group - 0.028Major - 0.245Gender	Group: 0.228 Major: 0.866 Gender: 0.112	0.228	1.0
4.1	Grade = - 0.38 + 0.231Group - 0.118Gender - 0.16Major + 1.08GPA	Group: 0.07 Gender: 0.361 Major: 0.245 GPA: 0.0	0.0	31.0
5.1	Grade = - 0.397 + 0.247Group - 0.176Major - 0.136Gender + 1.05GPA + 0.225CA - 0.059OR - 0.034AA + 0.291IN	Group: 0.065 Major: 0.213 Gender: 0.3 GPA: 0.0 CA: 0.424; OR: 0.84 AA: 0.922; IN: 0.501	0.0	31.3

Group: In-Class Group Exercise, CA: Caucasian, OR: Oriental, AA: African American, IN: Indian, HI: Hispanic

Table 2. Regression Equations for Male Students

	Regression Equation	p value for Individual Factor	p value for F	R-sq (adj)
1.1	Grade = - 0.239 + 1.01GPA	GPA: 0.0	0.0	21.1%
1.2	Grade = 2.52 + 0.075Group	Group: 0.722	0.722	0.0
1.3	Grade = 2.51 + 0.124Major	Major: 0.567	0.567	0.0
1.4	Grade = 2.53 + 0.181CA - 0.233OR - 0.250AA - 0.033IN	CA: 0.744, AA: 0.702 IN: 0.968, OR: 0.683	0.484	0.0
2.1	Grade = - 0.426 + 1.04GPA + 0.199Group	GPA: 0.0 Group: 0.29	0.0	21.3
2.2	Grade = - 0.257 + 1.02GPA - 0.065Major	GPA: 0.0 Major: 0.743	0.0	20.2
2.3	Grade = - 0.754 + 1.02GPA + 0.58CA + 0.352OR + 0.394AA + 0.763IN	GPA: 0.0 CA: 0.249 OR: 0.504 AA: 0.514 IN: 0.327	0.001	19.6
3.1	Grade = - 0.436 + 1.05GPA + 0.195Group - 0.047Major	GPA: 0.0 Group: 0.304 Major: 0.812	0.0	20.3
4.1	Grade = - 1.27 + 1.08GPA + 0.318Group - 0.035Major + 0.8CA + 0.56OR + 0.436AA + 0.979IN	GPA: 0.0, Group: 0.124 Major: 0.86, CA: 0.126 OR: 0.303, AA: 0.47 IN: 0.216	0.002	20.1

Table 3. Regression Equations for Female Students

	Regression Equation	p value for Individual Factor	p value for F	R-sq (adj)
1.1	Grade = - 0.314 + 1.09GPA	GPA: 0.0	0.0	38.6%
1.2	Grade = 2.64 + 0.324Group	Group: 0.139	0.139	2.0
1.3	Grade = 2.89 - 0.274Major	Major: 0.272	0.272	0.4
1.4	Grade = 2.80 + 0.217CA - 0.222OR - 0.180AA - 0.233IN	CA: 0.601 OR: 0.609 AA: 0.740 IN: 0.710	0.473	0.0
2.1	Grade = - 0.425 + 1.07GPA + 0.274Group	GPA: 0.0 Group: 0.110	0.0	40.3
2.2	Grade = - 0.255 + 1.09GPA - 0.306Major	GPA: 0.0 Major: 0.116	0.0	40.2
2.3	Grade = - 0.127 + 1.09GPA - 0.1CA - 0.45OR - 0.18AA - 0.11IN	GPA: 0.0 CA: 0.761 OR: 0.191 AA: 0.672 IN: 0.823	0.0	38.3
3.1	Grade = - 0.37 + 1.08GPA + 0.304Group - 0.34Major	GPA: 0.0 Group: 0.073 Major: 0.077	0.0	42.5
4.1	Grade = - 0.113 + 1.11GPA + 0.235Group - 0.481Major - 0.153CA - 0.543OR - 0.323AA + 0.087IN	GPA: 0.0, Group: 0.18 Major: 0.024, CA: 0.629 OR: 0.109, AA: 0.431 IN: 0.86	0.0	43.8

Table 4. Regression Equations for Major Students

	Regression Equation	p value for Individual Factor	p value for F	R-sq (adj)
1.1	Grade = - 0.143 + 0.956GPA	GPA: 0.0	0.0	25.5%
1.2	Grade = 2.53 + 0.197Group	Group: 0.489	0.489	0.0
1.3	Grade = 2.61 + 0.022Gender	Gender: 0.941	0.941	0.0
1.4	Grade = 1.8 + 1.17CA + 0.318OR + 0.633AA + 0.950IN	CA: 0.036, OR: 0.582 AA: 0.383, IN: 0.165	0.055	12.2
2.1	Grade = - 0.412 + 0.995GPA + 0.321Group	GPA: 0.0 Group: 0.191	0.001	26.8
2.2	Grade = - 0.162 + 0.957GPA + 0.029Gender	GPA: 0.0 Gender: 0.911	0.001	23.8
2.3	Grade = - 0.79 + 0.948GPA + 0.851CA + 0.212OR + 1.04AA + 1.1IN	GPA: 0.001 CA: 0.081 OR: 0.672 AA: 0.106 IN: 0.067	0.001	34.2
3.1	Grade = - 0.496 + 0.998GPA + 0.341Group + 0.101Gender	GPA: 0.0 Group: 0.179 Gender: 0.698	0.002	25.3
4.1	Grade = - 1.35 + 0.964GPA + 0.456Group + 0.182Gender + 1.07CA + 0.371OR + 1.14AA + 1.23IN	GPA: 0.0, Group: 0.065 Gender: 0.471, CA: 0.036 OR: 0.475, AA: 0.076 IN: 0.039	0.001	37.1

Table 5. Regression Equations for Non-Major Students

	Regression Equation	p value for Individual Factor	p value for F	R-sq (adj)
1.1	Grade = - 0.58 + 1.17GPA	GPA: 0.0	0.0	32.3%
1.2	Grade = 2.59 + 0.195Group	Group: 0.285	0.285	0.2
1.3	Grade = 2.89 - 0.376Gender	Gender: 0.037	0.037	3.6
1.4	Grade = 3.24 - 0.469CA - 0.69OR - 0.802AA - 1.54IN	CA: 0.254 OR: 0.107 AA: 0.110 IN: 0.111	0.284	1.2
2.1	Grade = - 0.677 + 1.17GPA + 0.191Group	GPA: 0.0 Group: 0.202	0.0	32.8
2.2	Grade = - 0.36 + 1.13GPA - 0.192Gender	GPA: 0.0 Gender: 0.207	0.0	32.8
2.3	Grade = - 0.125 + 1.13GPA - 0.276CA - 0.41OR - 0.557AA - 0.772IN	GPA: 0.0 CA: 0.421 OR: 0.252 AA: 0.184 IN: 0.34	0.0	31.4
3.1	Grade = - 0.455 + 1.13GPA + 0.195Group - 0.196Gender	GPA: 0.0 Group: 0.191 Gender: 0.196	0.0	33.3
4.1	Grade = - 0.047 + 1.08GPA + 0.257Group - 0.209Gender - 0.217CA - 0.373OR - 0.649AA - 0.783IN	GPA: 0.0, Group: 0.104 Gender: 0.176, CA: 0.522 OR: 0.293, AA: 0.122 IN: 0.33	0.0	33.3