2006-836: A MANUFACTURING PROCESSES COURSE WITH A MIXED LEARNING COMMUNITY AND NON-LEARNING COMMUNITY AUDIENCE: QUANTITATIVE RESULTS

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A Manufacturing Processes Course with a Mixed Learning Community and Non-Learning Community Audience: Quantitative Results

Abstract

Learning communities, where students take one or more courses together and are encouraged to work as a team and community, have been shown to be effective in reducing attrition and increasing retention of participants at the university level. At the Rochester Institute of Technology they have been shown to be very effective in reducing the number of first year students that do not participate in classroom activities and consequently fail. Many of these students fail in multiple courses and are unlikely to return their second year. This study explores the relative importance of the many variables influencing student performance on a manufacturing processes course, including participation in a learning community.

The relative performance of student members of a learning community vs. students that were not associated with the learning community in an introductory manufacturing processes course is compared. Data were collected about GPA, year in college, whether the student studied every weeknight or sporadically, and about their previous experience and knowledge of manufacturing. The ANOVA statistical analysis is used to investigate the effect of all variables in student performance.

Two variables, GPA and participation in the learning community are statistically valid predictors of success in the course. The data supports the conclusion that students on the learning community performed better than their peers that did not participate in a learning community.

Introduction

Learning communities (LC) are environments that promote student-student and student-faculty interaction. They have been shown to increase student achievement and satisfaction[1-7]. At the Rochester Institute of Technology (RIT), first year students are offered the opportunity to volunteer to join a department living and learning community in which students have the same class schedule and live in the same floor in the dormitory. The community faculty includes all the subjects that the students take together and meets periodically to share information and observations and to review each student's progress. Previous research has shown that the primary benefit of these meetings is the early identification of "outliers", i.e. students that are not participating in school activities and missing class[7]. With such early warning, student support services can help correct the situation.

Although there is much statistical data that support the conclusion that LC improve student performance, most of the research does not clearly separate LC from other factors that are known to increase student achievement. This research attempts to distinguish the "LC-effect" on student performance in a Manufacturing Processes class. The class is required for all first year students in the Mechanical and Manufacturing Engineering Technology Department. In addition, second and third year students from other departments take the course either as a requirement or technical elective.

Variables that have been proposed as predictors of student performance include the previous academic performance[8-10], self-discipline and motivation[11], time commitment and study skills[12], integration into the campus community[13-14], health[15-16], sex and age[17], previous knowledge or experience in the subject matter[18], and socioeconomic status[19]. This study uses the following variables: 1)high school GPA as proxy for previous academic performance, 2)whether the student has the habit of studying every weeknight or sporadically, 3)age, 4)year in college, 5)previous engineering or manufacturing work experience, and 6)participation in the learning community.

Student Learning Communities

Student LC facilitate cooperative learning[20], which has been shown to enhance learning and student performance in engineering curricula[21]. Research has shown that cooperative learning is more effective than competitive or individualized learning[22]. It also facilitates student integration into the larger campus community[2] which, according to Tinto's model of student retention can enable early intervention and higher retention.

The simplest LC allow students to work together cooperatively and sometimes as a team. At RIT, faculty is also part of the community. Interaction between faculty and students outside of the classroom is encouraged. This makes faculty more approachable to students and is especially beneficial to first year students.

Manufacturing Processes I

The course Manufacturing Processes I is a survey of traditional manufacturing processes including welding, machining, casting and forging. Because most of the students are first year students with no work experience, they are unfamiliar with the equipment and procedures used in industry. A laboratory introduces the students to machining equipment and shop procedures. Other processes are simply demonstrated during lectures, in the laboratory or with relevant films. The student's grades include three tests, including a final, weekly homework assignment, a team project and a laboratory grade. Students can accumulate a total of 1,620 points from which the final grade is calculated. Figure 1a shows the distribution and descriptive statistics of the of points accumulated by all students in the three sections of the course taught in the Fall of 2005. One section, labeled Section 3 on the table, had mixed LC and non-LC enrollment and the grade distributions and statistics for both groups are shown in Figure 1b and Figure 1c respectively. The original data are shown on Table 1.

Table 1 – Total Points Earned

All Sections	Section3-LC	Section3-nonLC
1394	*	*
1382	*	*
1452	*	*
654	*	*
1528	1528	*
1330	*	*
1420	1420	*
1519	1519	*
1370	*	1370
1452	*	1452
1532	*	*
1491	1491	*
445	*	*
1348	*	*
1227	*	*
1540	*	*
1527	*	*
1537	1537	*
1453	*	1453
1334	1334	*
1467	1467	*
933	*	*
1452	*	1452
913	*	*
1438	1438	*
1453	*	*
1459	1459	*
1089	1089	*
1518	*	*
1161	*	*
1543	*	*
1448	*	1448
1419	1419	*
1467	1467	*
1300	*	*
1481	*	*
1394	1394	*
1515	*	*
1367	*	*
747	*	*
1493	*	*
1530	*	*
1416	*	*
1302	*	*
1385	*	*
1306	*	1306
1275	1275	*
1120	*	*
1237	*	*
1412	*	*
1242	*	*
1496	1496	*
1298	*	1298
1509	*	1509
1055	*	1055
1123	*	*
1267	*	*
1507	*	*
1123	*	1123
1412	*	*
1552	*	*
1263	*	1263
1361	*	*
1111	1111	*
1507	*	1507
930	*	*
1468	1468	*
1286	*	*
1396	*	*
1073	*	*
1194	*	*
1373	*	*
1135	*	*
1529	*	1529
1418	*	*
1063	*	*
1261	*	*
1309	*	*
1293	*	*

Figure 1a-Descriptive Statistics for Earned Points (Results for All Sections)

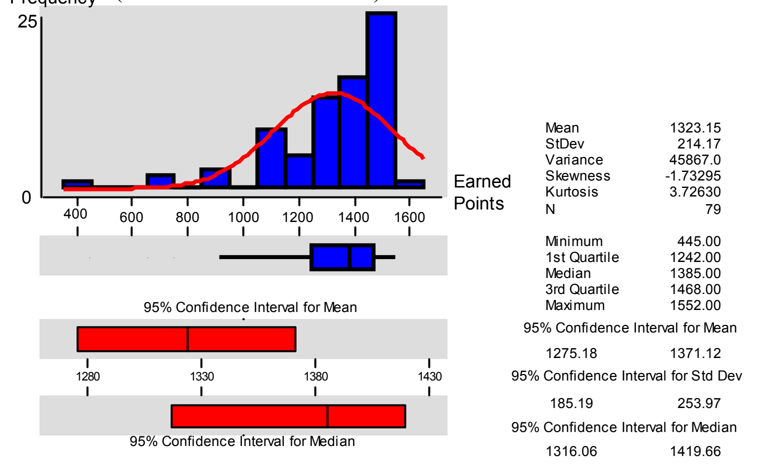
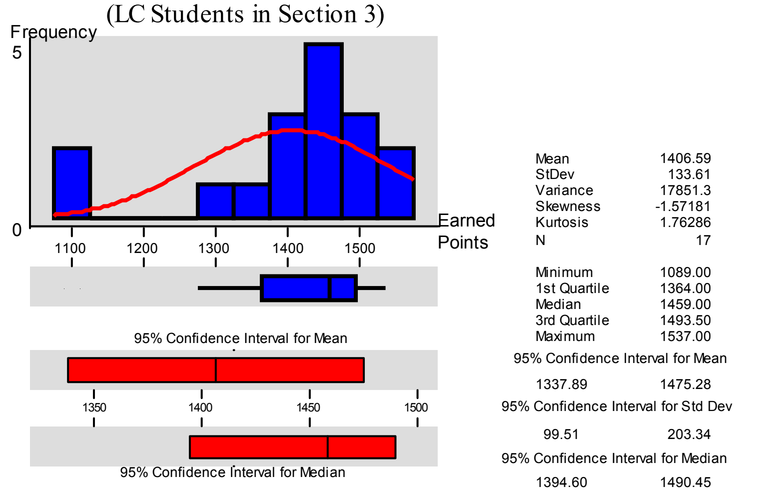


Figure 1b-Descriptive Statistics for Earned Points (LC Students in Section 3)



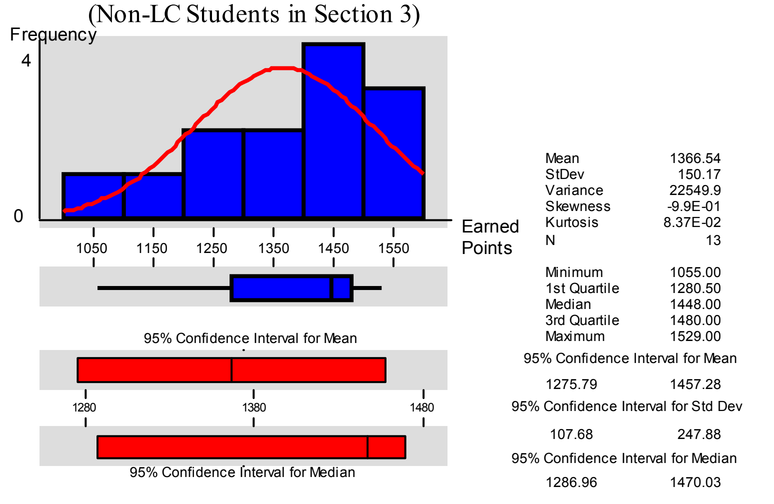


Figure 1c - Descriptive Statistics for Earned Points
(Non-LC Students in Section 3)

Data and Analysis

Table 2 shows the data collected in a survey. All the variables have two levels, Y=yes and N=no. Students listed their GPA at graduation from high school or in college and were grouped into GPA>3.5 and coded Y, or less and coded N. Their age was either more than 20 years or less. The experience variable was Y if they had work experience in an engineering of manufacturing job during at least one summer, part time, or full time. FirstYear is Y for first year student and N for all others. The next variable is Y for those that reported studying every night of the week and N for those that stated they did not study every night of the week. The final variable, LC, is participation in the learning community. The column POINTS is how many points the student accumulated during the course and is treated as the dependent variable. Minitab software[24] was used to perform the ANOVA test that can tell which of the variables are significant in student performance and points accumulated. The results of the analysis are shown in Table 3.

Table 2 – Variables Influencing Total Points Accumulated

GPA>3.5	AGE<20	Experience	FirstYear	StudyEveryNight	LC	POINTS
N	N	Y	N	N	N	1394
Y	Y	N	Y	Y	N	1382
N	Y	N	Y	Y	N	1452
N	N	Y	N	Y	N	654
N	Y	N	Y	Y	Y	1528
N	Y	N	Y	N	N	1330
N	Y	N	Y	Y	Y	1420
Y	Y	N	Y	N	Y	1519
N	Y	N	Y	N	N	1370
N	Y	Y	Y	N	N	1452
N	N	N	N	N	N	1532
Y	Y	N	Y	Y	Y	1491
N	Y	N	Y	N	N	445
Y	Y	N	Y	N	N	1348
N	Y	N	Y	Y	N	1227
Y	N	N	Y	Y	N	1540
Y	Y	N	N	Y	N	1527
Y	Y	N	Y	Y	Y	1537
Y	Y	N	Y	Y	N	1453
N	Y	N	Y	Y	Y	1334
Y	Y	N	Y	N	Y	1467
N	Y	N	Y	Y	N	933
N	Y	N	Y	Y	N	1452
N	N	N	N	Y	N	913
N	Y	N	Y	Y	Y	1438
Y	Y	N	Y	N	N	1453
N	Y	Y	Y	Y	Y	1459
N	Y	N	Y	Y	Y	1089
N	N	N	N	Y	N	1518
N	Y	N	Y	Y	N	1161
N	N	Y	Y	N	N	1543
N	Y	N	N	Y	N	1448
Y	Y	N	Y	Y	Y	1419
N	Y	Y	Y	N	Y	1467
N	Y	N	Y	N	N	1300
Y	Y	Y	Y	Y	N	1481
N	Y	N	Y	Y	Y	1394
N	N	N	N	Y	N	1515
N	Y	N	Y	Y	N	1367
N	Y	N	Y	N	N	747
N	N	Y	N	N	N	1493
Y	Y	N	Y	N	N	1530
Y	Y	N	Y	Y	N	1416
N	Y	N	Y	Y	N	1302
N	N	Y	Y	Y	N	1385
N	Y	N	N	Y	N	1306
N	Y	N	Y	Y	Y	1275
N	Y	N	N	Y	N	1120
Y	Y	Y	Y	N	N	1237
N	Y	N	N	N	N	1412
N	Y	Y	N	N	N	1242
N	Y	N	Y	Y	Y	1496
N	Y	Y	Y	Y	N	1298
Y	Y	N	Y	Y	N	1509
N	Y	N	Y	Y	N	1055
N	Y	N	Y	Y	N	1123
Y	Y	Y	Y	N	N	1267
N	Y	Y	N	N	N	1507
N	Y	Y	Y	N	N	1123
N	Y	N	N	N	N	1412
N	N	Y	N	N	N	1552
N	Y	N	Y	Y	N	1263
Y	Y	N	N	Y	N	1361
Y	Y	N	Y	Y	Y	1111
N	Y	Y	Y	N	N	1507
N	Y	N	Y	Y	N	930
N	Y	N	Y	Y	Y	1468
N	Y	N	Y	Y	N	1286
N	Y	Y	Y	N	N	1396
N	Y	N	N	N	N	1073
Y	Y	N	Y	Y	N	1194
Y	Y	N	Y	N	N	1373
N	N	N	Y	N	N	1135
N	Y	Y	Y	Y	N	1529
N	N	Y	N	N	N	1418
N	Y	N	N	Y	N	1063
N	Y	Y	N	Y	N	1261
N	Y	N	Y	N	N	1309
Y	Y	Y	Y	Y	N	1293

Table 3 – Results of ANOVA

Results for: MultiVariableData2.MTW

General Linear Model: POINTS versus GPA>3.5, AGE<20, ...

Factor	Type	Levels	Values
GPA>3.5	fixed	2	N Y
AGE<20	fixed	2	N Y
Experien	fixed	2	N Y
FirstYea	fixed	2	N Y
StudyEve	fixed	2	N Y
LC	fixed	2	N Y

Analysis of Variance for POINTS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
GPA>3.5	1	203811	250973	250973	5.91	0.018
AGE<20	1	45382	29615	29615	0.70	0.406
Experien	1	53831	66888	66888	1.57	0.214
FirstYea	1	96	14373	14373	0.34	0.563
StudyEve	1	0	6368	6368	0.15	0.700
LC	1	216247	216247	216247	5.09	0.027
Error	72	3058259	3058259	42476		
Total	78	3577626				

Interpretation of Results

Comparing Figures 1a, 1b, and 1c we can see that Section 3Section3-LC students accumulated the most points on the average, compared to all students (i.e. All Sections) and to Section3-non-LC students in Section 3. We can also see that the standard deviation or the spread of the grades is smaller for the LC students. These results are similar to previous results for the same course taught in the previous year[7]. In both instances, however, the difference is not significant at the 95% confidence level. For example, at the 95% confidence level, the mean of the Section 3-LC is between 1,337 and 1,475 and for all sections it is between 1,275 and 1,371. There is an overlap and we cannot conclusively state that the Section 3-LC mean is the larger one, or that LC student did better.

In Table 3, the multivariable ANOVA results show that of all the variables, only GPA>3.5 and LC have values of F that are significant (i.e. F>4). This means that students with GPA>3.5 and/or students that participate in LC will accumulate more points, on the average, than students without those attributes. Values of F close to 1 indicate that changing the value of the variable will not influence the number of points accumulated. The variables that were not significant in this study are: age, previous (limited) work experience in an engineering job, whether the student is beyond the first year of college and even studying every night.

Except for the surprising result that study habits are not significant, these results are in agreement with the bulk of published research. An explanation for the fact that study habits are not significant is that perhaps students did study every day but did not put more effort into Manufacturing Processes I than their peers with more irregular study habits. The question must be re-phrased in future studies.

The value P is the certainty with which we can state that a variable is significant. For GPA>3.5, P=0.018 and the probability that GPA>3.5 is not significant is 1.8%. Conversely, the probability that it is significant is 98.2%. Similarly, the probability that LC is not significant is 2.7% and 97.3% is the probability that it is significant.

Conclusions

Two variables are significant in predicting if a student will do well in the course Manufacturing Processes I at RIT. One variable is how well the student has done academically in the past, especially if the student was able to maintain a GPA greater than 3.5 in high school or in the first year of college. The second variable is whether the student is a member of a learning community of students that learns as a team. Students that have done well in their previous studies will continue to do well. Students that have not done as well in the past will benefit by participating in learning communities.

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