THE IMPACT OF APLIA ON GRADES: DOES GROUP WORK MATTER?*

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ABSTRACT

This study uses primary data from a Statistics for Business and Economics course offered by the business school at a primarily undergraduate Canadian university to examine the impact of Aplia-based group assignments on examination grades. The results of the study show that, in terms of the impact on grades, there is no significant difference between group assignments and individual assignments. The study employs a number of sophisticated econometric techniques, including OLS, the panel data random effects method, the logit method, the random effects logistic method, and the quantile regression method. All of the estimates led to similar conclusions: that Aplia-based group assignments have no advantage over Aplia-based individual assignments.

Keywords: Group assignments; individual assignments; grades.

JEL classifications: A22.

1. INTRODUCTION

In this digital era, technology has a big impact on our educational systems and learning processes. The new generation of students are more comfortable with technology and publishers make use of this opportunity by introducing online-based learning tools. One of the more popular online-based learning tools is Aplia, which contains online...
assignments geared toward undergraduate-level courses. Aplia assignments have a specific due date and, upon submission, students receive immediate feedback so that they can see which answers are correct.

Quite a number of studies have examined the impact of Aplia on student academic performance (Caudill & Long 2009; Pace 2010; Nguyen & Trimarchi 2010; Emerson & Mencken 2011; Collins et al. 2011; and Kennelly et al. 2011). The majority of these studies suggest that Aplia has a significant positive impact on student academic performance. All of these studies compare Aplia-based individual assignments with a control group that did not use Aplia. However, thus far, no study has focused on Aplia-based group assignments. In recent times, group work has become increasingly popular because of its supposedly positive impact on student performance, on the attitude of students towards learning, and on persistence or retention (Bentley & Warwick 2013; and Gibbs 2009). The objective of this paper is to examine the impact of Aplia-based group assignments compared to individual assignments.

The paper is structured as follows: Section 2 reviews the relevant literature; Section 3 discusses the data and empirical methodology; Section 4 reports the study’s results; and Section 5 summarizes our conclusions.

2. LITERATURE REVIEW

A number of studies have examined the impact of Aplia on student academic performance. Using data from finance courses at the University of West Florida (USA), Pace (2010) found that Aplia-based assignments improved student exam scores by 5 to 7 percentage points. Nguyen & Trimarchi (2010) reported results of experiments with Aplia in large introductory economics classes. They found that Aplia helped students to improve their course mark averages by a small but statistically significant 2 percentage points regardless of whether the use of this technology was required or optional, and regardless of whether the course subject was macro- or microeconomics. Using the data from four sections of a course in microeconomic principles at Baylor University during the Fall 2005 semester, Emerson & Mencken (2011) investigated the effect that Aplia-based online-graded homework had on student achievement as measured by the Test of Understanding in College Economics, final course grades, and performance on the departmental final exam. The study found that those
students who were assigned required homework through an automated homework system (*Aplia*) experienced significantly higher achievement than those in the control group, as measured by performance on a common portion of the final exam and their course letter grade.

Collins *et al.* (2011) used data from an introductory microeconomics course at Bellarmine University to analyze the effect of using *Aplia* on final exam grades. The study found that *Aplia* had a strong positive effect on grades on the final examination—each one-point increase on the assignments added 0.61 points on the final exam. Using data from microeconomics principles classes at Auburn University, Caudill & Long (2009) found a strong positive relationship between performance on homework assignments (which were submitted using *Aplia*) and exam performance. Conversely, Kennelly *et al.* (2011) used data from a managerial economics course at the National University of Ireland to compare the effectiveness of online and paper-based assignments and tutorials utilising summative assessment results. The course in the study had a large enrollment. Kennelly *et al.* (2011) found little evidence that a student’s performance on an assignment helped him or her perform better on the corresponding section of the exam.

A separate literature also considers the role of group work and assignments in the development of students’ understanding of economics and their preparation for the workforce. McGoldrick (2012), for example, argues that enhanced learning outcomes are associated with group learning environments and that such environments are effective because they are linked to increased student engagement with the material they are learning. Slavin (1996) shows that students who participated in group-based learning activities demonstrated greater willingness to ask the instructors questions, both inside and outside of class. Johnson *et al.* (1998) and Williamson & Rowe (2002) further show that students with exposure to group-based learning began to like the subject matter more, and were less likely to drop out of the courses that provided opportunities for group-based learning. A number of other studies used examination scores to demonstrate the positive impact of group-based teaching *vis-à-vis* a lecture-based approach (Zimmerman 2003; Marburger 2005; and Yamarik 2007). Group-based learning is also argued to enhance workplace-related skills such as communication and critical thinking (Sibley & Parmelee 2008).
The present study makes two contributions to the literature on group learning and Aplia use. Firstly, it tests the impact of Aplia-based group assignments on student performance relative to Aplia-based individual assignments, and is the first study to do this to the best of the authors’ knowledge. This may also have implications for the value of group-based teaching methods relative to traditional teaching methods at least in the field of economics. Secondly, it conducts these tests using a number of relatively sophisticated econometric techniques, including panel data and quantile regression. Few of the studies in the literature discussed above use such techniques.

3. DATA AND EMPIRICAL METHOD

The data used in this study were collected from a second-year-level Statistics for Business and Economics course taught by one of the co-authors during the Fall 2016 semester. This was a relatively small class offered by the business school at a primarily undergraduate university in Canada. In this course, students are introduced to statistics with an emphasis on its applications in business and economics. Topics include: descriptive statistics; an introduction to probability; discrete and continuous probability distributions; sampling and sampling distributions; interval estimation; and hypothesis testing and statistical inference. The assessment structure for the course was as follows: two midterm exams had a weight of 25% each; individual and group Aplia assignments had a combined weight of 10%; and the final exam had a weight of 40%.

The first midterm exam took place during the sixth week of the course, and the second midterm took place during the eleventh week. The midterms employed problem-based multiple-choice questions and short-answer questions to test the students’ problem solving skills and knowledge of the material covered in class during the preceding month. Specifically, the first midterm tested students’ knowledge of the material in chapters 3 through 5 of the course textbook, Anderson et al.’s (2015) Statistics for Business and Economics, while the second midterm focused on chapters 6 through 8 of this book.

The sample size for this study was 31. For the purposes of the study, data were collected twice: just before the first midterm and just before the second midterm. All students were given Aplia software purchased through a research grant. Before the first midterm, the students were randomly assigned to two sets. The first set of students was asked to complete their Aplia assignments individually, while the second set was
asked to complete their’s as part of a group. After the first midterm, the students who had completed assignments individually before the first midterm were asked to form groups and complete Aplia assignments as part of a group, while those who had submitted group Aplia assignments before the first midterm were asked to complete the second Aplia assignment individually. There were between two and three students in each group.

Each week, the students working in groups and the students working individually received the same Aplia assignment. These weekly assignments were comprised of problem-based multiple-choice questions that tested the students’ understanding of the material covered during the preceding week. The weekly assignment questions were similar to the questions on the two midterms. The students working in groups were encouraged to work on the Aplia assignments together as a group. Each group determined the role that individual students played within the group.

Students completed four assignments in the lead up to the first midterm exam and a further four assignments between the first and second midterms. Graded assignments were returned to students with feedback in the same week that these assignments were submitted, with the fourth and eighth assignments graded and returned a week before the first and second midterms respectively.

As pointed out earlier, a random sampling technique was used to form the groups in this study. To solve the free-rider problem associated with group-based learning, two techniques were used. First, the instructor required groups to confirm that all members participated in working on the Aplia assignment. Second, on collecting each of the weekly assignments, the instructor randomly selected one member from each group to come to the board and solve one of the assigned problems. This provided the motivation for all group members to participate in working on the Aplia assignment.

Data were collected from all students regarding their current GPA, gender, year of study and student status (domestic vs. international). Information on midterm marks was gathered from the instructor’s records. The study was approved by the University Research Ethics Board.

The principal dependent variable of the study was midterm marks. As outlined above, the course had two midterms, and marks on these midterms were used as the dependent variable. The major independent
variable was a dummy variable, ‘Group’. This variable took a value of 1 if the student completed a group assignment, and a value of 0 if the student submitted an assignment individually. Other variables included were ‘Year of Study’, ‘Gender’ and ‘GPA’. The dummy variable ‘Year of Study’ had three categories: first year, second year and third year. The base category was third year. The variable ‘Gender’ had two categories: male and female. The base category was male. The continuous variable ‘GPA’ measured the self-reported cumulative GPA of the student at the start of the Fall Semester of 2016.

We thus estimated the following model using the midterm mark as the dependent variable:

\[ MT_{it} = \beta_0 + \beta_1 \text{Group}_{it} + \beta_2 \text{Gender} + \beta_3 \text{Year of Study} + \beta_4 \text{GPA} + \epsilon_{it} \]  

(1)

This model was estimated using two methods: pooled ordinary least squares (OLS) and the random effects method. The pooled OLS method does not take into account unobserved individual-specific heterogeneity, hence it results in biased estimation, while the random effects method does take such heterogeneity into account.

The study also used a binary variable ‘Pass’ to indicate whether the student received at least 55% on the midterm (which is the passing grade at the university where the study was conducted). We then estimated the following model using ‘Pass’ as the dependent variable:

\[ \text{Pass}_{it} = \alpha_0 + \alpha_1 \text{Group}_{it} + \alpha_2 \text{Gender} + \alpha_3 \text{Year of Study} + \alpha_4 \text{GPA} + \epsilon_{it} \]  

(2)

This model was estimated using two methods: the logit method and the random effects logistic method. The simple logit method does not take into account unobserved individual-specific heterogeneity, while the random effects logistic method does take this into account.

Finally, the study used the quantile regression method on the pooled data. The ordinary least square method estimates the mean value of the dependent variable for given levels of the independent variables. In other words, the OLS model estimates how the variables “Group”, “Gender”, “Year of Study” and “GPA” affect the midterm results of the students on average, while the quantile regression method examines the relationship between a set of predictor variables and specific percentiles (or quantiles) of the response variable. This latter approach provides a more comprehensive picture by allowing one to consider the impact of covariates on the entire distribution of the dependent variable. Using the quantile regression method, the study estimated coefficients for the
20, 40, 60 and 80 percent quantiles of the distribution of the dependent variable.

4. RESULTS

Descriptive statistics for the data are shown in Table 1. This table indicates that 60% of students in the sample were female; 77% were domestic students; first-year, second-year and third-year students comprised 10%, 74%, and 16% of the sample respectively; and the average GPA of students was 3.11.

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Student</td>
<td>0.60</td>
</tr>
<tr>
<td>Male Student</td>
<td>0.40</td>
</tr>
<tr>
<td>First-Year Student</td>
<td>0.10</td>
</tr>
<tr>
<td>Second-Year Student</td>
<td>0.74</td>
</tr>
<tr>
<td>Third-Year Student</td>
<td>0.16</td>
</tr>
<tr>
<td>Domestic Student</td>
<td>0.77</td>
</tr>
<tr>
<td>International Student</td>
<td>0.23</td>
</tr>
<tr>
<td>GPA</td>
<td>3.11</td>
</tr>
<tr>
<td>Average Midterm Mark</td>
<td>65</td>
</tr>
</tbody>
</table>

*Source: Survey Data.*

Table 2 compares the average midterm marks for two sets of students: those who worked on Aplia assignments individually and those who worked in a group. These marks are compared for three categories: overall marks, first midterm marks, and second midterm marks. In all cases, students who worked in a group did better, on average, than students who worked individually. However, when the mean comparison t-test was used, these differences were not statistically significant at the 5% level.

The simple mean comparisons do not take into account other factors that could influence grades, such as GPA, year of study or gender. We therefore used the ordinary least square method to estimate Equation (1) above. Results from this estimation are shown in Table 3. The second column of Table 3 suggests that working in a group had a positive impact on midterm grades, but the coefficient was not statistically significant. Among the covariates, only GPA was found to have a significant positive impact on midterm grades.
A major drawback of the simple OLS method is that it does not take into account unobserved individual-specific heterogeneity that could impact grades such as prior interest in statistics. Panel data regression methods such as the fixed effects model and the random effects model control for these unobserved factors in the estimation process and thus provide more precise results. We used the Breusch Pagan LM test to determine whether unobserved individual-specific heterogeneity was present, and the results suggest that it was. Consequently, we utilized the panel data method. The Hausman test was then used to decide whether the fixed effects model or the random effects model was more appropriate. The fixed effects method assumes that unobserved individual-specific factors are correlated with covariates in the model while the random effects model assumes that unobserved individual-specific effects are uncorrelated with the covariates. Results for the Hausman test suggested that unobserved individual-specific factors were uncorrelated with the covariates, and we thus employed the

### Table 2: Mean Comparison

<table>
<thead>
<tr>
<th>Category</th>
<th>Working Individually</th>
<th>Working in a Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Midterm Mark (Overall Figure)</td>
<td>64.71 (2.58)</td>
<td>64.96 (3.48)</td>
</tr>
<tr>
<td>Mean Midterm-1 Mark</td>
<td>58.77 (3.49)</td>
<td>64.35 (5.41)</td>
</tr>
<tr>
<td>Mean Midterm-2 Mark</td>
<td>63.69 (3.76)</td>
<td>68.88 (3.74)</td>
</tr>
</tbody>
</table>

*Note: Standard errors are shown in parentheses.*

### Table 3: Results from OLS and Random Effects Models

<table>
<thead>
<tr>
<th>Category</th>
<th>Pooled OLS Model</th>
<th>Random Effects Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Work</td>
<td>0.743**</td>
<td>-0.058</td>
</tr>
<tr>
<td>Female Student</td>
<td>-0.057</td>
<td>-0.181</td>
</tr>
<tr>
<td>First-Year Student</td>
<td>-0.172</td>
<td>-0.185</td>
</tr>
<tr>
<td>Second-Year Student</td>
<td>-0.053</td>
<td>-0.057</td>
</tr>
<tr>
<td>Domestic Student</td>
<td>3.188***</td>
<td>4.435***</td>
</tr>
<tr>
<td>GPA</td>
<td>0.070</td>
<td>0.028</td>
</tr>
</tbody>
</table>

*Note: Standard errors are shown in parentheses, *** indicates coefficient is significant at the 1% level. ** indicates coefficient is significant at the 5% level.*
random effects model. As shown in the third column of Table 3, results of that model suggest that working in a group had a positive but insignificant impact on grades. As with the OLS model, random effects estimation also found that, among all the covariates, only GPA had a significant positive impact on grades.

To further explore the role of group versus individual Aplia assignments, we created a dummy variable, ‘Pass’ representing a mark of 55% or more on the midterm. To examine the impact of working in a group on getting a passing mark, we utilized two models: the simple logit model and the random effects logistic model. Results from estimation of these models are reported in Table 4. The second column of Table 4 indicates that according to the simple logit model, working in a group had a positive but insignificant impact on getting a passing mark. However, the simple logit model does not take into account unobserved individual-specific heterogeneity that could have an impact on grades. To consider the effect of unobserved individual-specific factors, use of panel data methods such as the fixed effects logistic model and random effects logistic model was used. After utilizing the Breusch Pagan LM test and the Hausman test, it was concluded that the random effects logistic model was more appropriate for the data in this
study. As shown in the third column of Table 4, the results of that model suggest that working in a group had a positive effect on achieving a passing mark; however, the coefficient was not statistically significant.

To check the robustness of these results, we utilized the quantile regression method to estimate coefficients for the 20, 40, 60 and 80 percent quantiles of the distribution of the midterm grade. The results of the quantile regression model are shown in Table 5. Highlights of those results are as follows: working in a group did not have a significant impact on the midterm grade in any of the four quantiles; in the 20th quantile, being a domestic student and having a higher GPA positively impacted the midterm grade; in the 40th quantile, GPA had a significant positive effect on the midterm grade; in the 80th quantile, GPA positively impacted the midterm grade.

In summary, the quantile regression estimates confirm that working in a group did not have a significant impact on midterm grades in our study.

5. CONCLUSION

This study used primary data from a Statistics for Business and Economics course offered by the business school at a primarily
undergraduate Canadian university to examine the impact of Aplia-based group assignments on examination grades. The results of the study show that, in terms of the impact on students’ disciplinary knowledge and problem solving skills, group assignments were ineffective relative to individual assignments. The study used a number of relatively sophisticated econometric techniques, including OLS, the panel data random effects method, the logit method, the random effects logistic method, and the quantile regression method. Estimates from all of these approaches led to the same conclusion: Aplia-based group assignments appear to have had no advantage over Aplia-based individual assignments in our study. Thus far, no other study, to our knowledge, has examined this question.

Our study does have some limitations that should be noted. Our sample size was relatively small and we focused purely on the effects of group versus individual assignments on course grades, and thus on whether students’ discipline-specific knowledge was improved by these assignments. It could be argued that group work also aims to develop workplace-related skills such as communication and critical thinking as suggested by Sibley & Parmelee (2008). The traditional examination scores we use as the dependent variable may not be good indicators of whether students have developed these non-curricular skills. But we suggest that learning discipline-specific knowledge continues to be the central role of courses such as ours and that our findings at the very least warrant further research with larger sample sizes to validate the conclusions we reach. Further work might also explore the implications of our findings for other academic disciplines.

REFERENCES


