Leveraging group members' knowledge in an undergraduate engineering class project: lower CGPA students attain higher outcomes

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ABSTRACT – Undergraduate group projects are typically assigned to evaluate the ability of the students to function effectively either as a member or a leader in a team. From the learning perspective, the lower the Cumulative Grade Point Average (CGPA) students are also anticipated to leverage the knowledge of their superior team members to attain higher course outcomes. In this study, the final marks of the students with CGPA higher than the average group CGPA (superior students) were compared with the final marks of the students with CGPA lower than the average group CGPA (weaker students). It was found that the weaker students were able to leverage the knowledge of their superior teammates with statistically significantly higher final marks ($\boldsymbol{M_{diff}} = \mathbf{14.11}$, $p<0.005$).

1. INTRODUCTION

Teams bring together individuals with different strengths that can result in outcomes which are not possible without everyone involved [1]. Literature on team-based learning emphasizes the importance of team composition and team design, and it is recommended that instructors organize teams to ensure diversity of team [2]. In this study, we investigated the final marks of the students with CGPA higher than the average group CGPA (superior students) and also the final marks of the students with CGPA lower than the average group CGPA (weaker students). The statistical comparison was made in order to find out whether prior CGPA acts as the covariate that may affect the final marks, or not.

Some studies have suggested that students' attitudes about group work are related to their level of academic achievement. Grzimek et al. [3] investigated the impact of GPA on students' preferences for classroom group work and its structure. Shaw et al. [4] found a negative relationship between GPA and preference for group work. Chapman and Van Auken [5] surveyed classes at 32 institutions and found a weak (but significant) negative correlation between students' GPAs and attitudes about group work. Low individual ability students had much stronger preferences for group work when matched with students having higher abilities. When students with medium or high abilities were matched with similar individuals, their preferences for group work did not change.

2. METHODOLOGY

The participants were the students for the subject of BMFR 3513: Product Design and Manufacturing, from the Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka (UTeM). A total of 53 students participated in this study. The participants were initially grouped into 4 different groups: 1) Students with CGPA equal or higher than 3.0 and his/her average group's CGPA is higher than his/her own; 2) Students with CGPA equal or higher than 3.0 and his/her average group's CGPA is lower than his/her own; 3) Students with CGPA lower than 3.0 and his/her average group's CGPA is higher than his/her own; 4) Students with CGPA lower than 3.0 and his/her average group's CGPA is lower than his/her own. However, after assigning the groups, we have found out that the number of samples was very small for Group 1 (7 cases) and Group 4 (3 cases). Hence these two groups were dropped to avoid remarkably uneven samples.

The class project requires the student to work in a team of 4-5 members where each group has to come out with the practical solution to solve some of the demand-driven innovation projects by Public-Private Research Network (PPRN) under the Ministry of Higher Education (MOHE), Malaysia. In addition, there were also some other industrial-related projects which have been considered in class. At the beginning of the semester, the vetting of their proposals was made by the subject coordinator, the Head of Department, the Integrated Design Project (IDP) committees and some Assistant Engineers. All teams have been supervised in terms of the technical knowledge and analysis of their inventions throughout the semester through lectures, assignments and technical reports. The assessment was divided into 80% marks from the group project and 20% marks from the test.

Table 1 Descriptive statistics of the samples used.

Group	Mean	Standard Deviation	Samples
2	76.52	7.62	22
3	74.50	7.61	21
Total	75.53	7.60	43

Table 1 depicts the descriptive statistics of the remaining samples used for this analysis. Data are unadjusted mean ± standard deviation of the final marks unless otherwise stated.

An analysis of covariance (ANCOVA) was run to determine whether the final marks differed based on the CGPA and group CGPA interaction (superior vs weaker students) whilst controlling for individual CGPA [1]. We

believed that the effect on the results of the final exam will depend, to some degree, on the student's individual CGPA which refers to the prior extent of knowledge attained before the course begins.

3. RESULTS

Table 2 depicts the adjusted mean ± standard error of the final marks. The adjusted means take into accounts the individual CGPA as the covariates that affect the final marks. There was a linear relationship between the CGPA and the final marks attained by each group as assessed by visual inspection of the scatterplot as depicted in Figure 1. The covariates appearing in the adjusted model are evaluated at CGPA = 3.04.

Table 2 Adjusted mean after incorporating covariate.

Group	Mean	Std Error	95% Confidence Interval	
			Lower Bound	Upper Bound
2	68.65	1.809	64.99	72.03
3	82.76	1.875	78.94	86.55

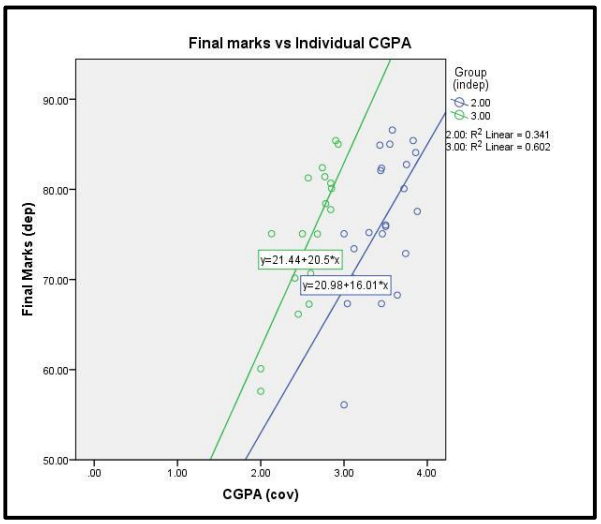

Figure 1 Linear relationship between covariates (Individual CGPA) and Final Marks

Standardized residuals for each of the group and for the overall model were normally distributed, assessed by Shapiro-Wilk's test ($p>0.05$). There was homoscedasticity and homogeneity of variances as assessed by visual inspection of a scatterplot and Levene's test of homogeneity of variance ($p=0.428$) respectively. There were no outliers in the data, as assessed by no cases with standardized residuals greater than ± 3 standard deviations.

After adjustments for individual CGPA, students with CGPA lower than 3.0 and his/her average group's CGPA is higher than his/her own (weaker students) had obtained higher final marks in comparison to the students with CGPA equal or higher than 3.0 and his/her average group's CGPA is lower than his/her own (superior students). There was a statistically significant difference in final marks between the groups, $F(1,40)=18.8$, $p<0.005$, partial $\eta^2 = 0.320$.

Post hoc analysis was performed with a Bonferroni adjustment. The final marks of the students with CGPA lower than 3.0 was statistically significantly higher than the final marks of the students with CGPA higher than 3.0 ($M_{\text{diff}} = 14.11, 95\%\ \text{CI}\ [7.53, 20.68], p < 0.005$).

It is therefore evident from the ANCOVA that the students with CGPA lower than 3.0 and has an average group CGPA higher than his/her own CGPA were able to leverage the group member's superior prior knowledge to attain higher final marks. Grade-wise, it is a jump of 2 grades (68.65 is a B, 82.76 is an A) between the group. Although there was a contribution of 20% marks from a test which was individually assessed, it did not affect much of the variation of the final marks attainment.

It can also be inferred from this result that the superior students with CGPA higher than 3.0 and had a lower average group's CGPA were at an average 2 grades lower than their respective weaker teammates. Further studies are warranted to look into other covariates that may affect these results.

4. CONCLUSION

In this study, the differences between the course attainment of the superior and weaker team members in an undergraduate group project were examined. Prior CGPA was as a significant covariate that affects the final marks. It was found that the weaker team members attained higher final marks and therefore were able to leverage the superiority of other team members with statistically significant results. This indicates that heterogeneous groups with respect to ability level are good to encourage interaction between higher and lower achievers.

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