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The Impact on Assessment Results of Changing to an Active Learning Approach: A Case Study from an Undergraduate Computer Science Degree Programme

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Abstract

This paper examines the impact of delivery and assessment changes in a module provided in the third year of a four-year undergraduate honours degree in computer science. It begins by outlining the initial structure of the module, and then discusses the rationale for alterations made to the hourly allocation of lectures versus hands-on laboratory classes, along with changes to the weightings of marks for written examination versus continuous assessment (CA). The paper next analyses the impact on student performance pre- and post-intervention and across the different assessment types, both written examination and CA project. Substantial effort was taken to ensure that the environment and circumstances were equivalent each year (pre- and post-intervention). The assessments took the form of an end-of-semester written examination worth 60% of the final marks, and a semester-long CA project worth 40%. The analysis shows a statistically significant (p=0.002) improvement in the grades obtained by students in their CA project. Further, although not statistically significant but of note, there was also a dis-improvement in their examination results (p=0.058) which resulted in no significant difference between the overall combined marks from one year to the next. A comparison of the exam grades versus the CA grades for the post-intervention group shows that almost a third of the students had a difference of 30% or more between their written examination and CA result, the CA mark being the higher of the two. Furthermore, these students scored a first-class grade in their CA project, suggesting that a good performance in their CA may have impacted their performance in the written examination, which arguably demonstrates that having some of the students' penultimate year's marks contribute to their final degree could improve their third-year grades and overall learning.

Keywords: active learning; academic performance; higher-education course structure; continuous assessment

Introduction

The diverse range of subjects currently on offer across the higher-education sector brings with it the challenges of finding the right balance of delivery mechanisms and assessment strategies for specific courses (Donnelly & Fitzmaurice, 2005; Foreman, 2003). Engaging with factors such as the nature of the subject and its related material, as well as the types of student cohort in order to optimise the student outputs, presents an ongoing challenge throughout the life of a course/module. In computer-science subjects, where theory and understanding need to be applied in a hands-on fashion, the allocation of time the student spends in lecture-style classes as opposed to laboratory hands-on classes is the subject of debate (Strayer, 2007; Mason, Shuman, & Cooke, 2013). In addition, the amount of marks allocated to written examinations as opposed to continuous assessment (CA) assignments/projects also attracts in-depth discussion (Gibbs, 2006).

This paper looks specifically at a module delivered in the third year (stage three) of a four-stage undergraduate honours degree programme in computer science. The emphasis of this module is to gain a deeper understanding of software-systems analysis and design, and to extend the knowledge and skills of implementing software systems by applying concepts/skills learned in other modules while also incorporating more complex design implementations. In an attempt to support the students in achieving a better understanding and to increase their applied skills in the subject, thereby improving their assessment grades, the delivery structure and marking scheme were altered to promote the emphasis on hands-on implementation. The hours allocated to laboratory time were increased from one to two hours per week, while the lecture hours were decreased from two hours to one per week. Additionally, the weighting of marks were altered from a 70/30% split to a 60/40% split for the written examination and continuous assignments respectively. (The details of the changes are described in the Method section below.)

In part, both the perceived and documented benefits of *active learning* – as espoused and tested in Freeman et al. (2014), Prince (2004), Briggs (2005) and Sowell et al. (2010) – played a role in the reasoning behind the move to alter the emphasis of the module: indeed future work with this module will most likely see its conversion to a *flipped classroom* model where lectures are delivered via recorded sessions provided online with contact hours dedicated to hands-on application of the material (Tucker, 2012). There has been much positive feedback from the students involved in modules such as the one described in this paper. Studies show that active learning, which is core to the flipped classroom concept, increases student performance in STEM courses (e.g. Freeman, et al., 2014). This seems to be true particularly for part-time students who can choose the most ideal time to study, and can consume lecture and tutorial-style content at a pace that suits their preference.

Method

This study utilises a module given to students in their third stage of a four stage honours degree programme in computer science. It is the third of three consecutive modules in software engineering which builds on the preceding two. Traditionally it was delivered over a single semester of thirteen teaching weeks, with two hours a week allocated for lectures and one hour a week allocated for hands-on laboratory work. The class number each year is around 70 students. Lectures are delivered to all students together and laboratory classes are broken into groups of circa 20 students with a laboratory teaching assistant assigned to each group. The assessment comprises an end-of-semester written examination and semester-long

CA assignment with 2 deliverables: one midway through the semester and one towards the end. The assignment asks the student to apply what is being taught in the lectures and laboratory work to progress a project (software application) of their own creation through the analysis, design and implementation phases. The written examination is a two-hour sitting where students answer three out of four possible questions. Pre-intervention, 70% of the students' final grade was allocated for the written examination and 30% for the CA assignment.

The study covers two successive years of the module instruction. As an intervention, the following alterations were made while keeping all other elements as they were: the number of hours allocated weekly to lectures and laboratory sessions was changed from 2:1 to 1:2 respectively; in addition the weighting of marks was changed to 60% for the written examination and 40% for the CA assignment. Over the two years, the same instructor delivered the module, classes were held at roughly the same times and the same format of lectures and laboratory hours was used. The same assessment criteria and marking scheme was used across both the CA assignment and written examination. Although close to 70 students were enrolled in the class each year, only those students who attended over 75% of the laboratory classes were included in the study to ensure the results were reflective of those who received the supervised laboratory hours. The average attendance in year 1 and year 2 was 63% and 67% respectively.

The study collected the results from both the written examination and CA assignment for each student included in the study across both years. The results for each assessment type and the final overall module grades were analysed using a two-tailed t-test along with a Pearson correlation coefficient test. The results are presented and discussed in the next section.

Results and Discussion

In each of the years of study, 25 students attended equal to or above 75% of the laboratory classes. The analysis of their results is presented in Table 1.

	Year 1 / Year 2 Weighting	**Year 1 Mean (SD)**	**Year 2 Mean (SD)**	**P value**
Written Examination	70% / 60%	65 (12)	57 (15)	0.058
Continuous Assessment	30% / 40%	***62 (14)***	***73 (8)***	***0.002***
Overall Result		64 (11)	63(10)	0.871

Table 1 - Mean results for assessment components pre- (Year 1) and post- (Year 2) intervention.

The results show a statistically significant improvement (p = 0.002) in the CA results pre- and post-intervention. Interestingly, there is no significant difference between the overall results from year to year – an observation explored below.

The module was designed to promote the use and application of what the students have learned across the three software engineering modules, and the rationale for adding more time in class was to foster a more active learning approach. The results show that the change had a positive impact when considering the CA assignments alone – an expected result of the increased active learning. However, the difference in the written examination results pre- and post-intervention, while not statistically significant with a p value marginally above the threshold (p = 0.058) warranted further investigation. Figure 1 shows a scatter plot of the written examination and CA marks post-intervention. With a Pearson correlation coefficient of r = 0.21, it shows a very weak correlation between the datasets. Furthermore, on closer inspection of the results, we see that post-intervention almost a third of students had a difference of 30-40% between their written examination and CA assignment marks, and all of those students scored at least 70% on their CA. Also, in the post-intervention year, only 12% (3 out of 25 students) scored better in their written examination while pre-intervention 60% of the students scored better.

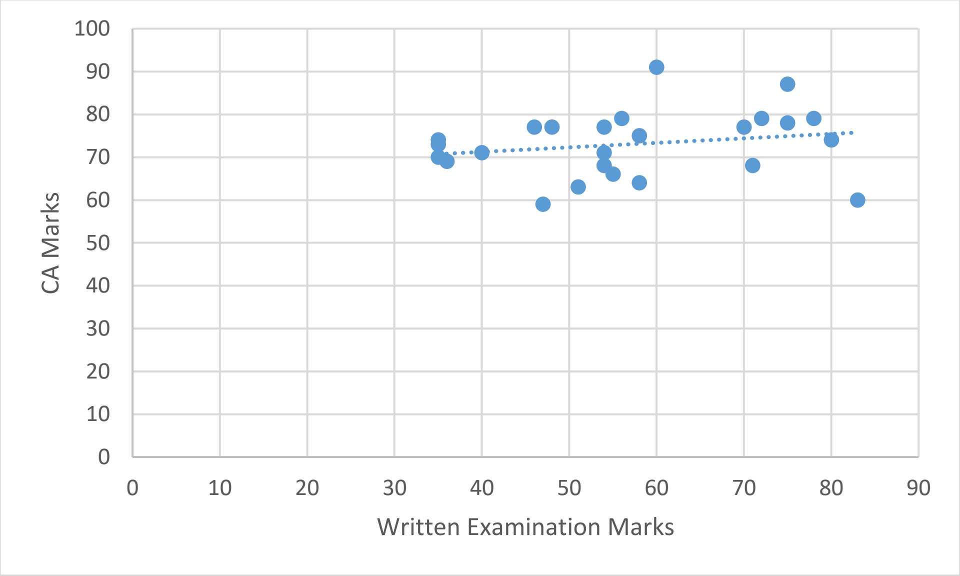

Figure 1 - Scatter plot with a Pearson Correlation Coefficient of r=0.21

Notwithstanding the limitations of this study (discussed later), the results indicate that although the desired effect was achieved with respect to the CA results, this was nullified by a dis-improvement in the written examination results, providing very little difference to overall final grades. There is an indication that when students do well in their CA, and know their marks well in advance of the written examination, they are less motivated to score highly in that final examination if there is an understanding that they will pass the overall module, even with a very low written examination result. Bearing in mind that the module is in stage three of a four-stage course and that students are only required to pass with an overall mark higher than 40%, this reasoning would explain the results and lend support to the argument that if these results formed part of the final degree award then this behavioural pattern could be changed for the better.

There are some limitations to this case study. The fact that two factors were changed (both the allocation of hours and marking weightings) as part of this intervention makes it difficult to ascertain which of these has had the greater impact and to what extent. However, the study can be viewed as an intervention which applies more emphasis and support to the CA and practical side of the module than had been done previously, and as such has triggered the responses above in as much as it can be ascertained from the analysis. An anonymous student survey would help here to gain additional insight into the student mind-set concerning their approach to the module.

When comparing the results of two different class groups it is important to take steps to ensure one is comparing like with like. To this end, every effort was made to ensure the environment, scheduling and delivery were as similar as possible. The cohorts of students used were of a similar profile having come up through the first two stages of the full time degree programme.

Conclusion

An intervention in the delivery structure and assessment weightings of a stage-three software engineering module which forms part of a four stage honours degree programme in computer science was described. The intervention took the form of an increase in the hours allocated to small group laboratory classes and a corresponding reduction in the hours spent in large lecture classes. In addition, the weighting of marks were altered from a 70/30% split to a 60/40% split for the written examination and continuous assessment assignments respectively.

The results were analysed and a statistically significant improvement in the continuous assessment marks was found. Also apparent were a number of indicators that suggest that there was a similar dis-improvement in the results of the written examination leading to final overall grades that were not significantly different.

The results suggest the need for some further work to be carried out, such as anonymous student surveys relating to their approach to the module from an assessment management perspective. In addition, there would be a benefit in investigating whether students of this module strategically spend much less effort in preparation for the final written examination if they have scored well in their CA assignments and, if so, whether that would change if the grades obtained in this module contributed to their final degree result.

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