ON THE CORRELATION OF COMPLETION PROGRESS IN VIRTUAL LEARNING ENVIRONMENTS AND STUDENT OUTCOMES

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Abstract

Since the recent emergence of Sars-CoV2 virus, the whole academic community shifted dramatically towards online, distance or blended type learning. This has meant that academics and teachers have had to learn new pedagogic and technologically enhanced learning techniques in a short space of time. Moreover, it has led to an increased reliance on remote learning tools and virtual learning environments (VLEs). Of primary concern over the past few years has been the desire to monitor and measure the apparent *engagement* of students with the new electronic material, especially in the HE sector. This paper sets out to try and use the built-in functionality of a popular VLE platform (namely Moodle) to quantify – in some sense – user engagement and then correlate this measure with student outcomes. The results in this study show that there is generally a strong correlation for student outcomes versus course completion across three sample modules with Pearson correlation coefficients of 0.76, 0.87 and 0.86 respectively. Finally, these results are compared to those drawn from physical in-class attendance versus student outcomes for the same modules, which generally gave a weaker correlation with Pearson correlation coefficients of 0.61, 0.85 and 0.46 respectively.

Keywords: VLE, LMS, Moodle, Engagement, Student Outcomes

1 INTRODUCTION

The global pandemic of Sars-CoV2 and its variants that first emerged in 2019, caused a dramatic shift in the delivery of teaching and learning across many sectors of education [1, 2, 3]. The focus of this paper, specifically, is the effect on the Higher Education (HE) sector in the context of a UK HE institution. During the past 2–3 years, students have been forced to learn remotely and educators have been compelled to provide teaching and learning under a completely new regimen. In the main, most HEIs segued rapidly into delivering lectures and seminars online and providing some means of online assessment [4]. Some of the changes were easier to make than others, for example, online assessment remains a challenge to provide securely especially in science disciplines with some solutions involving elaborate proctoring systems [5].

Over the period of the past two to three years, aside from the challenges of delivery, concerns have arisen over the quality and quantity of student engagement [6, 7] and how this affects student progression. There has been a perception that engagement can be elusive to achieve and perhaps even harder to *actually* measure. However, many Virtual Learning Environments (VLEs), or indeed Learning Managements Systems (LMSs) have the facility to measure student interaction with resources they contain, this can be through counting clicks or views and this data can be readily extracted. For simplicity, the term “VLEs” will be used to refer to all types of virtual learning platforms. Some VLEs even provide experimental plugins to measure ‘engagement’ in some sense directly. With the recent re-introduction of the Teaching Excellence Framework (TEF) in the UK [8], there is even more emphasis on mechanisms to improve engagement and hence progression. This research work sets out to identify if there is a correlation between the ‘completion progress’ of activities within a VLE and student performance on a given module. Further, a similar comparison is made between attendance and student performance to see which shows the strongest correlation.

This paper is structured as follows: Section 2 describes the background of the study, introducing virtual learning environments in general. Section 3 describes the methods, how the data was collected and how the specific VLE was set up for this study. Section 4 shows the results in several figures. Section 5 discusses the results and provides some analysis. Section 6 concludes the study and offers some ideas for future work.

2 BACKGROUND

Over the past decade or two, VLEs have become ubiquitous across the HE sector worldwide. There are many different platforms available, this work has focussed on the application of moodle.org [9] and specifically its course completion tools. On its website, Moodle states that,

'Course completion shows if a course has been completed. It can show the progress a student is making towards finishing the course according to specific criteria. The criteria can include meeting an activity's grade level or a manual checking "complete" by either the student and/or teacher. The report can also show if the student has completed another course(s) that is marked as a "completion dependent" course.'

Of course, how the progress completion system is set-up is critical to the way it behaves. In this study, the progress completion has been set largely to be automated, in that if a student completes an activity, then the activity is automatically marked as complete. This matter will be discussed further in Section 5.

Previous work on this subject includes Weaver *et al* [10] who focussed on a group of BSc Sports Science students at Edge Hill University, in Ormskirk, UK. They found that whilst the use of VLEs did not negatively impact academic achievement, careful alignment to the learning outcomes and summative assessments are required for successful integration into HE pedagogy. Leino *et al* [11] describe a psychology degree course based work that showed overall VLE activity and the use of optional online tests and engagement with lecture recordings were important predictors of academic achievement. Boulton *et al* [12] in a 2018 study found that, "VLE usage is more important in modules that adopt an instruction-based learning style". They also went on to test the predictive power of VLE usage in determining grades, their findings suggested that student engagement with learning at the University of Exeter generally hard to determine by VLE usage alone but can nonetheless help to predict performance for some disciplines, especially the sciences.

This work sets out to show that, since the onset of the pandemic and the increase in the use of online learning, the correlation between VLE usage and student outcomes is more significant than ever, especially for science and engineering based subjects.

3 METHODOLOGY

3.1 Participants

There are three modules in this study, (labelled modules X, Y & Z) each drawn from the undergraduate cohort (in years 1, 2 & 3 respectively) in a Bachelor of Engineering programme within the Department of Electronic Engineering at Royal Holloway, University of London. All the data is anonymised so no individual students can be identified. The sample (after inclusion criteria had been applied) comprised of 52 undergraduate students (44 male, 8 female) across the three separate student year cohorts in academic year 2021-22. Students were expected to interact with the VLE system on a weekly basis to watch short, pre-recorded videos on core subject material, attempt regular mini-quizzes and download laboratory scripts for the weekly in-person classes. Students who did not attempt the final exams, were excluded from the study in each cohort. This decision was taken as often these students had missed the final exam in 2021-22 due to illness and without the exam mark their overall grade would not have been a true reflection of their actual 'outcome'.

3.2 Assessment

The weekly in-class tests consisted of multiple-choice questionnaire (MCQ) style short answer questions on each of the modules and were embedded and automatically assessed in the VLE. Final exam papers were of the traditional 'unseen written' variety in an invigilated environment each being a 2-hour period (plus extra time for those according to their Disability and Dyslexia Support statements). Students had to answer one compulsory question in Part A and then two from three questions in Part B, this is the standard template for all three modules in the Department. These exam papers were marked and moderated according to the College's quality assurance guidelines.

For consistency, all three modules chosen for this study had the same assessment weightings comprising of the three elements of assessment: the mini-quizzes totalled 20% of the module, the practical lab element 30% and the final exam was worth 50%. The overall weighted mark for each module was used to form the 'final grade' in the results section and was compared directly to overall course completion or physical attendance in lab sessions in Section 4.

3.3 Course Completion Criteria

The course completion set-up is vital to the efficacy of this study and the predictive ability of the completion data. Essentially, completion activity was monitored on a weekly basis. Each week would comprise two to three short videos, two to three short low-value quizzes, one or two tutorial sheets and a laboratory exercise script. The course completion setting would track each of these activities by monitoring whether a student had clicked on the link, hence a very detailed picture of student progress through the term was constructed. In all three modules, there were between 96 and 117 course completion activities collected. More specifically, for the 1st year Module X, 117 individual events were captured, for the 2nd year Module Y, 96 individual events were captured and Module Z captured 116 events. We believe that this level of detail provided a very precise and granular profile of each student's engagement with the VLE and is in part reflected in the predictive quality of the results obtained.

3.4 Data Collection

Assessment data (in-class test, coursework assessments and final examination marks) for each cohort was also obtained from the Department under supervision from the Undergraduate Education Lead, with online self-directed study engagement also calculated from the individual logs created on the VLE. Data is protected in accordance with the Data Protection Act of 2003 and the General Data Protection Regulation of 2018 and is completely anonymised.

4 RESULTS

The results are presented as scatter plots for each of the three modules in the study, where the x-axis represents *either* the total VLE completion progress as extracted from Moodle or the overall in-class attendance, and the y-axis represents the final grade achieved by the student cohort (both quantities are in percentage points). MathWorks MatLab 2020b was used to produce these graphs and, using the built-in statistical tools, a line of best fit was added along with the Pearson correlation coefficient, r_{xy}, embedded into the plot, where;

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

where x_i and y_i are the sample variables from the two different data sets to be cross-correlated and $\bar{x}$ and $\bar{y}$ represent the respective sample means.

The Pearson coefficient is a widely used measure of linear correlation between two sets of data. An absolute value of precisely $r_{xy} = 1.0$ implies that a linear equation describes the relationship between x_i and y_i exactly, with all data points lying on a line. In practice, values of $r_{xy} > 0.7$ and where probability associated with a *permutation test* (also known simply as the p-test) where values of $p < 0.05$ are widely considered to show a strong positive correlation [13] that is statistically significant (i.e. having a better than 95% confidence level). The correlation coefficients for Modules X, Y & Z (see Figures 1, 2 and 3) based on course completion were $r_{xy} = 0.7558$, $r_{xy} = 0.8747$ and $r_{xy} = 0.8555$ respectively, with corresponding p-test values of $p < 0.001$, $p < 0.001$ and $p = 0.033$. These all indicate a strong correlation between end of module results and course completion percentages.

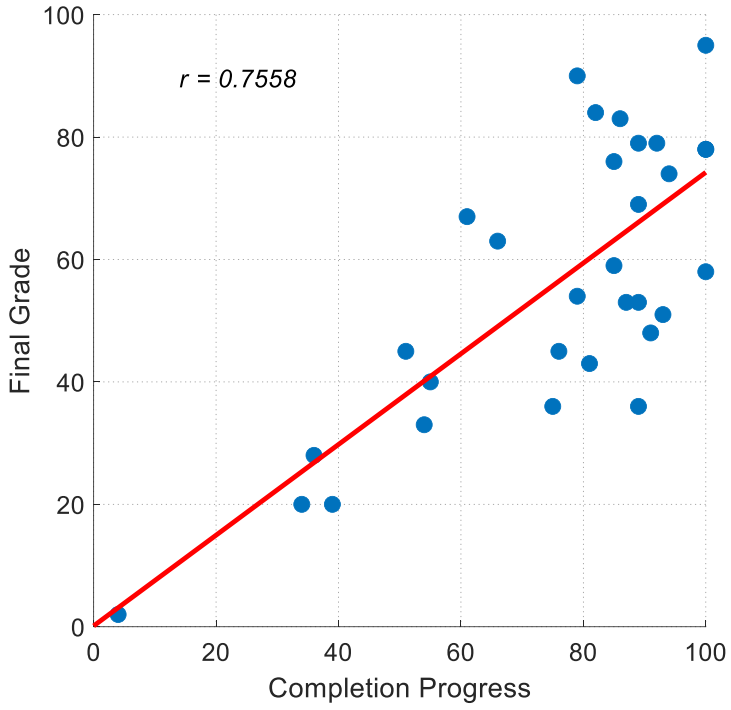

Figure 1. Correlation between student performance vs completion progress for Module X

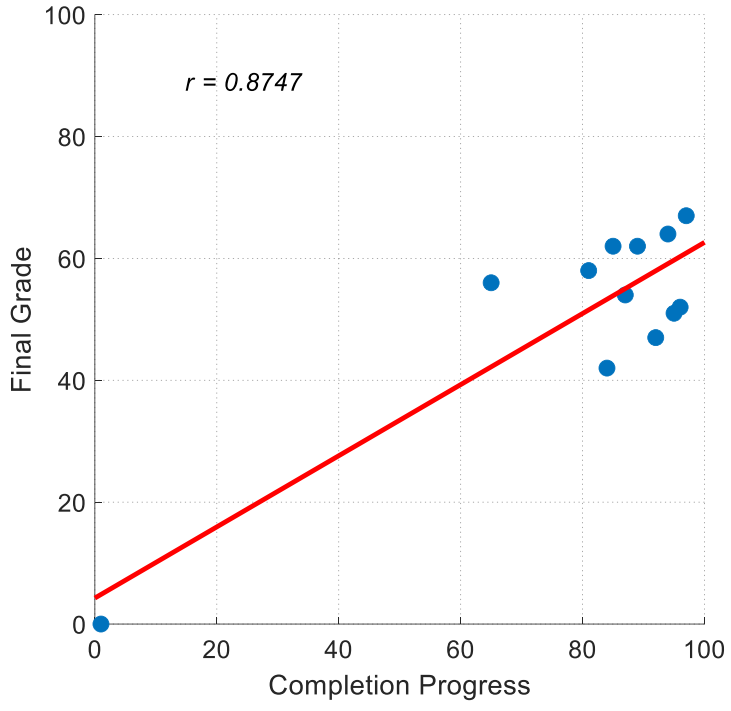

Figure 2. Correlation between student performance vs completion progress for Module Y

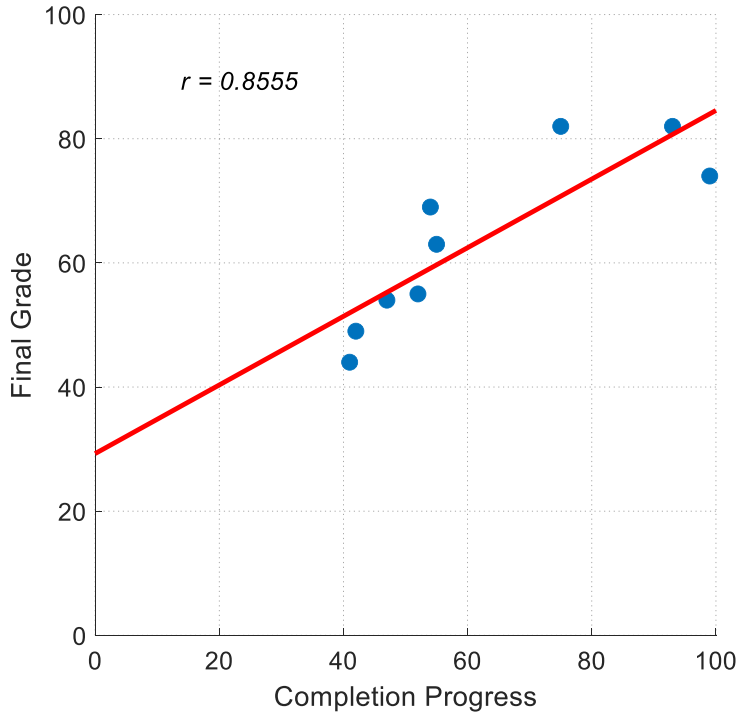

Figure 3. Correlation between student performance vs completion progress for Module Z

Conversely, the correlation coefficients which were based on in-class attendance alone show weaker correlations with final module grades in general. These being $r_{xy} = 0.6061$, $r_{xy} = 0.8505$ and $r_{xy} = 0.4599$ (see Figures 4, 5 and 6) respectively, with corresponding p-test values of $p < 0.001$, $p < 0.001$ and $p = 0.213$. It is worth noting that the weak correlation in Module Z could be related to the low number of data points.

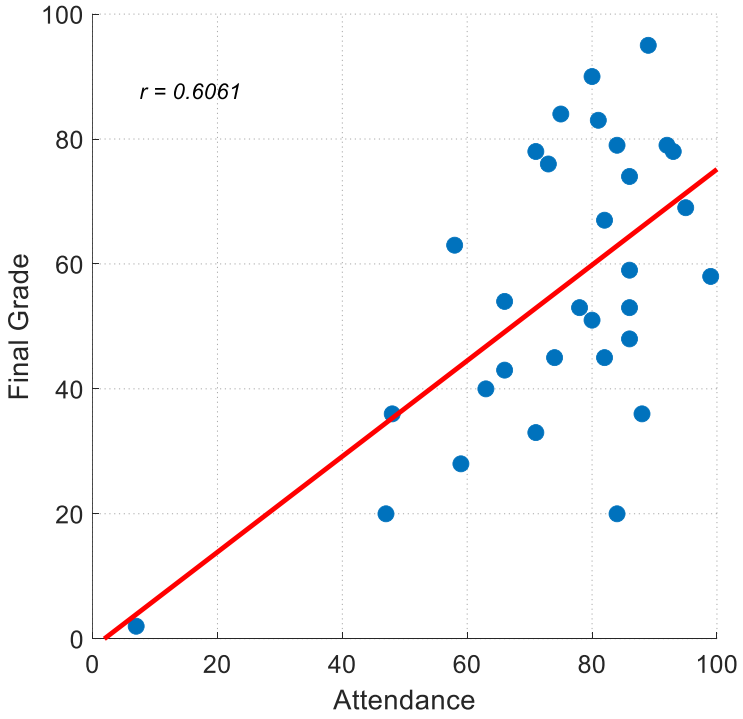

Figure 4. Correlation between student performance vs in-class attendance for Module X

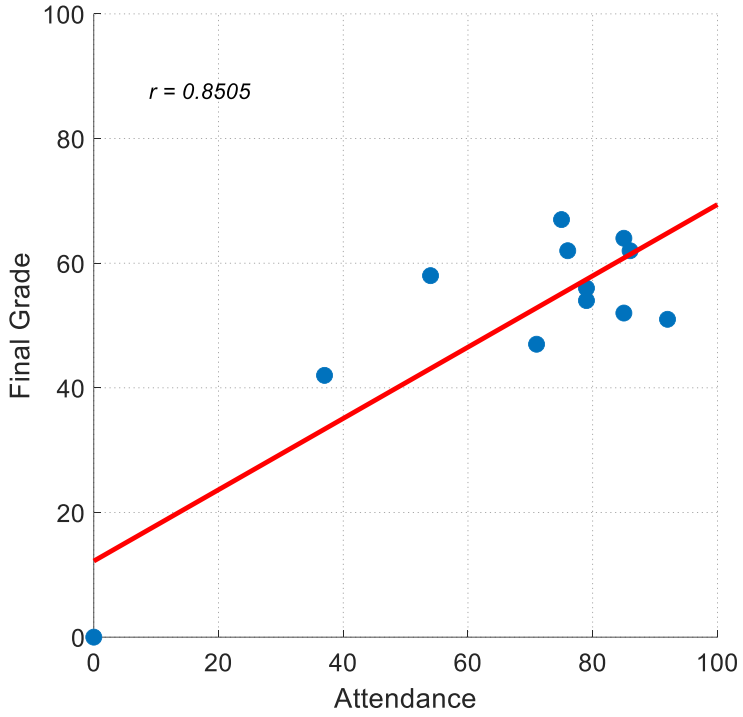

Figure 5. Correlation between student performance vs in-class attendance for Module Y

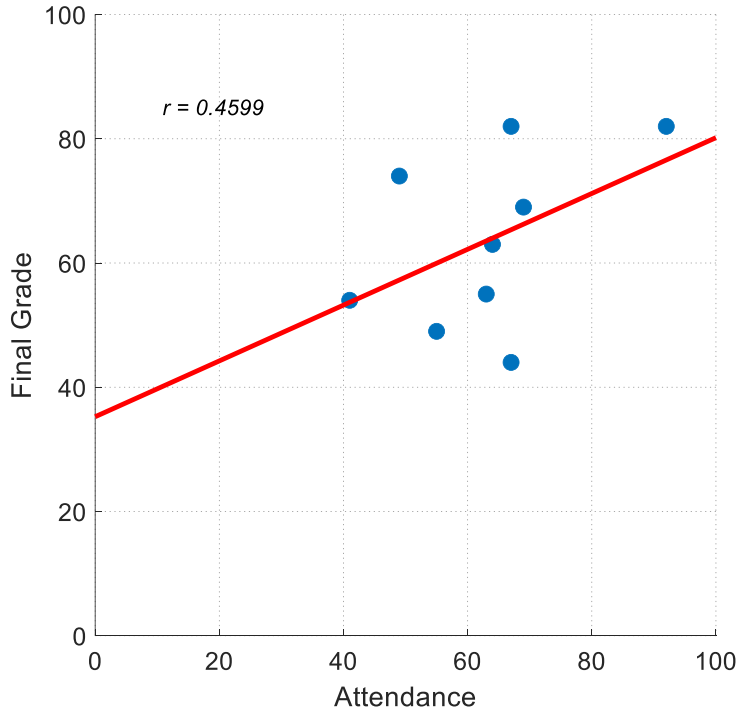

Figure 6. Correlation between student performance vs in-class attendance for Module Z

The overall results suggest that, for our study in general, the VLE course completion data was a *stronger* predictor of student outcomes and therefore we suggest a stronger predictor of student *engagement*.

5 DISCUSSION

The results show that student performance is highly correlated to their course completion progress on the sample modules on our VLE platform. Perhaps this is unsurprising, however, this does seem to support the proposition that better engagement on the VLE leads to better student outcomes. Alternatively, it might rather mean that more able students tend to make more effort to complete the target activities on the VLE, though this is difficult to disambiguate. The sample size is rather small and further studies would benefit from larger cohorts of students.

Moreover, precisely how the VLE course completion tool is set up – in some circumstances – could be misleading. For example, simply *clicking* on a link does not necessarily mean a student has actually read or undertaken that specific task. Inevitably, there are limitations to the veracity of the data that can be collected from such systems. Nevertheless, in the absence of better systems or data collection mechanisms, it is interesting to study their usefulness in determining student outcomes and engagement; this is the main objective of this study.

Furthermore, these initial results appear to support that there is some significant value in monitoring student progress on VLE platforms to enable early interventions for students whose course completion and engagement appears to be lower than a given threshold.

6 CONCLUSIONS

This study clearly shows that there is a strong correlation between course completion (in these example modules) and student performance. In this study, it seems that VLE completion and engagement is a more effective predictor of student outcomes than overall in-class attendance. There is perhaps a wider debate to be had if this approach would suit all modules or disciplines and which elements of course completion are the best predictors of performance. The process of linking many dozens of tasks for the course completion tool to track is also quite time consuming and needs updating every academic year for it to be accurate. However, our results do show that this work is statistically significant in the prediction of student outcomes and could be very useful in identifying students for remedial interventions.

6.1 Future Work

Future work might include analysing which tasks among the course completion progress have the strongest correlation to student performance on a module. Also, it would be valuable to investigate the correlation between actual time spent viewing pre-recorded lectures and student performance.

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