THE USE OF STUDENT NUMBERS TO RANDOMISE REMOTE QUANTITATIVE AND QUALITATIVE ASSESSMENT IN RESPONSE TO THE COVID-19 PANDEMIC

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Abstract: The sudden lockdown in March 2020 in the U.K. as the result of Covid-19 resulted in the requirement for in person unseen examinations to be replaced with other forms of assessment that could be undertaken remotely. This presented numerous challenges, one of which was the potential for collusion and plagiarism as the students were no longer being assessed under controlled examination conditions. This paper discusses the use of student numbers in Chemical Engineering at UCL to randomise various components of both qualitative and quantitative assessment. Questions were either created or amended, with values substituted for a portion of the student number, or a portion of the student number could be linked to qualitative criteria. These randomisations forced the students to undertake their own series of calculations or research to answer the questions, thereby reducing opportunities for collusion, but also plagiarism. In practice, although opportunities for collusion and plagiarism were reduced, there were still occurrences. The use of an initial randomisation in some cases made it easier to identify where collusion had occurred, but it also resulted in often distinct answers that highlighted different approaches to assessment by students. The use of randomisation also increased the workload for assessors, with customised mark schemes and increased subject knowledge or research required to suitably evaluate the answers provided. Increased levels of randomisation to mitigate collusion and plagiarism will further increase workload and should be recognised when trying to balance competing priorities for educators responsible for designing and implementing assessment.

Keywords; assessment, collusion, plagiarism, COVID-19

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1. INTRODUCTION

The onset of COVID-19 and the associated pandemic in early 2020 brought about the most significant challenge for higher education globally in decades (Marinoni *et al.* 2020). The impact spread across all aspects of teaching and learning support, with the requirement to switch to forms of online, distance learning (Wahab 2020), which impacted on all aspects of planning, delivery and assessment, as well as learning support from universities, as highlighted by (El Firdoussi *et al.* 2020, Strielkowski 2020, Toquero 2020, Turnbull *et al.* 2021) amongst many others.

Many of the challenges faced existed over different timescales and to different degrees, dependent on the varying locations of institutions globally and their associated timetables for teaching and learning (Marinoni *et al.* 2020). In the U.K., the onset of COVID-19 and associated restrictions towards the end of March 2020 coincided with the end of term 2 for many institutions, including UCL, and the end of lecture and seminar teaching activities for most students. At UCL the focus of the curriculum after term 2 is on assessment and project supervision (including dissertations), and in terms of pedagogy there was a requirement to ensure that the students could be appropriately assessed in a rapidly evolving and uncertain environment.

UCL was already well placed for this, in having a mature online learning platform, Moodle, for online submissions of most assessment types. However, many modules were assessed at least in part through in person, unseen examinations, which are a form of convergent assessment. These had to be replaced with other forms of assessment that could be submitted electronically, whilst still presenting a significant intellectual challenge to students. Given the timing, these assessments had to be developed and approved within a short period of weeks.

Whilst many modules had an examination component, some also relied heavily upon coursework components, or were entirely comprised of other forms of assessment. This institutional knowledge allowed the department to specify the use of take-home ‘projects’ or written assessments to replace examinations in most cases. These new assessments could be of varying length and complexity, appropriate to the needs of each module, but at their core they should challenge the students to problem solve within the confines of the module’s learning outcomes, and for them to explain those outcomes. The approach was rolled out to numerous assessments across modules throughout the pandemic, evolving with experience to improve the experience for staff and students.

The shift to take-home assessments, however, presented some additional concerns. The assessments could be conducted over days or weeks, rather than the short period associated with an examination. Whilst the merits of unseen, in person examinations have been the subject of much debate, the way they are conducted does make it more challenging for forms of academic misconduct such as plagiarism, collusion and contract cheating to occur (Richardson 2015).

To address the challenge of potential plagiarism and collusion, an element of controlled randomisation of aspects of these student projects was introduced. At UCL, this involved modifying quantitative assessments so that certain numbers could be substituted with random values associated with the student number, creating a form of divergent assessment. Similarly, for qualitative assessment, criteria for answering the question could be linked to these student numbers.

In this work we discuss the process, challenges and outcomes associated with randomising student assessments using the student number for assessments undertaken since the onset of COVID-19. Whilst the randomisation has improved the diversity of student submissions, it has also created additional load for both module co-ordinators and assessors, who must devise more complex assessments and be capable of assessing the wider range of outcomes that occur as a result.

2 METHODOLOGY

There are several different methods noted in the literature for the randomisation of assessments for students, some in relation to COVID-19. Examples are often associated with eLearning or other online or digital learning applications and include random assignment of questions to students in quizzes (Griffin and Gudlaugsdottir 2006) and divergent take-home assessments (Bradley 2016), as well as randomised questions and the order of questions in online examinations from large question banks (Gamage *et al.* 2020, Sabrina *et al.* 2022). This insight informed our method; however, we needed a different approach to the challenge, as we had limited time to implement this change in March 2020. We had to consider two factors; the randomisation of newly developed written take-home assessment, and coming up with a way to randomise the variables used in the questions that was quick and simple to implement, readily understandable by the students and systematic in its outcomes.

2.1 Selecting the random variables to use in questions

Given the time constraints as well as the desire for a simple but conformable way to randomise the assessment, it was determined that the student number could be used as a source of numbers that could be substituted into calculations to randomise the outputs. The numbers could also be linked to a table or selection of criteria to randomise qualitative criteria.

The student number is 8 digits long, providing a range of numbers that can be used individually or in combination in assessment settings. This number is also different from the student's unique personal identifier, which is a separate string of numbers and letters associated with the student and is used to identify candidates in assessment settings at UCL.

The questions could specify portions from the student number that could be used for a particular calculation or to identify a particular criterion to be considered. In these examples, portions within the student number were linked to letters (e.g., YY, ZZ). These letters were then used in questions, where the students would be asked to substitute the numbers into the equation, or discuss the criteria associated with their unique number.

The students were provided with clear instructions at the beginning and during the assessment, explaining to them the randomisation, and which numbers from the student number corresponded to letters, and how those values should be used to complete the assessment, as shown in Figure 1.

Please note. In order to randomise each of your projects, the questions will be linked to your student number, which is an eight-digit number;

The fifth and sixth digits will correspond to XX, and the seventh and eighth to YY;

E.g.: 18163849; XX = 38 and YY = 49.

Figure 1 – instructions given to students so that they could select the numbers required to answer questions in their assessment.

The questions were then written out with certain values replaced with letters in the question (XX, YY), with instructions to replace these letters with their numbers from their student number.

2.2 Randomising questions

The approach to randomising questions is different for quantitative and qualitative components. For quantitative questions, although outwardly it seems straight forward to substitute one number for another, the implications of using those numbers in calculations can lead to undesirable or unrealistic outcomes, when compared to a fixed question in an examination or in coursework.

Therefore, the randomisation of quantitative questions would require the question to be set up, and then a range of substitutions of numbers tested, using the full range of numbers that could potentially replace numbers already in the question, and still give a sensible answer. Further randomisation could be introduced by substituting for other numbers, but this also compounds the complexity and a requirement to thoroughly check all calculations before finalising the assessment. To simplify this process, the questions were set up in Excel and a range of numbers tested to substitute for others within the calculation.

For qualitative assessment, ranges of numbers or individual numbers from the student number could be linked to certain criteria, e.g., a country or a process. The student would then be required to discuss the problem with respect to the question asked. This would require them to undertake their own research to answer the question correctly or apply their knowledge and understanding appropriately. Criteria or variables could be listed against the values for the question, allowing the student to quickly identify what they needed to discuss.

2.3 Marking of assessments

In terms of marking: for quantitative assessments a spreadsheet was set up with the questions, where the marker could enter the student number, and it would generate all the correct answers for that student. For qualitative assessments, a broader marking rubric was set up that allowed the assessor to evaluate how the student explored answers given, using criteria specific information to support their answer (the specific criteria being identified by values from the student number, e.g., a country). In preparation for this, the assessor had to evaluate the literature to check the student's answer if some elements of the criteria were discussed in detail.

3 EXAMPLES OF ASSESSMENTS

The methodology described above was applied to numerous assessments during the pandemic and has been subsequently used to randomise assessments that have substituted for, and ultimately replaced, examinations for some modules, as well as other assessments such as coursework and reports. Two examples, one qualitative and one quantitative are discussed below.

3.1 Qualitative assessments

Qualitative assessments were modified through changing the criteria being evaluated in the question, which would lead to divergent outcomes. For essays, reports etc., this could be for example changing the numbers associated with a variable being discussed, or changing one of the variables of the question (e.g., a country being evaluated), or a combination of the two.

In this example, for one particular module the students were asked to evaluate the prospect of a mine being developed in a particular country, with ore (the rock containing the mineral of interest) containing a particular amount of that mineral, in this case sphalerite. The question was randomised by changing the amount of sphalerite present, along with silver, linking them to values from the student number. In addition, a table of countries linked to values from the student number was included, so that different students had different countries to discuss in context. Another variable, in this case distance to the nearest town, was also randomised, which provided some additional discussion. The full randomisation of the question is shown in Figure 2:

As a result of this evaluation it has been shown that there is 7.2 million tonnes of measured sphalerite ore with an average mineral grade of (1+**X**)*2 %, along with 0.000**YY**1 % accessory native silver. A further 4.1 million tonnes of indicated ore, and at least 3.8 million tonnes of inferred ore (both with the same average mineral grade and accessory silver content) have also been identified in the deposit. There is no lead associated with the deposit, and the metallic component of the sphalerite is 100 % zinc (no iron present).

Countries are listed below; your country corresponds to your value of YY:

1 – 5: Spain
6 – 10: Botswana
11 – 15: Greenland
16 – 20: Mongolia
21 – 25: New Zealand
26 – 30: Bulgaria
31 – 35: Nigeria
36 – 40: Sweden
41 – 45: Bolivia
46 – 50: Indonesia
51 – 55: Taiwan
56 – 60: Ireland
61 – 65: Pakistan
66 – 70: Tajikistan
71 – 75: Algeria
76 – 80: Vietnam
81 – 85: Argentina
86 – 90: Norway
91 – 95: The Philippines
96 – 99 (and 00): Sri Lanka

At the beginning of your coursework, write your student number and the corresponding sphalerite grade and country of the ore body.

The mine is in a remote region, ~ 500 m above sea level, and is **YY**+5 km from the nearest town.

Figure 2: An excerpt from a question in a project with randomisation of several variables.

The question was open-ended at Level 6/7, encouraging students to evaluate the information available to them and produce their own answer. The variables required the students to undertake their own research into the feasibility of mining in their assigned country, and to consider the impact of the variables on the viability of the proposed operation. The numerical variables would also affect the viability of the potential operation, thereby further increasing the range of outcomes.

The randomisation ensured a range of student outcomes; and there was a range of responses to the question set with some exploring the variables in more detail than others. This made the prospect of collusion more challenging, in fact, no collusion was detected in this assessment. There was no plagiarism detected in this assessment as the apparent nature of the question and the randomisation made it less advantageous to copy large portions of text into the assessment, as the content would have to be discussed in context to provide an appropriate answer to the question.

The randomisation did, however, have implications for staff cognitive load. Whilst the question was set up to test students' understanding of the impact of mineral grade (quantity) on a potential development, country factors had a significant impact on the feasibility of development. Whilst varying the quantity of mineral is easily accounted for, having a range of countries required the assessor to evaluate a much wider range of outcomes, and to invest considerably more time in understanding the implications for mine development in multiple locations as well as validating the students' answers.

Given that staff already have substantial time pressures, this does suggest there are limits to how much randomisation one can reasonably have in assessment, if it has a significant impact on how much time it takes to satisfactorily mark the assessment. However, from this example, increasing the level of randomisation in a qualitative assessment did impact positively on the frequency of academic misconduct, implying the concept is worth pursuing, bearing the time factor in mind.

3.2 Quantitative assessments

Quantitative randomisation is relatively straight forward to implement (but can have impacts on qualitative aspects of a question). As described, values from the student number can substitute for values in calculations, allowing for a randomisation of outputs. To increase the level of randomisation, further values can be substituted.

As can be seen in Figure 3, several values have been substituted into the questions, thereby randomising the answers for each student. This is a simple way to add a level of distinctness to the question, and to reduce the ease of collusion in this form of assessment. The randomisation of answers can also impact on qualitative aspects of questions if present, for example if the student was asked to comment on the answer given with respect to what might be expected.

a) Figure 1 shows a Sankey diagram for wind energy showing the different energy losses on the way to producing electrical energy. The initial power of the wind is ***Z*** MW, where ***Z*** is the last non-zero digit of your student number (if the final digit of your student number is 0, then you should use the penultimate digit). You must state the initial power of the wind at the beginning of your solution.

i) What is the overall efficiency of the system? **[1]**

ii) How much power is converted into useful electrical energy (power output)? **[1]**

iii) The average windspeed in the area is 6.5 m/s, what should the length of one of the turbine blades be? Assume air density is 1.2 kg/m^3. **[4]**

iv) The electric generator losses and friction losses are known values of the system. The availability loss however may vary due to wind availability and any unexpected maintenance. If the wind turbine is constructed using blades that are 10m longer than you calculated in part iii) (if you do not have an answer for part iii) assume that the answer is 100m). What would be an acceptable value for the availability loss in order to maintain the same power output as previously calculated? **[4]**

AND

b) One aspect of a Life Cycle Assessment is inventory analysis, where we quantify the environmental burdens in the life cycle of the activity we are studying. This is quantified using the formula:

$B_j = \sum_1^i b_{j,i} x_i$, where $b_{j,I}$ is the burden j from process i, and x_i is the mass flow associated with that process.

Figure 2 shows the environmental burdens from CO_2 and CH_4 at each stage of the life cycle for a product. The functional unit (FU) is ***DEF*** tons of the product (X_2). Where ***D, E*** and ***F*** are the **last** three digits of your student number. You must state your FU at the beginning of your answer.

What would be the total environmental burden from CO_2 and CH_4 (B_{CO2} and B_{CH4}) over the whole life cycle for this product? **[8]**

Figure 3: Examples of quantitative questions considering renewable energy technologies and life cycle assessment.

Although these changes were designed to minimise collusion, the randomisation for quantitative questions has highlighted unexpected examples of simple collusion, where students have copied and pasted solutions from others' work, without changing the randomised numbers. This highlights both where the copied work has come from, and clearly what has been copied into another assessment. Without this randomisation, these instances of collusion might have gone undetected.

In terms of marking, whilst not as challenging as the randomisations contained within the qualitative example (later), the quantitative randomisation still requires the assessor to set up a more complex mark checker, where the student numbers can be entered to produce all the answers associated with the student in advance. There is also additional time required to check each student's calculations, particularly where errors are present and may carry through. This adds to the assessment burden faced by assessors and should be taken into consideration when specifying a level of randomisation within assessments.

4 DISCUSSION

Randomisation of elements of assessments was seen as a way to quickly respond to some of the initial challenges presented by the onset of COVID-19. The randomisation had a positive impact on academic integrity with respect to qualitative assessment, as it resulted in unique answers having to be developed for each student. The use of the student number, itself a unique random number that the students already had, streamlined the process as there was no need to use software to generate and distribute random numbers, for example as in Griffin and Gudlaugsdottir (2006).

The use of randomisation also made it more challenging to engage in academic misconduct with quantitative questions, as each student would have a unique answer to the questions present. These observations tie in with the observations of (Bradley 2016) who noted a reduction in similarity scores for divergent assessments. Where collusion has occurred, it has been more easily identified as the students have 'failed' to sufficiently edit their work, in some cases copying over the randomised elements linked to another student, making the collaborators easier to identify.

Randomisation, whilst having a positive impact on academic integrity, inevitably has an impact on staff load. This occurs in the set-up of questions, where for quantitative elements the questions must be set up and tested for the full range of possible values that can be substituted into questions; this is also important in ensuring those answers are sensible within the context of the question. The more randomised values in the question, the more complex and time consuming the testing to ensure all outcomes were sensible, and that must also be taken into account.

In terms of qualitative assessment, the questions must be well considered with respect topic or values under consideration; for example, where the students may be asked to consider the implications of the answer to a randomised quantitative question, does that full range of potential answers result in a sensible discussion. Randomised qualitative questions with long form answers in particular impact staff cognitive load, as the full range of answers may require staff to familiarise themselves with a much greater range of literature to fairly and consistently mark the answers given. One colleague commented that: *"I regularly spent twice as long assessing written essay style questions, to check the reference material of the student, and to ensure the answers were sensible in context."*. Given that assessors are expected (and often struggle) to meet the 4-week turnaround time for marking, these additional requirements place additional burden on staff, even in the most ideal of circumstances where no errors are present in the mark scheme, for example.

Randomisation is one way in which one can look to minimise and identify academic misconduct in assessments, however, the benefits must be balanced against the increasing load and assessment burden that staff in universities face. The randomisations trialled during COVID-19 have evolved as we have learnt from that initial experience, to clarify questions for students and optimise the assessment load for staff. However, we must strive to ensure that it is fair for assessors as well as students, and so constraining some criteria to reduce staff load is desirable in the long-term, whilst maintaining the distinctiveness and, reduction in collusion in particular, that can be brought about through randomising the questions.

5 CONCLUSION

Randomisation of take-home assessments during COVID-19 to substitute for in person examinations, linking portions of a student's student number to variables in qualitive and quantitative assessment had a positive effect on academic integrity. These forms of divergent assessment, whilst making it more challenging to engage in plagiarism and collusion significantly increase the cognitive load for assessors, who must be prepared to produce complex questions, and thoroughly mark a greater range of answers. This should be taken into account when designing assessment, ensuring the right balance between the randomisation, complexity and volume of questions, with the availability of staff to fairly assess the range of answers that result.

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