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Challenges for Conducting the Online Assessment for A Large Class in Engineering Mechanics

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ABSTRACT

Due to the Covid-19 pandemic, we had to perform an online assessment for a large class of more than 300 students for an engineering mechanics module. We designed the online quiz with multiple-choice and fill-in the blank questions, and incorporated two forms of randomness in the questions to minimize plagiarism. The students' examination scores were generally in normal distributions, which suggested that the online quiz was challenging enough to differentiate the performance of the students. Hence, we believe that it is possible to create high quality and credible online quizzes, which would be useful for large class courses.

Key words: Mechanical Engineering; Plagiarism; Online assessment.

INTRODUCTION

In this article, we would like to address the challenges we faced when conducting the online assessment for a large class module (about 400 students) on basic mechanics. Traditionally, the final assessment is a sit-down examination on solving problem sets with invigilators in an examination hall. In general, the assessment involves: Drawing diagrams of the problem; applying the correct physics to derive the governing equations; and finally solving them to arrive at the final solutions [1–3]. However, to design a similar examination online turned out to be quite a challenging process. The complication arises because we need to minimize the risk of plagiarism [4]. A common strategy is to built-in randomness in quiz, and also to have "on-line" invigilators to monitor the process of the examination. In this article, we will focus on how the online quiz was designed and implemented using our in-house learning platform, the LumiNUS (https://luminus.nus.edu.sg/).

METHODS AND PRELIMINARY RESULTS

We implemented the online examination using the Quiz tool in LumiNUS, which is an online educational platform developed by the National University of Singapore. The types of questions supported by the tool include: multiple choice question (MCQ), True or False, Fill in the Blank (FIB), and Matching. For this module, we find the MCQs and FIB types most suitable, but it could not be used directly without significant modifications. Figure 1 illustrates the differences between a conventional exam question, and its online version.

Figure 1(a) depicts the general description of the problem. The next section defines specifically what the question wants. For the conventional examination, it is usually a short statement that contains the variables to be solved (such as in Fig 1(b)). This works for the conventional question because the

Three rods *AB*, *BC* and *CD* are connected by pin joints at *B* and *C*, as shown in Fig. 1. Rod *AB* is made to rotate about the joint *A* fixed to the vertical wall at a constant angular velocity of ω. Rod *CD* is also free to rotate in the same vertical plane about joint *D* fixed to the ground.

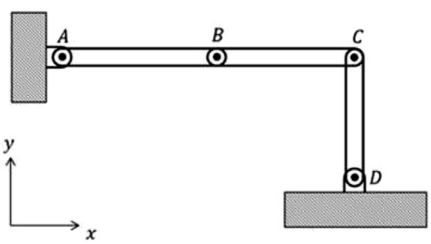

Figure 1

Given the following information for the configuration:
- The length of the rods are $\underline{AB = 1.0}$ *m*, $\underline{BC = 1.0}$ *m*, and $\underline{CD = 1.0}$ *m*.
- Angular velocity of rod *AB*, $\underline{\omega = 2.0}$ *rad/s* in the ***clockwise*** direction.

(a)

For the position shown in the figure, determine the angular velocity and acceleration of rod *CD*. (25 *marks*)

(b)

For the position shown in the figure, determine:

(a) The location of the instantaneous center of rotation for rod *BC*. (*3 marks*)
  (i) A
  (ii) B
  (iii) C
  (iv) D

(b) The velocity at point *B*. (*4 marks*)
  (i) 1.80 *m/s* ↓
  (ii) 2.20 *m/s* ↑
  (iii) 2.70 *m/s* ↓
  (iv) 3.30 *m/s* ↑

(c) The magnitude of the angular velocity of rod *BC*. (*5 marks*)

(d) The acceleration of point *B*. (*4 marks*)
  (i) 3.60 rad/s^2 ←
  (ii) 5.63 rad/s^2 ←
  (iii) 8.10 rad/s^2 ←
  (iv) 11.0 rad/s^2 ←

(e) The acceleration of point *C*, expressed in terms of the angular acceleration of rod *CD*, where α_{CD} is taken to be in the positive direction. (*4 marks*)
  (i) $0.9\alpha_{CD}$ ←
  (ii) $0.9\alpha_{CD}$ →
  (iii) $1.1\alpha_{CD}$ ←
  (iv) $1.1\alpha_{CD}$ →

(f) The magnitude of the angular acceleration of rod *CD*. (*5 marks*)

(c)

Figure 1. (a) General problem description; (b) conventional exam question; and (c) online quiz format.

students were credited for their thought process in terms of workings. And careless mistakes made in the earlier steps were usually not be penalized further in the final solutions. However, it is inappropriate to adopt the same approach for the online quiz, if credit points were only given based on the final answers. We were concerned that the students may be severely penalized for their carelessness. Hence, such an online quiz would fail to correctly assess the student learning outcomes of the module.

To overcome this issue, we modified the question statement by breaking it into several different parts, as shown in Fig. 1(c). It is emphasized here that the end goals for both the examination styles are the same, which for this question would be to calculate the angular velocity and acceleration of rod *CD*. But for the online quiz, the solution process was a more guided approach. For example, to get the angular velocity of rod *CD* in part (c), the MCQs in (a) and (b) would provide some hints on how part (c) could be solved.

The MCQs were used for the earlier parts of the question so that the students were tested and credited for giving the right answers, demonstrating the understanding of the basic concepts of the topic. Students with good understanding were likely to get these points, because careless mistakes made in the calculations would not likely end up in the MCQ options. The subsequent FIB parts were included to further evaluate their understandings. They helped to differentiate the good students from those that were simply lucky with the MCQs. For this quiz, we had about 40 % of the total score that were FIB type. Figure 2 plots the distribution for class final score for the online quiz, which comprised four different questions of 25 marks each. Figure 3 further shows the distributions of the scores for the four questions separately. In general, they are normally distributed, and this suggests that the online assessment was challenging enough to test and differentiate the students sufficiently.

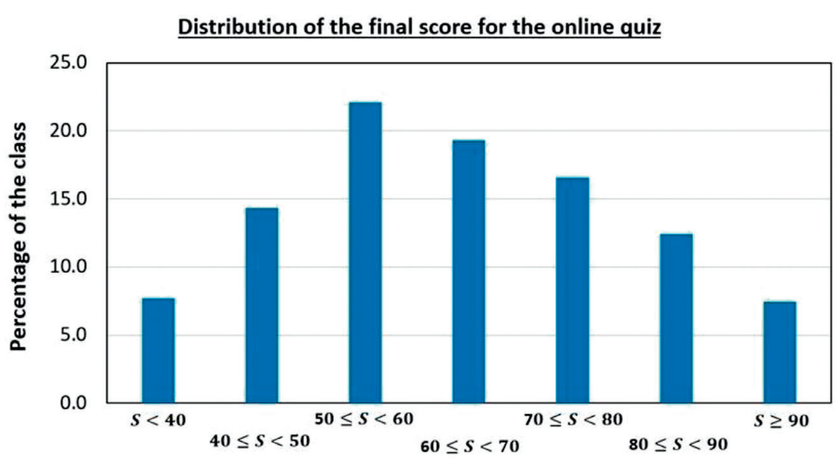

Figure 2. Final online quiz score distribution for a class of 360 students.

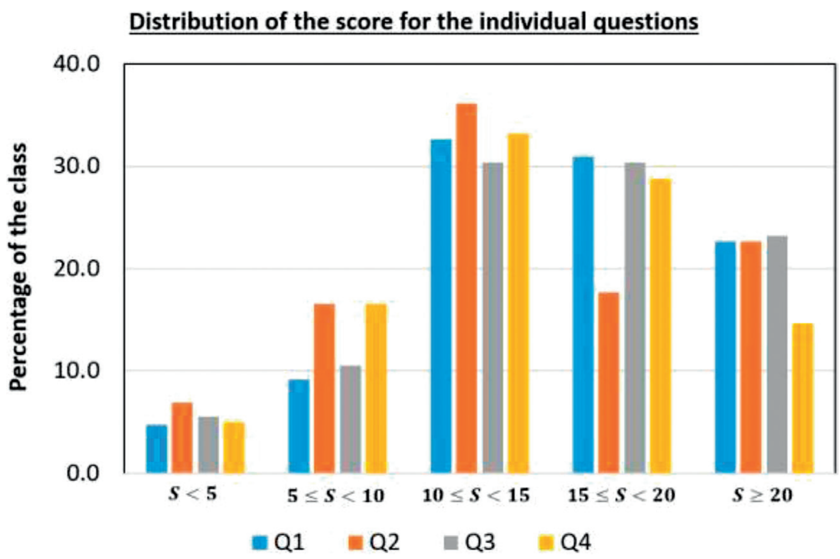

Figure 3. Distribution of the scores for the four questions separately. Each question is 25 marks.

In order to minimize plagiarism, we used two forms of randomness in the quiz. First, the order of the options for all the MCQs were randomized with the LumiNUS Quiz tool random function. Secondly, multiple variations of the same problem were created with different numeric for the problem variables, such as those underlined parameters shown in Fig. 1(a). For the example in Fig. 1, we used different dimensions for the rods, and also changed the input angular velocity to create four variations for each problem. And they were randomly assigned to the students. This means that about one-quarter of the class would be attempting the same question for each problem. For the entire exam paper with four questions, the probability of two students doing exactly the same set of problems would be less than 0.4 %. Although we cannot eliminate plagiarism, it makes sharing of the correct answers more difficult.

NEXT STEPS

From this exercise, we believe that it is possible to create high quality and credible online quizzes. The main issue with plagiarism can be adequately addressed by having randomness for some parameters in the exam paper. To further improve on this, we can include another level of randomness for each part of the question. For example, part (b) and (d) in Fig. 1(c) can either be solving the solutions at point *B* or *C*. In other words, there can also be variations within each question.

In this assessment, we were unable to test the students' abilities to draw free body diagram (FBD). It is often a critical step in solving problems in mechanics because the governing equations can be derived from the diagrams. A simple way to test this part is to do it in the MCQ format, in which the students have to choose the correct FBD from a given set of FBDs. Another possible solution is to create a solution template that allows easy building of FBD with pre-defined components. Similar to building Lego, students will have to choose the correct components, and then placed them in the correct positions to complete the FBD.

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