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A Guide to Online Assessment in Large Engineering Design Classrooms

By

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ABSTRACT

Student protests in 2015 and 2016 along with the inherent colonial nature of African universities has sparked reflective conversation among university academics in the areas of curriculum development and teaching practice in South Africa. Consequently, the online classroom, though typically perceived as pedagogically unconventional at residential universities in South Africa, is increasingly seen as an innovative way to encourage educator and student engagement with discipline-specific content. In addition, online assessment at residential universities in South Africa is growing in popularity due to its time-saving and efficiency properties. However, there is very little guidance available to educators who wish to conduct online assessments in large classrooms. The purpose of this study is to provide a guide to educators on how to execute online assessment in large classrooms, with specific application to engineering design. The study begins by outlining why an educator may want to consider online assessment for a large classroom. Thereafter, the study explores face-to-face assessment theory vis-à-vis online assessment theory with respect to purpose and efficiency. Following this, the study characterizes the nature of the engineering design classroom used in this study. Subsequently, the study explains the merits and drawbacks of online assessment and provides practical recommendations on how to overcome potential and typical challenges faced in a large engineering design classroom. Findings may prove valuable to other teaching environments and disciplines interested in effective online assessment for large classrooms.

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1. Introduction

The role of assessment in education is multifaceted. While assessment is primarily used to gauge student learning, it is also used to improve curricula and reflectively enhance the teaching and learning process (Gaytan and McEwen, 2007). Assessment is traditionally defined as “the wide variety of methods or tools that educators use to evaluate, measure, and document the academic readiness, learning progress, skill acquisition, or educational needs of students” (Great Schools Partnership, 2015). Similarly, online assessment “involves translating the unique benefits of face-to-face interaction to online activities” (Gaytan and McEwen, 2007).

However, this “translation” is sometimes misinterpreted when online assessment is confused with computer-graded tests or multiple choice-type questions. In this study, we assert that online assessment is not the same as computer-graded tests. Rather, it is a combination of computer-graded, and sometimes layered multiple-choice questions, with discussion or essay-style questions, which gives educators more freedom to diversify assessment methods, even in large classrooms. The reason we make this distinction is that the size of the classroom sometimes influences the kinds of teaching and assessment methods employed in a teaching strategy. For example, as class size increases, methods of assessment shift from expensive, conventional approaches, such as essay-writing, to more cost-effective and efficient methods, such as computer-graded testing or multiple-choice questions (Paré and Joordens, 2008). With this in mind, there is very little objective information available to guide educators on when, why and how to make use of online assessment in a large classroom.

Thus, the aim of this study is to contribute to the sparse research on online assessment for South African students by examining, in detail, the application of online assessment in a large classroom. The objective of the study is to provide a guide to educators on how to execute online assessment in large classrooms, with specific application to engineering design, so that they may realise the benefits and drawbacks of online assessment in the South African context. This study hypothesises that online assessment, in a large classroom, reduces grading timelines and thus, provides educators with an opportunity to provide feedback that is more detailed to students.

2. Conceptual framework

2.1. Assessment Theory

Assessment theory has evolved over time. Between 1900 and 1980, the dominant paradigm of learning theory and learning measurement was deeply rooted in the interaction between social efficiency curriculum, hereditation theory of the intelligence quotient (IQ), associationist and behaviourist learning. Learning during this time was viewed as granular, and accompanied by objective tests to measure achievement (Shepard, 2000). By the 1980s, new views of learning and instruction emerged, while the traditional measurement of learning remained, creating a disjoint between instruction and learning measurement. From 1990 onwards, the paradigm of learning theory was rooted in cognitive and constructivist frameworks and accompanied by a diversity of learning measurement strategies.

Despite the drastic theoretical shift in teaching and learning practice, most residential universities in South Africa make use of the neo-behaviourist model of mastery learning. This model was developed by Bloom, Hasting and Madaus (1971) who purport that an effective learning strategy comprises of small units of learning followed by formative assessment. While this model appears to be a balanced combination of Shepard’s old and emerging paradigms of learning and measurement, the neo-behaviourist education framework, as applied in the South African context, appears to be prioritising student throughput rates without always considering student enrichment. The lack of longitudinal data on students, as highlighted by Sondlo (2013), does not allow us to investigate this which exacerbates the focus on student throughput rates and seems to encourage a symptomatic approach to learning measurement as opposed to a systematic approach.

2.2. The History of e-pedagogy

The origins of e-assessment can be traced back to 1975 in the United States. Hench (2014) outlines three stages of evolving e-pedagogy prevalent in the United States between 1975 and 2012. Stage 1, characterised by computer-assisted instruction and measurement between 1975 and 1990, was primarily behaviourist meaning that learning measurement typically focused on objectively observable behaviors and disregarded any independent activities of the mind. Stage 2, characterised by an increase in computer-based instruction together with computer-assisted instruction, between 1990 and 2000, was a combination of behaviourist and constructivist learning paradigms. Stage 3, though still characterised as a combination of behaviourist and constructivist learning paradigms from 2000 to 2012, is more constructivist than behaviourist in nature. This could be attributed to the increased use of educational technologies and the fact that educational technologies support constructivist e-learning and e-assessment platforms. Though Hench (2014) specified these stages for the United States, they were very much a mirror of the global transition from behaviourist to constructivist approaches to teaching and learning.

It appears as though online assessment presents educators with an opportunity to balance automated-grading style questions with engagement questions, in a more constructivist setting. It also provides students with an opportunity to familiarise themselves with the technology accompanying the assessment, which is important in the South African context where university students are not as proficient with technology or computer literacy (Hlalele, 2016).

3. Methodology

This study makes use of a descriptive research design in the form of a case study. The study analyses the structure of a first year engineering design course offered to the 2018 cohort of students from a large residential university in the Gauteng province. Because of the nature of the research design, no data collection instrument or sampling technique was used. Instead, the course and how online assessment was applied within it was examined up-close and in-depth, which is in line with a case study approach (Yin, 2011). The module used in this research is a first year, first semester module, which serves as an introduction to engineering as well as an introduction to engineering design. The class is a foundation module in the mechanical, electrical, electrical with IT and civil engineering science programs. The nominal class size is 390 students but ranges between 360 and 420 students. The mode of instruction is face to face, divided into a one and a half hour lecture per week, three tutorials, two workshops and one practical per semester, all of which are compulsory.

The tutorials, workshops and practical are three hours and fifteen minute sessions. In addition to the formal contact time, the students have access to the lecturer and co-lecturer via three hours of consultations per week as well as voluntary contact with the tutors during the tutorial timeslot on weeks that do not have a formal tutorial, workshop or practical. On a whole the typical first year engineering student at the University spends between five and ten hours per day in lectures, tutorials and practicals during weekdays. This, together with independent learning, forms an 8 credit module, which is equivalent to 80 notional hours for the semester. In the South African context, 1 credit is equivalent to 10 notional hours. Notional hours of learning are defined as “learning time that it would take an average learner to meet the outcomes defined. It includes concepts such as contact time, time spent in structured learning in the workplace, individual learning and assessment." (South African Qualifications Authority, 2000, p. 12).

The students are provided with a learner guide upon commencement of the module in addition to weekly lecture slides, tutorial content and supplementary material. The learner guide provides an overview of the course content, course structure, the module requirements, student role and responsibilities, a module semester schedule, overview of the assessments and recommended reading material. All material is made available to students on the learning management system, Blackboard.

Assessments follow the typical neo-behaviourist approach and comprise of two semester tests, two assignments, a practical, three tutorial tests and an examination. The first assignment is a group-based video project and the second assignment is an individual engineering design project. The practical is a group-based engineering design task. The tutorial tests are thirty-minute tests based on the content covered in the corresponding tutorial. The semester tests are one and a half hour assessments that have elements of theory and engineering analysis commonly used in engineering design tasks. The semester tests, assignments, practicals and tutorial tests constitute a semester mark. The examination is a three-hour assessment in the same vain as the semester tests. The semester mark and the examination mark are weighted equally towards a final grade for the module.

Originally, the assessments were paper-based submissions apart from the video assignment. The video assignment is submitted on a DVD or shared via the students' choice of cloud-based storage systems. The practical has remained a paper-based assessment, where the students submit a group report on the assigned design task along with a tested design prototype by the end of the session. The tutorial tests were administered as a closed book, paper based test, prior to the end of the tutorial session. The semester tests and the examination were administered as closed book paper-based tests.

Due to the large class size, paper-based assessments, particularly the tutorial tests, semester tests and the examination required significant time to grade. The large grading timelines typically delay student feedback and influences time available to spend on other meaningful teaching and learning interventions and research.

As a result of the volume and frequency of assessment here, initial attempts were made to administer the tutorial tests using Blackboard. Whilst this worked for the simple tutorial tests that contained basic theory, analysis and calculation-based questions, significant thought was given to how one could use the online approach for more complex assessment whilst still being able to assess the method employed by the student. To overcome this, a past semester test was replicated in Blackboard and tested by the lecturer. In addition, another lecturer assisted in testing the approach by taking the mock test from the perspective of a student and provided critical feedback. The university provided assistance by ensuring that appropriate infrastructure was provided in the form of sufficiently sized and equipped computer laboratories. The academic technologies division provided institutional support concerning set up of specific question types, security of the assessments, moderation processes and evidence collection for quality review. The study satisfied the ethical clearance requirements of the residential university.

4. Data Analysis, Findings and Discussions

In this context, migrating from a paper-based assessment to an online assessment provided a variety of challenges. The primary challenge was to maintain the macro-structure of the assessment, thus, maintaining the quality of the assessment. Secondary challenges, yet vital to the success of the approach, were to ensure appropriate mechanisms for moderation, evidence collection for compulsory module evidence files, assessment security as well as mitigating and managing unforeseen technical glitches.

4.1. Maintaining the Assessment Structure and Quality

To overcome the challenge of preserving the macro-structure of the assessment, questions were fragmented in to smaller questions that either lead into the next question or act as a follow- up to the previous question. Source: Authors' own presents an example of how a question from the original paper-based assessment was fragmented into smaller questions for the online assessment.

From Source: Authors' own, in the online version of the question, Q.1, Q.2 and Q.5 were graded automatically by Blackboard. For this reason, clarity was provided in the question with respect to the units that the result must be reported in and the rounding of decimals must be specified. With this approach the student can still obtain part marks for the method employed by assigning marks to either a follow up question (Q.3 is a follow up of Q.2) or via a prior question (Q.4 requires the specification of the formula to solve Q.5). The assessor grades the questions that require the detailing of the method used (Q.3 and Q.4 in the case of the question in Table 1) manually.

There are some minor logistic issues to be considered that have a notable impact on the student-side experience. The assessor has the option to allow students to view the auto graded question results as they submit an answer, after the complete test is submitted or post-grading of the entire class. The method that may pose the least in-test or post-test stress is to allow to students to view the results only after the entire class has been graded for a particular assessment.

Blackboard creates a grade column for an assessment when an assessment is deployed, even though the assessment may not be available to students. This column, by default, is available for the students to view in their individual grade centres. Thus, students can view their grades as the assessor completes grading the respective student's assessment. Subsequently, it is advisable for the assessor to hide this column from students' view until the entire class is graded and the assessor is confident and has met the institutional requirements to disclose the grades to the students.

Various questions required a structure that varied from the one discussed in Table 1. The theory questions were presented as essay questions that were graded manually. Thus, the theory questions structure remained unchanged. Questions that required the calculation of multiple values, such as in truss analysis, were presented as multiple fill in the blanks, which were graded automatically. However, multiple solution options should be provided to ensure that all forms of the correct answer are considered. In this case, the method is not assessed - which is still in line with how the assessment was graded in the original paper-based assessment. One of the challenges that remain is how to structure a question that requires the student to sketch a solution. For example, the drawing of shear force and bending moment diagrams.

Table 1: Comparison of the structure of the Paper-based and online-based version of a question.

Original paper-based version of the question		**Online-based version of the question**	
Question	**Mark Allocation**	**Question**	**Mark Allocation**
A clevis and a plate are joined by a bolt as in Figure 2. The diameter of the bolt is [d]mm. The shear stress is [t] MPa. The force is [P] kN. Take G = [g] GPa. a.) Is the bolt in single or double shear? b.) Calculate the shear stress in the bolt. c.) Calculate the shear strain in the bolt.	(2) (5) (3)	Q.1. A clevis and a plate are joined by a bolt as in Figure 2. Is the bolt in single or double shear? Q.2. A clevis and a plate are joined by a bolt as in Figure 2. The diameter of the bolt is [d]mm. The force is [P] kN. Take G = [g] GPa. Calculate the shear stress in the bolt in MPa. Provide the answer to two decimal places. Q.3. Explain the method you used to get to the answer in the previous question. You may use formulae. Q.4 What is the formula that relates the shear strain (y) to the shear stress (t) and the modulus of rigidity (G)? Use / for divide and * for multiply. Q.5. A clevis and a plate are joined by a bolt as in Figure 2. The diameter of the bolt is [d]mm. The shear stress is [t] MPa. Take G = [g] GPa. Calculate the shear strain in the bolt. Provide the answer to five decimal places.	(2) (2) (3) (1) (2)

Source: Authors' own

4.2. Moderation and Evidence Collection

Across all universities in South Africa that offer Engineering, the Institutional and Engineering Council of South Africa (ECSA) requirements must be adhered to in terms of the moderation processes and evidence collection applied across all Engineering modules. The module evidence file is a compulsory ECSA requirement, as all modules must have a file with evidence of all aspects of the module. The module evidence file, commonly referred to as the ECSA file, is used as evidence during the ECSA program accreditations. In terms of moderation of online assessments, the ideal scenario would be to have a mechanism that allows for dual grading of a single assessment. In this way, the assessor and moderator could provide individual grades and consolidate the grades for the moderated scripts during the moderation and approval processes. However, at the time of this study, Blackboard only provided this option in the case of assignments. Thus, all scripts were downloaded to a spreadsheet file, which the moderator graded. In this module, the moderated spreadsheet was printed to serve as evidence in the compulsory module evidence file. The excel file does not provide the moderator with any of the grading notes that the assessor provides to a student. Thus, for this particular module, the assessor may need to find a way to provide the moderator with access to the module if the moderator requires access to the grading notes.

4.3. Assessment Security and Technical Glitches

In this particular module, assessment security in online assessments poses unique challenges that are not present in paper-based assessment. Primarily, the use of a lockdown browser is vital to ensure that the student(s) being assessed is locked into the test and does not have access to any non-permitted software or information via the computer or learning management system. Furthermore, a password, that is only obtainable in the proctored assessment venue, must be set to prevent a student from accessing the test outside of the proctored venue.

To ensure that a student does not obtain the password leave the venue and complete the test in a non-proctored venue, a strict attendance and submission register should be used. Thus, when a student enters the venue they must sign to prove that they have attended the test. Prior to leaving the venue, the student must sign and state the time, which serves as evidence that the assessment is submitted. Should any academic transgression occur, the submission time is used as a security measure.

In this particular instance, the institutional policy regarding online assessments is that the student should be granted two attempts within the time limit and that forced completion should not be activated. The logic behind the prescription of two attempts is to ensure that the student has recourse in the event of a technical glitch. Forced completion results in the assessment being automatically submitted when the time expires, if the computer crashes or a network failure occurs. However, based on experience from the 2018 cohort of this particular module, it is preferable to avoid forced completion in case of a computer crash or network failure. The affected student can be moved to an alternative computer to continue the assessment where all saved answers restored. However, the assessment is not automatically submitted when the time expires. In a proctored venue, the time limit can be enforced and adherence to this can be monitored via the assessment logs on the instructor side. It is preferable to have access to network updates and maintenance schedules to ensure that an assessment is not scheduled during those periods as this may compromise the system stability. It is advisable to provide the students with a fill in paper-based copy of the test in the event of a complete network failure so that the assessment cannot be completed.

4.3. Impact on Grading Timelines

In this particular content, the time required to grade the online-based semester tests and examination significantly decreased in relation to the paper-based assessment. The grading of the semester tests, uploading of the marks and collection of sample scripts for compulsory module evidence files, on average, required five days of dedicated work. The online-based semester tests required one full day of dedicated work to complete all of the above processes. In the case of grading of the examination, the added steps of auditing, moderation and mark approvals required ten days of dedicated work for the paper-based assessment. The online-based examination required four full days of dedicated work to complete all of the above processes. The collection of evidence, moderation and approval processes for the examination required the same amount of time in both the paper-based and online-based assessment. However, the grading and auditing of the scripts reduced the timeline in this particular context.

5. Conclusion and Recommendations

The findings from this study contribute to the knowledge of online assessment and literature in a number of ways. Firstly, in this particular context, the results from this study validated the research hypothesis, which suggested that a shift from a paper-based to an online-based assessment reduced the grading timelines significantly which in turn resulted in students receiving feedback in reduced time. Secondly, the results suggest that to ensure that the online-based assessment preserved the macro-structure of the original assessment approach in a large classroom, questions need to be fragmented and clearer guidance should be given regarding units to be used and the rounding of values. Thirdly, adjustments need to be made to the moderation and evidence collection processes to ensure that these processes remain aligned with the institutional and professional body (ECSA) requirements. Fourthly, whilst the grading timelines were reduced in this particular context, there was a minor increase in administrative load, which is vital to ensure that assessment security is preserved and that technical glitches are mitigated.

Lastly, the findings from this study also suggest that when applying online assessment, it is important to find a viable method to assess questions that requires the student to sketch a solution. While there are applications that would allow for the sketching to be done on the computer, these applications require the student to exit the lockdown browser environment which creates assessment security concerns.

While this study finds that online assessment in a large classroom is useful in many ways, more research needs to be conducted into various aspects of online assessment. For example, it would be useful to investigate whether specific online assessment tools are more suited to certain disciplines. In addition, an investigation into effective online assessment for smaller classes may prove more effective to smaller learning environments. Lastly, an investigation into the learning management systems on the South African market and their capabilities could likely assist educators in choosing an online assessment platform that best suits their teaching environment.

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