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Threshold Exams, Viva-Voces and Major Projects for Grade Agency and Assessment Authenticity in Higher Education

Benjamin Halkon[a]; Hamed Kalhori[a], Beata Francis[b], and Anna Lidfors Lindqvist[a].
School of Mechanical and Mechatronic Engineering[a]/Associate Dean (Teaching and Learning) Portfolio[b],
Faculty of Engineering & IT, UTS, Ultimo, NSW 2007, Australia
Corresponding Author Email: Benjamin.Halkon@uts.edu.au

CONTEXT

The need for more authentic assessment methods has become increasingly evident in response to rapid industrial advancements and shifting graduate competencies. As a result, engineering curricula require redesign to incorporate individualised, project-based learning and contemporary assessment strategies. This paper reflects on a recent initiative undertaken within a mechanical engineering program at an Australian university to address these challenges.

PURPOSE OR GOAL

The objective is to evaluate the effectiveness of integrating modern educational techniques in enhancing student performance and engagement. This analysis focuses on how innovative assessment methods better prepare students for professional demands. The ultimate goal is to offer insights into improving education through authentic and adaptive learning experiences.

APPROACH OR METHODOLOGY/METHODS

The course structure integrated threshold exams, project-based assessments, and continuous self-led learning. Students engaged with resources from academic and industrial sources and participated in interactive workshops. Weekly online exercises reinforced learning, and students who passed a threshold exam progressed to a project phase, applying their knowledge to practical scenarios.

ACTUAL OR ANTICIPATED OUTCOMES

The multi-phase approach fostered enhanced learning outcomes, particularly for students who advanced to the project phase. Observations indicate that combining threshold exams with guided projects improves competence and engagement. The approach supports a gradual transition from theoretical learning to practical application.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The innovative assessment model demonstrated potential in enhancing student learning and performance. The findings suggest that incorporating project-based learning and threshold exams can lead to better outcomes and higher engagement levels. Further refinement and broader adoption of these methods could improve educational practices in engineering disciplines.

KEYWORDS

Threshold exams, Project-based learning, Authentic assessment, Industry relevant

Introduction

Rapid technological advancements and evolving industry demands necessitate a significant transformation in engineering education (Institute for the Future, 2015). Modern graduates must not only master traditional skills but also gain proficiency in emerging tools and methodologies. Traditional assessment methods, such as high-stakes exams and purely theoretical coursework, often fail to adequately prepare students for the multifaceted nature of contemporary engineering practice. Additionally, challenges associated with academic misconduct, such as plagiarism and the misuse of generative AI (GenAI) (Qadir, 2023), further compromise the effectiveness of conventional coursework. To better equip students for these challenges, engineering curricula must incorporate innovative, individualized, and project-based assessments (Fatahi, 2023).

The School of Mechanical and Mechatronic Engineering (MME) at our institution recently implemented a comprehensive curriculum redesign, encompassing introductory subjects, technical stream subjects, and design studios (Hadgraft et al., 2019). This redesign involved a collaborative effort among stream-specific academics, broader faculty members, and educational leaders within the Faculty. Authentic, project-based learning has been shown to significantly enhance student engagement, motivation, and educational outcomes, offering a more practical and meaningful learning experience (Hadgraft et al., 2016). As part of this redesign, our approach integrates both threshold exams and projects to ensure mastery of fundamental concepts while fostering practical skills through hands-on learning experiences (Willey & Gardner, 2012, 2017). These methods aim to align student outcomes more closely with professional demands, creating a flexible path for learners who wish to excel beyond the minimum competency level.

This paper reflectively explores the integration of threshold exams and projects within the redesigned curriculum of MME Engineering program based on the observations made in Dynamic Systems and Control B. Threshold exams aim to ensure that students have mastered essential concepts before advancing , while the projects component provide practical, hands-on learning experiences to bridge the gap between theory and practice which allows the students that are motivated to achieve a higher grade to do so. By reflecting on the design of this subject and the impact of these methods on student performance and engagement, this study aims to offer valuable insights into their effectiveness and provide a model for other subjects or engineering programs seeking to enhance their curricula.

Through this study, we aim to evaluate the impact of these innovative educational strategies on student learning and performance, providing a framework for other engineering programs to follow in response to contemporary educational and professional demands.

Framework for Student Grade Agency

Threshold assessments have been used in various academics setting. Willey & Gardner (2012, 2017) demonstrated how threshold exams have the potential to improve confidence and assurance of learning. These exams are often applied in online settings and offered for students complete remotely. The convenience of accessing information online, with the increased use of GenAI and online collaborative platforms to support cheating and plagiarism challenge the efficacy online assessments (Sevnarayan, 2024). Therefore, this subject adopted the use a Mastery Exam and the incorporation of a *viva voce* oral examinations to allow for a safeguard against such potential breaches of academic integrity as it requires students to demonstrate their understanding of the threshold concepts (Cole, 2023; Elkhatat, 2023).

A third, more contemporary component of the subject framework was the incorporation of a subsequent, self-led, open-ended Major Project phase. This was completed following confirmation of threshold learning, allowing learners who elected to pursue it the opportunity to extend their knowledge and understanding beyond threshold (sufficient to secure a Pass) through Novice (Credit), Proficient (Distinction) to Expert (Higher Distinction).

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Figure 1 shows the framework which is the interaction of the Mastery Exam concept with the Major Project phase and the *viva voce* assessment verification implemented. This framework was designed to give students the agency to pursue their desired grade, allowing them to either opt-in or opt-out to complete project work to demonstrate higher learning achievement.

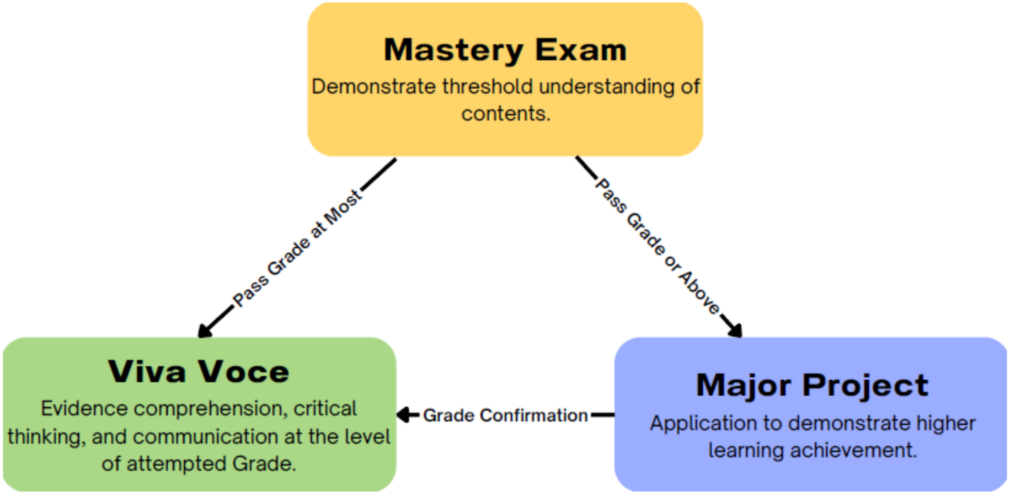

Figure 1 – Integration of (Mastery) threshold exam, *viva voce* and Major Project phase

Subject Design

Dynamics Systems and Control B (DS&C B) is a new subject developed specifically in response to the MME curriculum redevelopment exercise at great personal and collective effort and cost to the School and Faculty for the Autumn 2023 (AUT23) session. Among other fundamental pedagogical changes during this curriculum redevelopment process, a substantial shift to studio-based teaching and learning activities and the switch to "grade, no mark" outcomes were core concepts. The DS&C B subject, and it's prerequisite forerunner – Dynamic Systems and Control A (DS&C A).

A team-teaching design approach was employed across both the DS&C A & B subjects, to align subject conception and development and integrate common delivery approaches and assessment strategies. The design of the subjects is anchored in the philosophy of authentic learning, emphasising real-world, industrially relevant applications and project-based assessments to foster deeper understanding, appreciation of and skill acquisition. By using the framework

Scaffolding of Subject Learning

The ultimate offering consisted of online learning material arranged into three learning blocks to be completed over the first nine weeks of the session. The materials were strategically organised in Canvas to support incremental learning. Weekly content was organised into modules, only visible and accessible upon successful completion of all prerequisites. With knowledge increasingly at our fingertips, from the smartphone/laptop, our task as educators is to assist learners to be able to access legitimate sources of knowledge and to be able to critically evaluate what they discover. To this end, Canvas pages were curated to make use of existing, best-in-class content from authenticated, persistent sources including, for example, website of other experts in the subject domain, instrumentation, equipment and solution suppliers. Where the required material was not accessible, specific resources were created by members of the subject design and teaching team. All pages produced were populated with brief commentary and useful tips and insights to enable the learner to be able to effectively navigate the materials and understand the context, importance and relevance of each collection of materials. At the completion of various online exercises, candidates were required to complete knowledge confirmation activities. These were primarily implemented within Canvas using H5P. Figure 2 shows a typical example of this approach.

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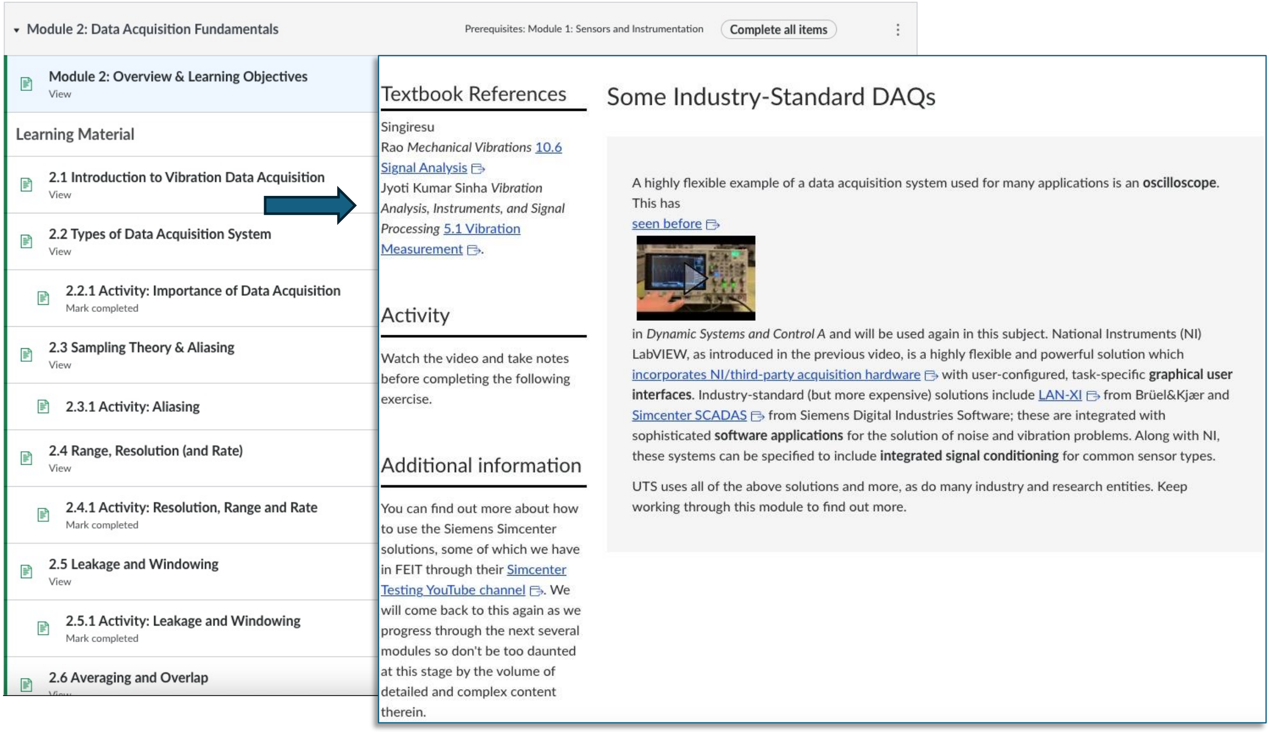
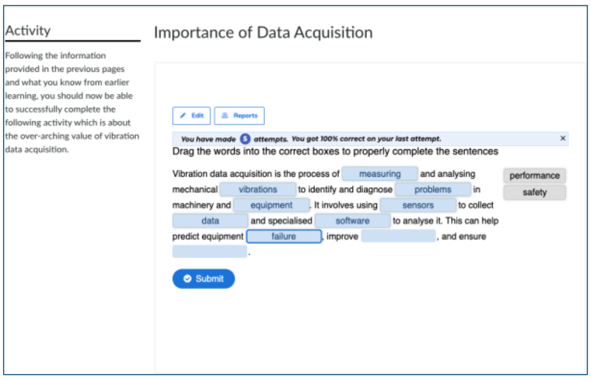


Figure 2 – Example of interactive Canvas-implemented self-led learning interface with commentary

At the completion of various online exercises, candidates were required to complete a varied range of knowledge confirmation activities. These were specifically created for the intended purpose by the teaching team and were primarily implemented within Canvas using H5P. The intention was to “gamify” the learning experience, making it fun to complete the activities. A range of available approaches were explored, including “drag the missing word”, “select the correct answer”, “complete the crossword”.

Figure 3 shows some typical examples of these kinds of activities. Additionally, more traditional numerical solution exercises were also implemented, often using randomised (within sensible ranges) to allow learners to explore and develop their ability to solve real-world dynamics, control and vibration problems. All modules are “book-ended” with *Overview & Learning Objectives* and *Summary & Additional Resources* pages. Additional, generally available modules were prepared including a general *Resources and Support*, those specific to laboratory exercises, to the Mastery Exam and to the Major Project phase, including resources to support access to laboratories where the experimentally focused projects could be completed safely.



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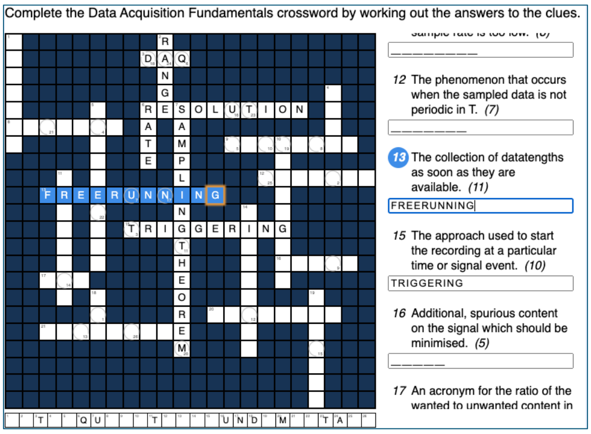

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Figure 3 – Examples of interactive H5P knowledge confirmation activities implemented in Canvas

The primary nine teaching weeks featured two-hour online interactive workshops. Prior to each interactive workshop, candidates were required to complete online pre-work to establish foundational knowledge. The workshops then involved a review of the material, using score trends and outcomes from the activities as a guide for the interactive discussion. At the conclusion of the interactive workshops, a bespoke Kahoot! quiz was used to gamify the candidates' learning in a safe and fun environment. At the conclusion of the session, a $100 gift card prize was awarded to the Kahoot! player with the most accumulated points with the two runners-up each receiving a $50 gift card prize. An example Kahoot! interactive quiz question is shown in Figure 4.

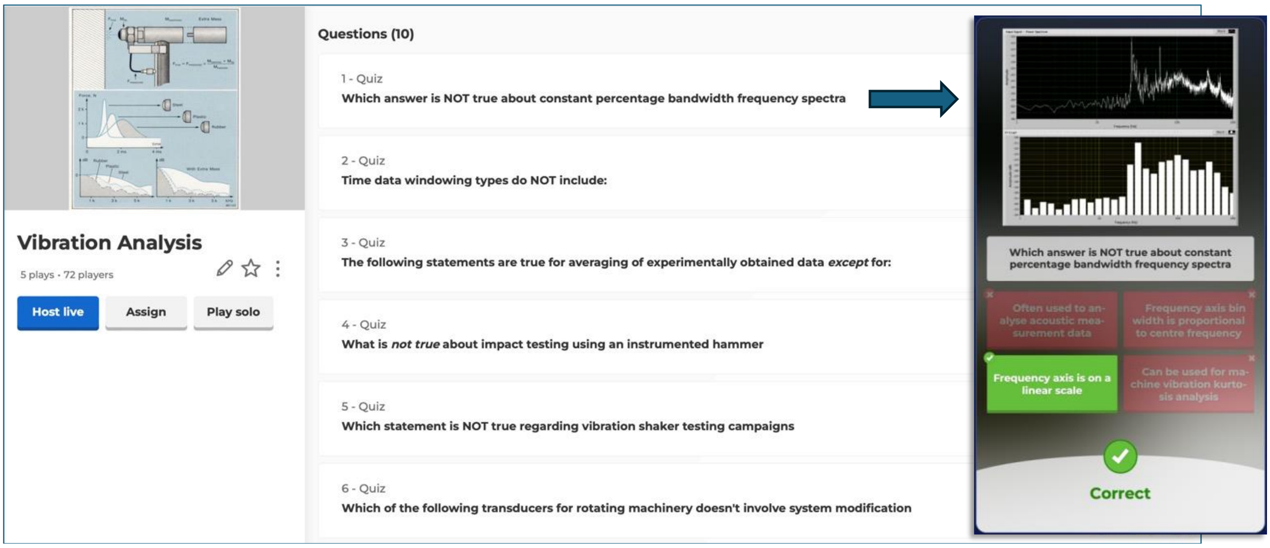

Figure 4 – Example, end of weekly workshop, interactive Kahoot! quiz question

Interactive workshops also included guest sessions from MathWorks Australia and Navantia Australia colleagues, providing students with detailed exposure to industry-standard tools, methodologies and relevant problems and challenges. Weekly face-to-face tutorials and one lab per three-week learning block reinforced theoretical concepts through practical applications.

In Week 7 an online, randomised "Mastery Exam" was made available. For successful completion, students must achieve an 80% or more pass mark by the end of Week 9 in order to be eligible to enter into the ~6-week Major Project phase commencing from Week 10. Those unable to secure a pass mark by the end of Week 9 were allowed to continue to revisit self-guided online learning content with a view to securing a Mastery Exam pass mark outcome by the end of the STUVAC2.

Some candidates who were eligible for the Major Project elected not to form groups, instead preferring to exit the subject with a Pass only. All candidates who secured a Mastery Exam pass mark outcome, either before or after the cut-off and did not complete the Major Project, were required to have this pass mark outcome validated, subject to completing a successful *individual viva voce*. These took place in Assessment Week 1 or 2 (A1 or A2). Candidates who completed the Major Project were ultimately required to present their findings to secure either a Pass or better during *group viva voces*. These group viva voces were scheduled during Assessment Week 3 (A3).

Mastery Exam

The Mastery Exam was a complex online system within Canvas consisting of multiple questions banks (QBs) with 1, 2 and 3 pt questions therein. Each question bank focused on a specific module and, separately, on each of the Lab1s. QBs contained multiple questions with a total of *~250* questions prepared. Questions were in a range of forms including approaches similar to those implemented in the Each candidate's Mastery Exam attempt was randomised by taking a different set of several questions from each QB with a total of 120 points from 77 questions to be attempted. For a number of the numerical and formula-based questions, further randomisation of the variables within the question *was* incorporated. These variable randomisations were carefully implemented to be between sensible, applicable limits and with sensible resolution, such that the possible incorrect answers achievable were authentic in the context of the intended application. The resulting outcome of the Mastery Exam design and implementation is that no two attempts are the same. Tracking of each student attempt and the scores obtained was possible, allowing an understanding of student strategies to achieve a successful outcome. This tracking was also highly valuable in subsequent viva voces , allowing assessors to interrogate the manner in which students improved their performance and where verification of their understanding and skills acquisition should be focused. A score of 96 (80%) is required to satisfy the assessment task. Figure 5 shows the process of building of Course question banks, structuring the Mastery Exam quiz to pick numbers of questions from question banks, giving an example of a randomized numerical question.

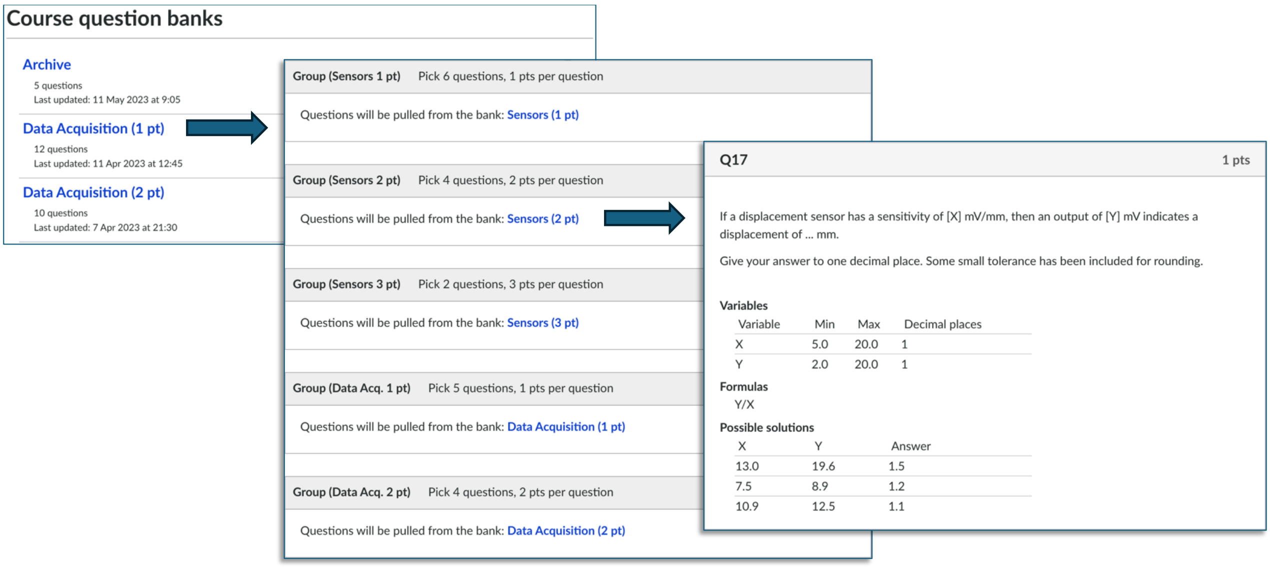

Figure 5 – Mastery Exam question banks, quiz structure and example randomised question

Major Project

The Major Project phase ran from Week 10 through to Assessment Week 3 (A3). Major Project groups worked on an open-ended task, selected from a range of options, some internally conceived, some informed/led by external industry collaborators. Tasks were published in Wk10 on similar templates with specific guides to expected outcomes to align with a rubric for Credit, Distinction or Higher Distinction grade outcomes. A maximum of four groups per task were allowed, with allocations complete on a first-come, first-served basis implemented directly within the Canvas infrastructure. Figure 6 shows some of the list of major project topics and an example project.

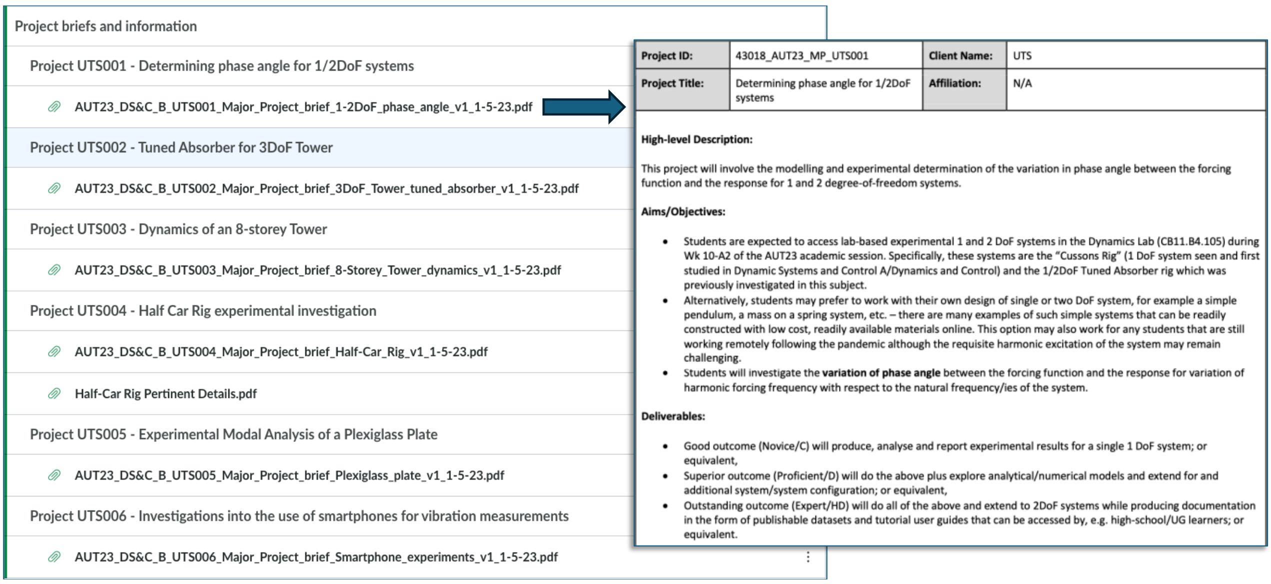

Figure 6 – Major Project topics and example completed template for one project

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During the Major Project phase period, groups enjoyed on-demand access to experimental facilities (subject to the preparation and approval of project risk management paperwork and completion of a laboratory induction within the UTS-selected RapidGlobal system), and technical, academic, tutor, industry representative support. Groups were required to work akin to the way in which they might be expected to do if working in a consultancy business upon graduation. For example, groups had to submit bids for access to resources and record and submit time sheets for approval.

Individual Viva Voces

Students who achieved a Mastery Exam pass mark outcome were required to have their outcome validated in a one-on-one, recorded ~20 min *viva voce* completed during A1 or A2. This subgroup consisted of both those who secured their Mastery Exam pass mark *in advance of* the cut-off for the Major Project phase (but who elected not to form groups to complete the Major Project) and those who secured it *after* the Major Project deadline but before the end of STUVAC2.

Viva voces were scheduled in zoom and were automatically recorded for subsequent review where required. During the viva voce examination, assessors interviewed each candidate on the outcome of their Mastery Exam pass, using their online score sheet as a reference to guide which questions they would be asked and expected to give a coherent answer to. Questions were selected to determine knowledge and understanding of the concept threshold fundamentals. A small number of candidates who were unable to convince the assessor of the legitimacy of their Mastery Exam pass mark outcome did not have their Pass for the subject confirmed, being instead graded with a Fail. In threshold Pass/Fail cases, and where moderation between assessors was necessary, review of candidates' performances from the online video recording was completed.

Group Viva Voces

At the completion of the Major Project phase, groups were required to present and be examined upon their approach to solving their selected tasks. Group viva voces were ~40 mins in duration and were again held in zoom and recorded for review where required. Candidates were required to explain how they had built on their knowledge of the threshold concepts, previously demonstrated through their successful Mastery Exam pass mark outcomes, and expand their knowledge towards Credit, Distinction or Higher Distinction, depending upon which elements of the pre-specified rubric they had attempted to satisfy to secure their higher than Pass grade.

Groups were asked to identify whether or not one or more group members warranted a higher grade than others. This was completed in a professional manner. In some cases, groups were able to reach a consensus that grade outcomes were not necessary to be aligned for all group members but could be adjusted based on the value/merit of each individual member contribution. In some cases, where groups and individual(s) within groups had failed to convince the assessor that they had progressed (substantially) beyond threshold learning during the Major project phase, candidates were assessed on the fundamentals and taken back to their Mastery Exam outcomes.

Observed Outcomes

The implementation of the Mastery Exam and Major Project phases aimed to achieve several clearly defined goals: to assess student understanding of foundational concepts, to promote collaborative learning, and to facilitate practical application of theoretical knowledge. Of the 98 candidates on the subject at the time, 82 successfully completed the Mastery Exam by the end of Week 9, demonstrating a threshold grasp of the core material. This successful completion enabled them to self-form groups and progress to the Major Project phase, where they were able to apply their knowledge in a practical context, self-guiding their learning, with support, over seven weeks.

A total of 61 candidates opted to undertake the Major Project to be completed from Week 10 to Week A3. A total of eight projects, some industry-defined, were offered on a first-come, first-served basis with a maximum of four, three-person groups per project allowed. Meanwhile, an additional eight candidates went on to secure their successful Mastery Exam outcome by the end of Week

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12. A total of 26 candidates (not all of the 29 that were eligible) registered to have their P outcome validated during a ~20 min viva voce during Week 12 and Week A1.

In total, 13 candidates secured their P while 13 candidates did not provide a convincing enough defence to have their P validated and were given a Z for the subject with substantial feedback as to the shortcomings given during the viva voce. All viva voces, for P (Mastery Exam only) and P-HD (Major Project) were conducted in zoom meetings which were scheduled from Canvas.

Give that many students, when freed from the shackles of having inactive group members, were able to make substantial progression of their learning, the division of marks for those that attempted the Major Project was quite high. To determine the grades, each group was invited to a ~40 min group viva voce to determine the grade, no mark outcome (indirectly validating their Mastery Exam outcome simultaneously).

In some cases, for very poor performance, it was even possible that Fails were given when students could not answer questions about their Major Project. The assessor reverted to their Mastery Exam attempt and if they were not able to answer those questions, the outcome was deemed to be invalid. The following split over the 97 candidates as shown in Figure 7 was observed during AUT23.

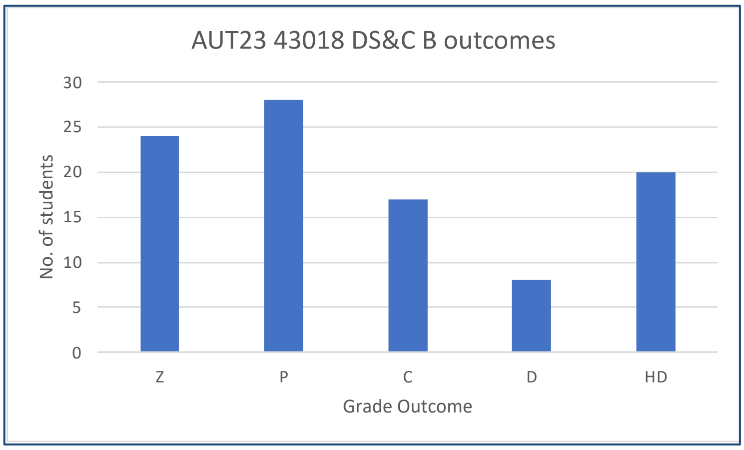

Figure 7 – Grade outcomes showing bias towards HD due to major project enhanced learning

Discussion

The Mastery Exam provided an objective means of testing that students had mastered essential course content. However, the incorporation of the Individual Viva Voce safeguarded the integrity of this assessment process, ensuring that all students met a minimum threshold of competency and were also able to evidence this. For those wishing to further their knowledge and understanding, skillsets and excel, the Major Project phase offered an opportunity to advance their learning, working collaboratively with peers to tackle complex, real-world problems.

This tiered approach to assessment allowed for differentiation among learners, offering flexibility for students to progress from basic competency to higher levels of achievement. Overall, the initial findings and observations, while yet to be rigorously analysed over multiple sessions, suggest that this model of threshold exams coupled with viva voces and project-based learning enhances both student performance and engagement, offering a pathway to improved educational outcomes.

As observed in previous sessions with the now-retired forerunner subjects, overall marks suggest the somewhat binary divide between candidates who can do the subject very well and those who cannot. However, the marks distribution is reasonable for a subject of this type with around 21% receiving HD, 8% D, 18% C, 29% P and 25% failing.

Conclusions

Some students are very well prepared. Learners still say they do not know how to use MATLAB and that they don't have the maths skills but these are now included in a Wk0 Revision module.

Those that can do it ultimately (informally) recognise the importance of the prerequisite skills they have been taught previously. Those that come to the sessions and engage with the tutors perform very well and enjoy the subject, despite its relative difficulty. They get a great deal out of it and give excellent feedback, particularly for the laboratory components (during both the laboratory sessions and the Major Project phase). Alas, many candidates do not invest the required amount of time and effort and do not get good outcomes accordingly. It is suggested that the framework developed as part of this subject design can be transferred to any discipline with the potential to improve assessment in fidelity and higher demonstrated learning of those students wanting to participate.

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