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Response to Student Feedback for 1st Year Mechanics Subject at Swinburne University of Technology

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ABSTRACT

CONTEXT

The subject ENG10003 Mechanics of Structures is common to all Engineering degree courses at Swinburne University of Technology. In the 2020 COVID year, the course was delivered fully online. Student feedback from the Subject Assessment Surveys for 2020 largely uncovered the limitations they perceived in the online delivery of the subject for its first time. A particular inference made, was that some students claimed they gained little additional benefit from the online delivery of the subject than from going through presentation of the theory and example solved/worked problems in textbooks.

PURPOSE OR GOAL

In reviewing the content of the delivery, student comments were vindicated in places as some material was based on inclusion of its electronic form of treatment with worked examples made available by the publishers of the recommended textbook. Some of the more positive feedback from students related to the screening of the videoed performance of the two experiments and their results presented in Weeks 7 and 10 of the online delivery. Students were required to perform analysis of the measurements made available to obtain key results and then to compare these against their theoretical counterparts in a report forming part of their assessment for the subject. The inclusion of experiment-based evidence on topics treated in other weeks of the subject delivery was therefore seen as a positive step towards increasing value to students of the online delivery of subject ENG10003 in 2021.

APPROACH OR METHODOLOGY/METHODS

The content of the online delivery of ENG10003 in every alternate week of Semester1 2021, was therefore supplemented by excerpts of experiment-based material drawn from www.Mechanics-Lab.com and made available by Strucomp P/L as a trial. The trial was anticipated to provide an opportunity to judge the efficacy of inclusion of experiment-based evidence as an enhancement to the learning of topics relevant to the subject. In addition, relaxing of COVID restrictions during the latter part of Semester 1, allowed students optional attendance of two "Open Sessions" where they could perform the TechnoLab™-based experiments used in the online delivery of ENG10003, hands-on for themselves.

ACTUAL OR ANTICIPATED OUTCOMES

Informal student feedback has been quite positive. Results from a purpose-specific quiz and the Subject Assessment Learning Survey for the subject, also show favourable responses for the inclusion of experiment-based verification of topics in the delivery of ENG10003.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Whilst hands-on performance of experimentation on physical models for obtaining experiment-based evidence supporting the understanding and acceptance of basic principles and analysis/modelling techniques treated in ENG10003 has been acknowledged by students as superior to online delivery of such material, these students still feel it worthwhile to include videos of experiment-based evidence of topics in the online delivery of the subject.

KEYWORDS

Hands-on experiments; experiment-based evidence; validation of theory

Introduction

The waxing and waning of the severity of the COVID pandemic restrictions over the past two years has disrupted the normal operation of practically all industries and businesses in Australia, including the Tertiary Education Sector (TES) in Engineering.

Complete campus shutdowns on several occasions with odd stints in-between of a few weeks of return to short periods on campus have occurred during this time. When not in complete shutdown, limits on staff level presence and on room capacities on campuses were imposed by State and Federal governments that in the most required fully online delivery of under-graduate and post-graduate degree courses in Engineering.

The preparedness of universities to going fully online for delivery of courses varied from subject to subject, largely dependent upon the extent and ready availability of suitable material in electronic form, for all topics covered. In addition, in-house experience for online delivery and the resources needed to do so effectively, varied from university to university. Whatever the situation for a quality online delivery of its engineering subjects of any university, it has generally been accepted by academics, and their students alike, that this would fall very short of an on-campus experience of a subject delivery.

Specific areas that online delivery would not be able to adequately provide a substitute/ equivalence to on-campus delivery would be reasonably obvious: face-to-face interaction with academic staff and fellow students, both academically and socially; activities that are organised for students working in groups; and access to learning facilities such as physical laboratories and engineering workshops.

Arguably, the most academically important area in this list, especially when it comes to the learning of fundamentals in Engineering, is the performance of physical experiments to verify basic principles and/or modelling/analysis techniques in Statics and Mechanics of Solids/ Structures/Materials. These are the subjects that the majority, if not all, of first and second year level students undertake in Engineering courses at Australian Universities and which underpin later year subjects that deal with the analysis and design of structures (buildings and general infrastructure; mechanical and aerospace structures).

In recognition of the importance that hands-on performed experiments has on students in consolidating and reinforcing their understanding of topics associated with these experiments, (Tsang et al, 2019; Lewis and Williams, 1994; Bonwell and Eison, 1991; Haritos, 2018; Finkel and King, 2013; Kolb et al, 1999; Khamar, 2015), the delivery of the subject ENG10003 Mechanics of Structures at Swinburne University of Technology for the first time in online form in Semester 2, 2020, included presentation material of the two experiments students in this subject would have otherwise performed hands-on in pairs on classroom bundled sets of TechnoLab™ experiment test rigs.

Video/photographic recording was purpose-arranged of these experiments performed hands-on by a student actor in such a way as to intimately capture all key features and results. The strategy here was to provide as immersive an experience as possible so that student viewers felt as if they were present, actively witnessing the experiment performance and the associated results.

Feedback from Questionnaires & Student Learning Assessment Survey in Semester 2 2020

The two experiments from TechnoLab™ that were video/photographically captured and presented in the online delivery of ENG10003 were: Experiment T3 – *7-bar Warren Truss* (see Fig. 1a) and Experiment F8 – *Shear Force and Bending Moment in a Simply-supported Beam*, (see Fig. 1b). These experiments were the only two performed by students hands-on (in pairs) in Subject ENG10003 and for which they wrote up a structured report that formed part of their subject assessment, prior to the advent of COVID.

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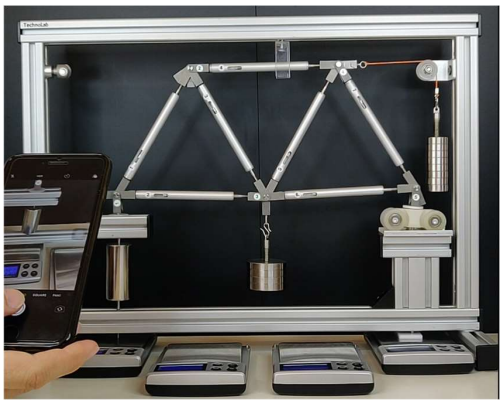

Figure 1a: Experiment T3 - 7-bar Warren Truss test rig (combined load case)

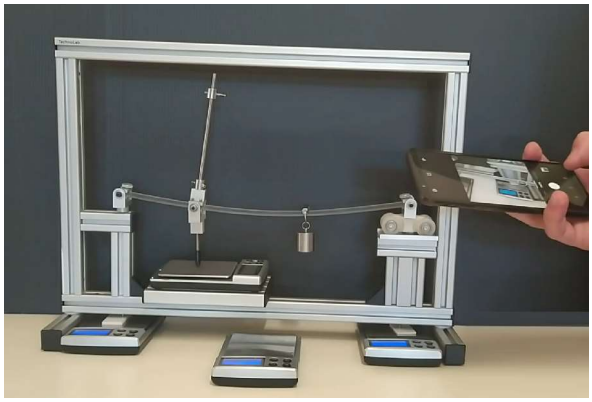

Figure 1b: Experiment F8 - Shear and Bending Moment in a simply supported beam

Video/photographic capture of these two experiments being performed by a model student was organised ahead of Semester 2. The “footage” was edited in such a way as to provide all the key step by step details and identification of the key results, both as viewed in the video, and in still photographs, to lend authenticity to the presentation of the results.

Students had an opportunity to provide some “targeted” feedback of their experience with the video presentations and the conduct of the experiments themselves via a short questionnaire noted on the structured report sheets for each that they were required to submit as personal reports forming part of their assessment for the subject.

The short block of feedback questions and the mean response scores to these in the reports for the two experiments T3 and F8 are reproduced below in Tables 1 and 2 respectively.

Table 1: Mean Scores for T3 7-bar Warren Truss - Laboratory Session Feedback

In this practical, rank the parts (on a scale of **1 - lowest to 5-highest**) you gained most from:	
1. Matching theoretical calculations to actual measured values.	3.2
2. Learning about measurements using photogrammetry.	3.3
3. Visualising what a pin-jointed truss actually looks like and seeing how it works.	3.6
4. Overall, has this laboratory session helped you understand more about trusses?	3.7
5. Other feedback: _____	

Table 2: Mean Scores for F8 *Shear Force & Bending Moment in a Simply-supported Beam* - Laboratory Session Feedback

In this practical, rank the parts (on a scale of **1 - lowest to 5-highest**) you gained most from:	
1. Matching theoretical calculations to actual measured values.	3.7
2. Visualising what a simply supported beam actually looks like and seeing how it works.	3.6
3. Was this laboratory session worth doing (compared to working through more examples)	4.5

The high percentage response levels of 64% and 65% of this class of 287 students, respectively, for the rated questions in these two online Lab session questionnaires was attributed to the fact that these formed part of a Report for each submitted for assessment purposes. However, a much smaller percentage of students in the class actually provided “Other feedback”.

The scoring for both online lab sessions in the short questionnaires largely suggested that inclusion of these sessions was indeed helpful to the students' learning (ie on top of the lecture treatment and the online worked examples).

For Experiment F8, a question was specifically focused on the value of delivering the Lab Session online. 90% of the students that responded, preferred experiencing this online session over the option of otherwise going through more worked examples on the topic.

Specific Student Comments – Experiment T3 (7-bar Warren Truss)

The few student comments (less than 10% of the class) for Experiment T3 are reproduced below:

1. *this lab was pretty interesting just took ages to complete, helped me understand how to do the calculations a lot more which was awesome*
2. *the lab really useful but I wish to do it in the campus for more understanding*
3. *This lab has shown me the areas I need to improve on and has demonstrated my understanding in particular of analysis of trusses using joint and section method is insufficient.*
4. *Good practice for method of joints and section*
5. *In this class, I have a great understanding of the calculation of the carriage structure, and I also learned to use photography to measure data.*
6. *I feel as though personally I struggled a lot with this lab, my understanding on what was required and how to proceed was highly hindered with how it was delivered due to not being in person*
7. *I learnt how to effectively use the summation of internal forces in two systems.*
8. *Hard during COVID-19 but still understood the exercise.*
9. *However, it would have been more beneficial to actually be there to interact with the experiment, obviously this wasn't possible.*

The majority of students appreciated the learning experience offered them and some went so far as to suggest the online presentation was next best to having the opportunity of performing the experiment for themselves. The perceived value to them of a "hands-on" experiment performance, was mentioned in several of the written responses.

Specific Student Comments – Experiment F8

Very few students (only two) provided comments on Experiment F8, as, although there were "lines" drawn for such in the Questionnaire block for these, a specific heading "Other Feedback" in front of these lines was inadvertently missed when compiling the Report Sheets for this experiment. The two specific comments are reproduced below:

1. This Lab would have been cool to do in person.
2. Honestly I found this prac very confusing however I understand it was originally meant to be taught in person not online.

With only two written comments for the online form of presentation for Experiment F8, perhaps at best a case can be made that the students concerned, believe that there would be value in performing this experiment for themselves, hands-on, rather than working off its video presentation.

ENG10003 Subject Learning Assessment Survey Semester 2, 2020

At the conclusion of Semester 2, students were invited to complete the Student Learning Assessment Survey (SLAS) for all subjects studied in that semester, that included those enrolled in subject ENG10003 Mechanics of Structures. The 2020 Semester 2 version of the SLAS's was modified to include an extra statement specifically requesting their rated opinion of the effectiveness of the online delivery of ENG10003, on top of their rated opinions against the six "standard" statements of satisfaction of subject delivery.

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The rating value results for the subject ENG10003 compared to whole-of-university and that of the Faculty of Science, Engineering and Technology, FSET, are presented in Table 3.

Table 3: Mean SLAS Scores for ENG10003 – Standard six and additional for "online" learning

Rate your level of agreement with the following statements about this unit...	Mean /10 Subject	Mean /10 University	Mean /10 Faculty
"Standard" six statements of satisfaction of subject delivery	7.70	7.82	7.70
I found online learning an effective way to study this unit.	6.80	6.96	6.84

The rating values for subject ENG10003 were consistent across all six standard statements of student satisfaction and with the results for FSET and for the University as a whole, viz in the high 70's when expressed as a percentage.

The additional request for a SLAS rating, that for the level of satisfaction with the online delivery of the subject, was a clear 9% below the mean rating level for the standard six statements of satisfaction, and this too was in keeping with scoring levels for the faculty and for the University as a whole.

Response to requests for suggestions to improve delivery of ENG10003

There was also provision on the SLAS forms for students to provide their feedback on two requests, one being*: In my opinion, aspects of this unit that could be improved are…*

Some 83 responses were offered by way of opinion (29% of the class) on this request. Most dealt with relatively minor individual issues, especially related to lack of one-to-one communication/assistance and on their relative perception of the delivery of topics in the subject as presented by the three separate lecturers involved with it in Semester 2, 2020. Several dealt with the perceived inequity in fees paid relative to service received which would be more of a "gripe" on the overall course than specific to subject ENG10003.

A "guarded" selection of some of these is listed below.

1. This unit is important for all engineering student so it is better to study this unit on campus but the fact is corona virus is the barrier.
2. the labs as having more and an ability to test more structures and the way in which they work i feel could be very beneficial
3. The labs were somewhat frustrating, having to use photos to measure values. Obviously it's difficult at the moment to have an alternative to this, but maybe providing the values might help students feel more confident in their answers.
4. Better communication of assessment and lab tasks especially information on what needs to be done in assessment area.

As is usual when requesting feedback, there's some differences of opinion that can easily be seen in this list.

Item 2 in the comments list, in particular, supports informal comments made by students during the live subject presentation sessions that it would be useful to have more, but shorter, targeted videos of hands-on experiments in the subject delivery.

Responses to student opinion of best aspects of ENG10003 (Semester 2 2020)

The other request for feedback from students on the ENG10003 SLAS forms was*: In my opinion, the best aspects of this unit are…*

Only 12% of the class, provided their opinion on this request. Most were quite succinct and there was a clear favourite aspect - the "Truss Build" exercise – which involved individual student construction and load testing of a pin-jointed truss subject to well-defined constraints on geometry, materials used and application of the loading to "failure/collapse".

Again, a “guarded” (some comments included names of lecturers/tutors) selection of these opinions from the SLAS for this subject are listed below.

1. very clear lectures that are really good length - weekly assignments and tests work well with the provided tutorials - building a bridge is really fun
2. I felt I learned most from tutorials in this unit as it gave me the chance to do probs using the methods attained in lectures, providing the opportunity to actually apply the theory to better consolidate how to do certain types of problems. I also found the labs quite useful, however admittedly felt they were hindered by our inability to attend and perform the experiments ourselves. Despite this I felt taking real measurements of a given experiment aided in understanding how the equations in theory translate to real world applications.
3. The videos for the assignments and tests are very clear and helpful to understand
4. Truss lab was really good. Lectures are well prepared and easy to understand

In summary, students appreciated the hands-on opportunities of the Truss Build exercise, the videos (labs) and the assignments (includes the video-labs), and opportunities interacting in detail with tutors and lecturers, albeit online.

It was deemed likely that the inclusion of shorter videos of experiments (than for the assessed T3 and F8 assessable lab. sessions) in the online delivery of ENG10003 for Semester 1 2021, had the potential to improve on the student online delivery experience.

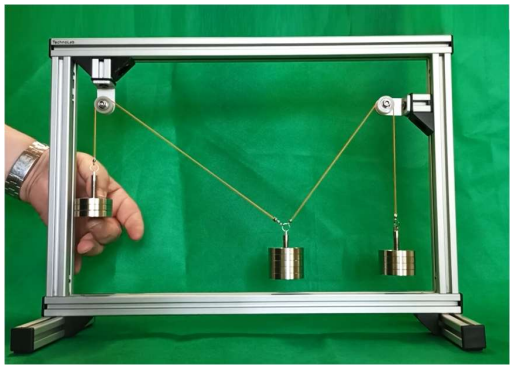
Short videos that provide experiment-based evidence of key Engineering concepts or corroborate the results of worked examples of application of theory dealt with in the subject, were made available to ENG10003 from www.Mechanics-Lab.com for trialling purposes.

Feedback from Questionnaires & Student Learning Assessment Survey in Semester 1 2021

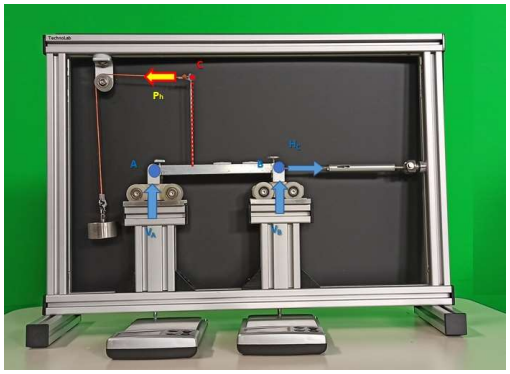
A selection of four of these experiment-based video lessons, on top of Experiments T3 and F8 (the two Lab. Class experiments adopted for assessment), was included in the online delivery of ENG10003 in Semester 1, 2021, averaging one topic per fortnight of delivery.

Still-photo extracts from these four experiment-based lessons, defining the topic for the additional material treated in this way, are depicted in Figures 2(a) to 2(d). The time spent in the online delivery of these segments varied from 5 minutes for the segment 2(a) and 15 minutes for the segment 2(d), so formed a small, but significant component of the delivery.

The SLAS statements on which scoring was being requested was modified by SUT from the “standard” six in Semester 1, 2021 to only five similar statements. The extra statement on the effectiveness of online mode of delivery for learning was “dropped”. Other differences noted for the 2021 Semester 1 ENG10003 class included a much smaller student cohort of only 80 students (of which only 25 responded to the SLAS) and 2 weeks of COVID lockdown “relief”.



2(a) 2D equilibrium of 3 Forces at a point



2(b) 2D equilibrium of a rigid bar

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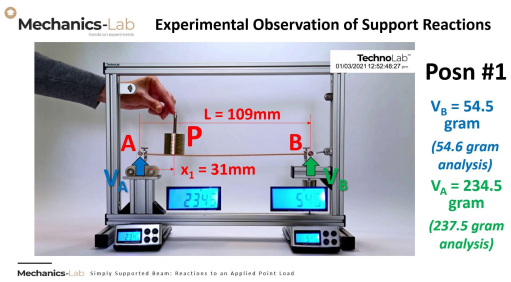
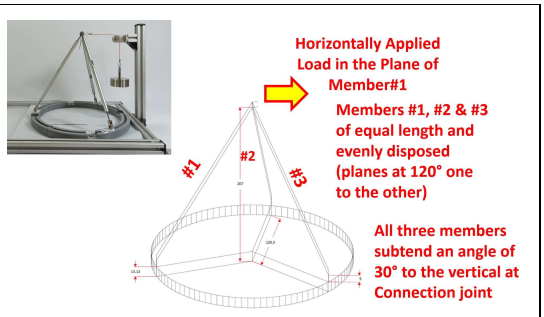


2(c) Reactions of a simply supported beam



2 (d) Forces in a tripod under horizontal load

Figure 2: The four additional experiment-based verification video segments adopted within the online delivery of ENG10003 in Semester 1 2021

The result for the mean of scores for all five statements for subject ENG10003 in Semester 1 2021 is compared against that for the University as a whole and for the faculty FSET, in Table 4 below. The result for the subject is now higher than for both FSET and SUT as-a-whole, whereas in Semester 2 2020, (see Table 3) the score for a comparable set of statements, was on par with that for FSET and lower than for SUT as-a-whole.

This suggests that an "improvement" has been achieved with the changes made in the subject delivery for Semester 1 2021 compared to Semester 2, 2020.

Table 4: Mean SLAS Scores for ENG10003 – Semester 1, 2021

Rate your level of agreement with the following statements about this unit...	Mean /10	Mean /10	Mean /10
	Subject	University	Faculty
Revised five statements of satisfaction of subject delivery	7.92	7.48	7.76

Response to requests for suggestions to improve delivery of ENG10003

A small number of students provided their feedback on the request*: In my opinion, aspects of this unit that could be improved are…* A selection these is listed here.

1. Adjust lab session so that off-shore students can participate as much as they can.
2. More in person classes if allowed by uni
3. Provide examples of previous final projects
4. Providing more support to students who need help
5. Would have been better to have more face to face learning, but that was not aloud
6. Unit is handled very well, with almost all resources easily found through recordings or lecture slides, nothing to improve in my mind.

Most of these suggestions related to assessment improvements. A couple (responses 2 and 5) appreciated the short stint of relaxed COVID restrictions when a near 50% capacity of Prac Classes/Tutorials rooms was permitted for classes to enable an on-campus experience.

It was during this short stint before the next lockdown that hands-on performance of Experiment T3, that of the 7-bar Warren Truss, was made possible in the ENG10003 Prac-Class room. Students in ENG10003 performed Experiment T3 individually (instead of in pairs), on each of the 12 replicates of the test rig of this experiment in this room, whilst respecting the 1.5m distancing rule. (The normal capacity of this room is 24 students).

Responses to student opinion of best aspects of ENG10003 (Semester 1 2021)

Only 12 responses from the cohort of 80 students were received on their opinion of *the best aspects of this unit are…* A selection of half of these is listed here, again "as received".

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1. Going through the Mastering Engineering assignment during tutorials was helpful, rather than on our own
2. Having the Lab to be able to build on everything we had previously learnt
3. In person labs.
4. Interesting and well structured content. Lab activities were useful - along with the on-campus demonstrations. The final project was very insightful in the sense that we had to build a model bridge from scratch, and apply analysis techniques learnt from all the modules learnt thought the semester.
5. The lab sessions, with the use of the interactive beams and truss' are a great.
6. The practical aspects in the unit, from building a bridge to seeing how trusses and beams work has been really helpful. The practical aspects in this unit have made it really enjoyable and feel like its own experience compared to other units. the teaching staff have all been really nice, supportive, helpful and approachable throughout the unit.

The hands-on aspects of the subject (bridge building and experiments) figured largely here.

A separate quiz was run in ENG10003 to obtain further clarity on student appreciation of their limited hands-on experiences and the online experiment-based support material inclusions.

The four TechnoLab™ experiment test rigs that were used to provide experiment-based evidence of basic principles and/or experimentally derived solutions to worked problem exercises and included in the online delivery of ENG10003 in Semester 1 2021, (as depicted in Figure 2) were made available to students of the subject at two Open Sessions by the suppliers of this test equipment. The timing of these was out-of-class-session and out-of-lockdown but still respecting COVID distancing restrictions.

The quiz contained four separate components with sub-questions and was made available to all students enrolled in ENG10003 for response. Again, a small portion of the students in the cohort (approx. 20%) provided feedback to the quiz. Details are presented in Table 5 below.

Table 5: Feedback from ENG10003 Semester 1 2021 quiz on experiment-based material

(a) Bridge-Building Project	**Excellent - good**	**Fair - poor**
Helpfulness of bridge project in understanding how a real-life bridge performs	95	5
Relevance of bridge project to theory learnt in Modules 1 - 5	90	10
Helpfulness of bridge project in understanding theory learnt in Modules 1 - 5	90	10
(b) Mechanics-Lab Clips in Online Delivery	**Excellent - good**	**Fair - poor**
Relevance of video clips of experiments presented in lectures to theory (for example: truss game, centre of gravity, force equilibrium)	86	14
Helpfulness of video clips of experiments presented in live lectures to supplement lecture materials	90	10
Relevance to theory of Week 10 online lab on bending moment and shear force diagrams	62	38
Helpfulness of Week 10 lab in understanding how beams behave under bending	71	29
(c) Hands-on TechnoLab™ Warren Truss Experiment	**Excellent - good**	**Fair - poor**
Relevance to theory of Week 7 Truss lab experiment performed individually on campus	84	16
Helpfulness of Week 7 lab experiment performed individually in understanding how a truss behaves when loaded	78	22
(d) Hands-on TechnoLab™ Experiments – "open" session	**Excellent - good**	**Fair - poor**
Helpfulness of performing hands-on experiments compared with performing more worked examples of applying the theory	84	16

It is clear, that students in ENG10003, recognised the learning value from their hands-on performed exercises on physical systems i.e. Bridge-Building project, Experiment test rigs on

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Warren 7-bar truss (assessable exercise) and those used to produce the experiment-based support material for on-line presentation.

It is also clear that the students valued the experiment-based support material segments presented to them on-line.

Concluding Remarks

This paper presented and discussed student feedback prior to and after implementing changes in response to this timely feedback by Swinburne University of Technology in subject ENG10003 Mechanics of Structures. Feedback in consecutive semesters of subject delivery, was obtained under significant COVID restrictions and even lockdown.

Students reported highly valuing the inclusion of experiment-based support material segments presented to them online as a change made in approx. every second online delivery session in Semester 1 2021. Action to implement these changes was instigated from student comments made in the SLAS for ENG10003 by the class in Semester 2 of 2020.

The bridge-building project (in 2020-2021) and test rigs for Experiment T3: Warren 7-bar Truss, together with the physical model kits used to produce the experiment-based support material for on-line presentation, when made available to perform experiments on-campus “hands-on” in Semester#1 2021, (albeit under restricted distancing requirements), were noted as being highly appreciated by students in the relevant ENG10003 classes.

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