



Pearson

Mastering Engineering

University of Hull, UK

Continuing to drive student engagement in a changing HE landscape

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Executive summary

About the resource

Mastering Engineering is a digital learning resource designed to work alongside specific print or eBooks. It provides a variety of different question types which can be studied independently or assigned by the lecturer as formative or summative assessment. Tutorials guide students through engineering concepts in multi-step problems, which also provide feedback specific to students' errors. Optional 'Help Me Solve This' hints break down the problems into smaller steps. The Mastering gradebook records key data, such as automatically graded scores and lecturers have access to diagnostic charts providing unique insight into class and student performance.

Executive summary

Dr Catherine Dobson originally introduced Mastering Engineering into the Fundamentals of Mechanical Engineering module at the University of Hull in 2011/12. Given the length of time Mastering has now been in use, this 2020 study draws together previous and current findings using an in-depth study conducted in 2015/16 and new research compiled in 2019 to understand the trends over four years of Mastering Engineering use on the same module.

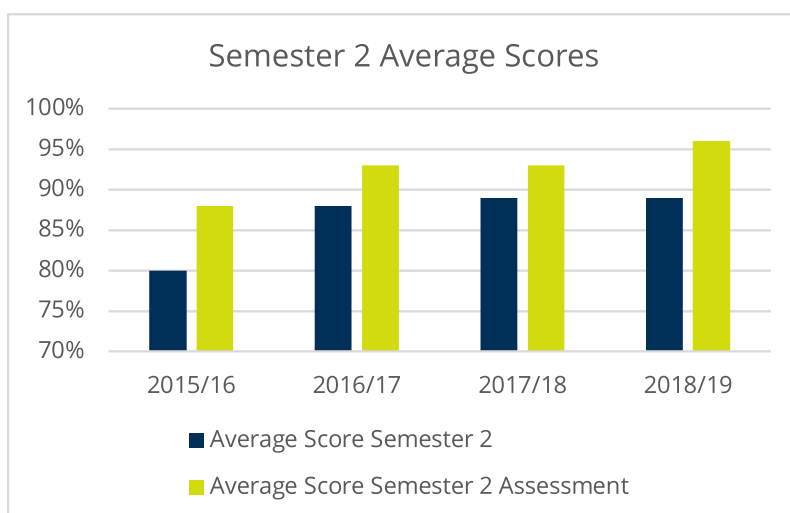
We start with a contextual update on the UK higher education landscape, the University of Hull and the Department of Engineering. We then review the 2015/16 study before moving on to look at the course development over five years and considering future indications. We then draw everything together in a conclusion.

Statistical analysis from 2015/16 demonstrated that:

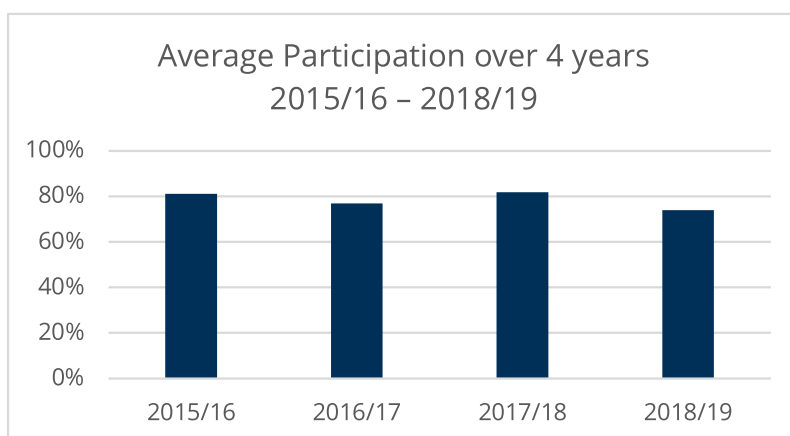
- 1. The better a student did on Mastering, the better they did in their Exam**
Strong – medium correlation Exam Semester 1: $r=.80$, $p<.01$; Exam Semester 2: $r=.41$, $p<.01$
- 2. The better a student did on Mastering, the better they did in their Coursework**
Strong, positive correlation Coursework $r=.73$, $p<.01$
- 3. The more difficult a student found the assignment, the lower their course mark**
Inverse, weak relationship Difficulty $r=-.32$, $p=.004$
- 4. Students who spent more time on Mastering performed better on the course**
Significant, medium relationship Time $r=.40$, $p<.01$

While detailed statistical analysis wasn't possible for the 2018/19 cohort, looking at the data over five years we find:

- **Consistent performance:** Average overall scores on Mastering remained consistent year on year, ranging between 86% and 91%.
- **Supporting attainment & progression:** In the last three years, scores have increased incrementally on Semester 2 Mastering assignments and the final Mastering Assessment compared to 2015/16, while maintaining similar average scores in Semester 1.



- **Participation:** Mastering remained a reliable, consistent way to engage students over four years, suggesting that the clear structure, support and implementation provided an effective, compelling way with which to motivate students to connect to their studies.



Semester 1 data for **2019/20** indicates that Mastering participation has increased to 80% in Semester 1, even while lower face-to-face attendance continues to challenge the teaching team.

- **Consistently positive student experience:**
 - **8.2 out of 10** for Mastering Engineering in 2015/16: in response to the survey question 'How likely are you to recommend Mastering Engineering to another student?'
 - **100%** of students thought that Mastering had **impacted 'a lot' on their learning** in 2015/16.
 - In 2018/19 module evaluations, positive student comments about Mastering Engineering were common e.g. **"Mastering Engineering software has been extremely helpful and encourages you to do the work every week as it is graded."**

For a full set of **Key findings** see pages 11 and 12

Part 1

The HE Environment

The HE environment and the University of Hull

“Engineering is a growth area that the University wants to invest in. We already successfully offer one fully online programme, and it is hoped that this will be extended into other parts of our provision. It’s part of the University vision to be carbon neutral by 2027.”

- Dr Catherine Dobson, Head of Engineering, University of Hull

There are increasing pressures in the Higher Education sector overall and there are also a number of issues affecting University of Hull specifically.

Among other issues, UK universities are currently:

- facing reduced student numbers due to demographic changes at this point in time with fewer 18-year-olds moving into higher education
- continuing to respond to student expectations of value for their tuition fees
- dealing with the potential effects of the Covid-19 pandemic:
 - a potential longer-term impact on international applicants
 - with so many institutions innovating and teaching in new, digital ways, this may be a catalyst for faster or permanent rates of change in teaching and learning online
- considering – and in some cases mitigating for – the potential impact of the Augar report.

Similarly to most universities, Hull is facing a number of challenges and is operating in a different landscape to that of 10–15 years ago. It has undergone a drop in league table position² which, whilst now recovering, leads to a pervading sense of uncertainty that is driving change at an institutional and departmental level. With the effect on finances in particular, any technology enhanced learning must demonstrate its value in and impact on teaching and learning.

The University of Hull has been considering their response and actions to ensure they can fulfil their vision and be recognised for academic excellence that empowers people to shape the future. To do that, in response to the changing environment, they are considering a range of changes. There is a planned overhaul of all departments with some taught programmes encouraged to consider how they move to digital teaching and remote learning to help with financial costs associated with physically hosting courses. The changes are needed, but they require innovative, future-facing teachers who can imagine a new way forward.

The current experience in the Department of Engineering

"Quite rightly students are expecting more because they're paying more."

– Dr Catherine Dobson, Head of Engineering, University of Hull

Dr Catherine Dobson became Head of the Department in 2018. She has seen changes in student behaviour over the years, but most recently **attendance** and **engagement** seem to have changed, which is concerning. This was especially clear on her Fundamentals of Mechanical Engineering course in both lectures and computer labs (face to face Mastering Engineering tutorial sessions) when compared to 2015/16:

"Student engagement seems to have really dropped; students don't attend lectures as regularly... and what I found, which did worry me, was there's less attendance at the computer lab [tutorial sessions]." – Dr Catherine Dobson

Whether or not students attend, the learning outcomes on the course are the same and, as a resource, Mastering Engineering needed to provide value by delivering on those outcomes. Even with lower attendance in lectures, Mastering Engineering still needed to be shown to support engagement, attainment and progression through the course.

To secure funding for Mastering Engineering year on year **Dr Dobson is required to demonstrate its value**, observing that the value it brings centres around:

- **improving and monitoring student engagement**
- **accessibility for students**
- **automated marking for teaching staff**

Dr Dobson emphasises Mastering Engineering's contribution to the successful running of the course stating that, *"There's certainly not enough time to do a large volume of marking; this way I can set lots of questions [that are automatically marked]. We feel that it's beneficial to the students and the staff."*

The fact that students often comment on how they find Mastering Engineering useful in their module evaluations helps to demonstrate its value and its crucial role in supporting student engagement. It is worth considering whether the benefit to students and their need to engage through Mastering Engineering is even greater if they do not physically attend sessions.

"The fact that they can log on anywhere is really important, plus access the additional online learning resources. Quite rightly students are expecting more because they're paying more." – Dr Catherine Dobson, Head of Engineering, University of Hull

The student experience and perception of added value are especially important given that in the University's future, some courses will be online and that student expectations are likely to continue to stay high, in line with their fees.

Part 2

Findings

Introduction

As the module leader, Dr Catherine Dobson introduced Mastering Engineering into this course at University of Hull in 2011/12. Classes have fluctuated in size through the years from 170 at their peak, to 100 in 2019.

The course team identified a number of challenges they wanted to address to make the course more successful:

- Engaging and motivating students (**increasing attendance and therefore knowledge level**).
- Modern and worthy of tuition fees (**student satisfaction**)
- Accessible outside the classroom (**flexible learning**)
- Allow for even more practice (**increased practice, increased knowledge, increase achievement**)
- Allow a snapshot in time of student performance and identify areas students were finding difficult to understand (**improve support and feedback**)
- Automating marking (**manage increasing class sizes**)

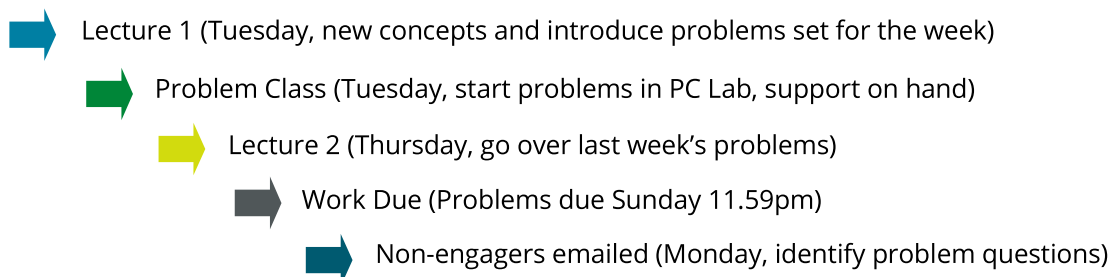
In 2015/16 we published a detailed study¹ on the effects of using Mastering Engineering to address these challenges. (See *References*.)

This update considers course data across all years, where available, to demonstrate longitudinal trends or compares 2015/16 against 2018/19 insight to show a snapshot of the experiences then and now for lecturer and students.

Course structure

From 2015/16 the way in which Mastering Engineering was implemented settled into a consistent pattern. In each semester static content makes up 50% of the total module assessment which comprised 15% Mastering online assessments, 10% written assignment and 25% exam. . Mastering Engineering was integrated fully into each week with homework assigned and then discussed in tutorials. It is used for practice and summative assessment.

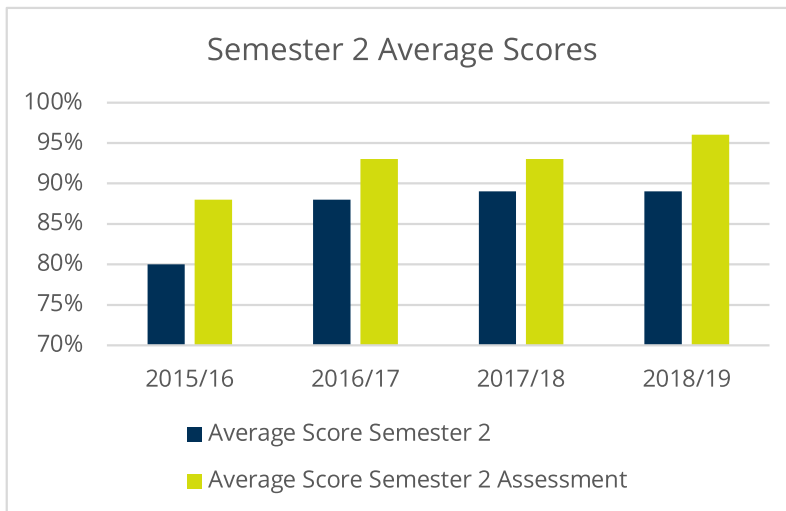
Each week the students followed the same structure:



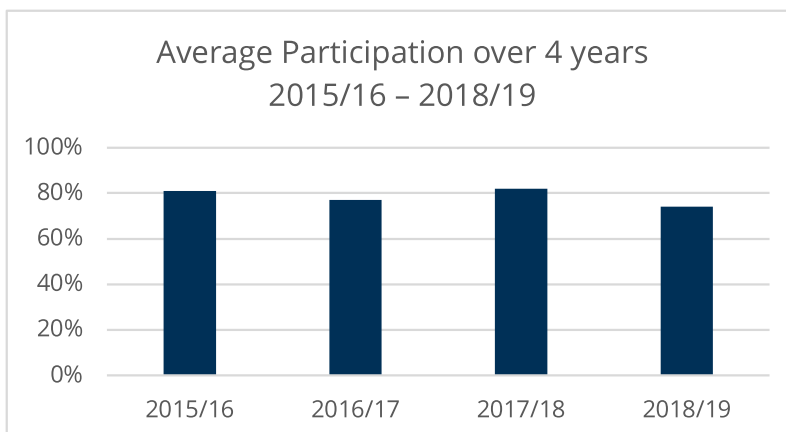
The course assigned credit and had a clear structure and an engaged teaching team who monitored, supported and discussed the weekly work set on Mastering Engineering.

Key findings

- **Consistent performance:** Average overall scores on Mastering remained consistent year on year, ranging between 86% and 91%.
- **Supporting progression:** In the last 3 years, students have scored better on Semester 2 Mastering assignments and the final Mastering Assessment than in 2015/16.



- **Effective student support through analysis:** the transparency of the Mastering Engineering gradebooks enabled lecturers to target effective support for the more challenging topics for example, Semester 2 grades improved year on year as shown above.
- **Participation:** remained consistent over 4 years, suggesting that the clear structure, support and implementation provided an effective, compelling way with which to engage students in their assignments.



Key findings continued

- **Engagement:** Mastering continues to engage and motivate students. Dr Dobson has seen lower attendance on the course in the last 3 years and the average participation rate in Mastering had decreased from 83% in 2017/18 to 74% in 2018/19. Despite this, students continue to engage with their Mastering Engineering resource. More detailed analysis in 2015/16 demonstrated the weekly assignment structure set up by the lecturer was observed to support successful student completion of work.
- **Future indications:** Early indications for 2019/20 show that participation has increased again to 80% in Semester 1, whilst lower attendance continues to challenge the teaching team.
- **Consistently positive student experience:**
 - In 2015/16: In response to the survey question 'How likely are you to recommend Mastering Engineering to another student?' Mastering Engineering scored **8.2 out of 10**.
 - In 2015/16 **100%** of students thought that Mastering had impacted 'a lot' on their learning
 - In 2018/19 module evaluations, student comments about Mastering Engineering included examples such as *"Mastering Engineering software has been extremely helpful and encourages you to do the work every week as it is graded."*

2015/16 Statistical Analysis

1. **The better a student did on Mastering, the better they did in their Exam**
Strong – medium correlation Exam Semester 1: $r=.80$, $p<.01$; Exam Semester 2: $r=.41$, $p<.01$
2. **The better a student did on Mastering, the better they did in their Coursework**
Strong, positive correlation Coursework $r=.73$, $p<.01$
3. **The more difficult a student found the assignment, the lower their course mark**
Inverse, weak relationship Difficulty $r=-.32$, $p=.004$
4. **Students who spent more time on Mastering performed better on the course**
Significant, medium relationship Time $r=.40$, $p<.01$

See 2015–16 study¹ for detailed findings on achievement, participation, study patterns and student feedback. (See References)

Part 3

Themes in 2015/16

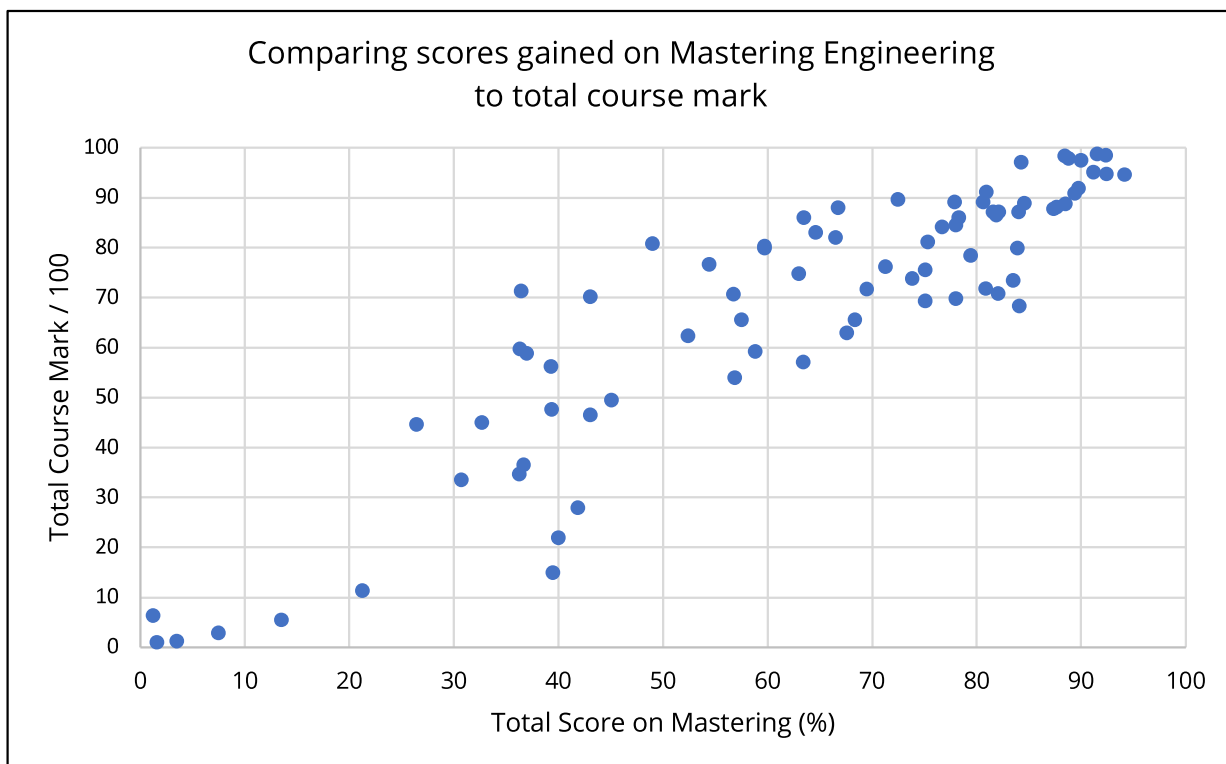
Student performance in 2015/16

The 2015/16 study showed that performance on Mastering Engineering was clearly linked to performance on the course*. For reference, these were the salient findings:

2015/16 Statistical Analysis

- 1. The better a student did on Mastering, the better they did in their Exam**
Strong – medium correlation Exam Semester 1: $r=.80$, $p<.01$; Exam Semester 2: $r=.41$, $p<.01$
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Significant, medium relationship Time $r=.40$, $p<.01$

Effectively this means that doing well on Mastering is a leading indicator of performance on exams, coursework and final course marks. One of the factors in higher performance for this cohort appeared to be the time spent on Mastering (this may be on the assignment but more likely on self-study resources).



*To discover more detailed trends please go to the full study (See *References*.)

Final module marks in 15/16 combine the Mastering Engineering assessments (15%), coursework (35%) and exams (50%) over both semesters. Students need 40% to pass.

To say that high performing students also perform well on digital resources is not surprising. However, identifying their successful learning behaviours, such as time spent, are key. This helps to show struggling students how they could start to improve their performance by engaging with Mastering Engineering.

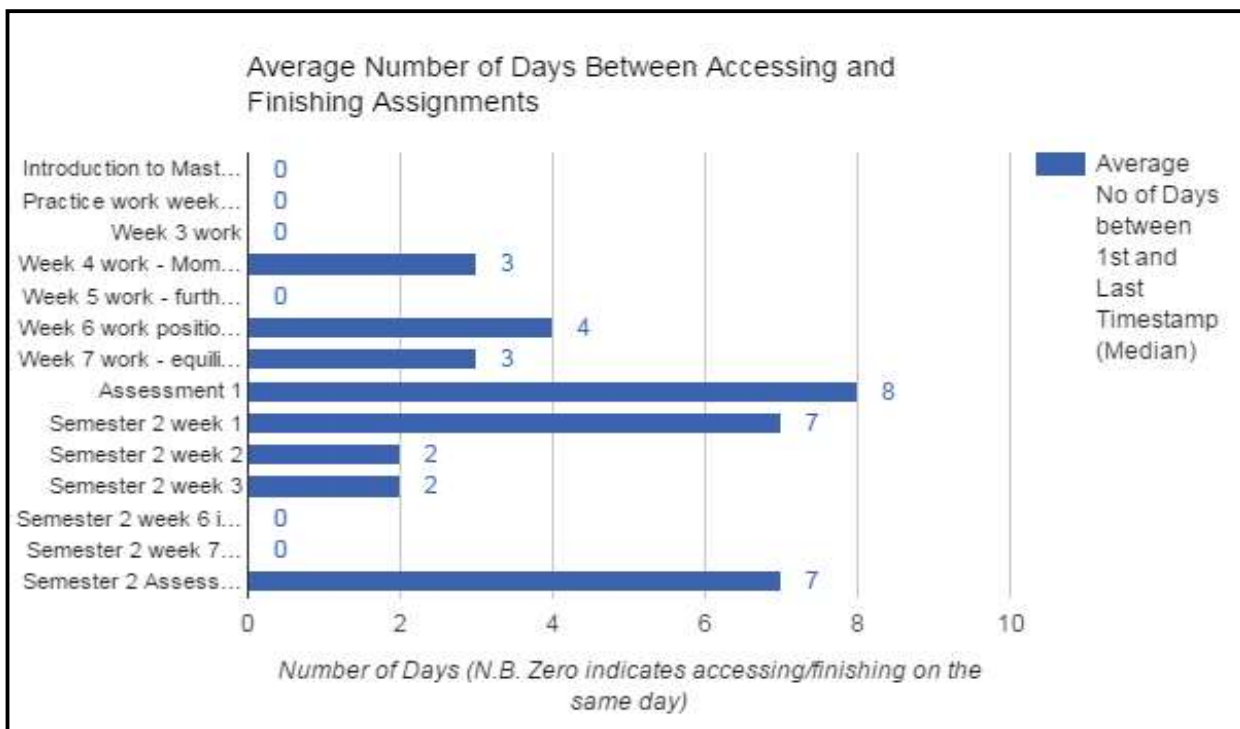
In similar studies³ into MyLab resources, it has been shown that completing up to just 25% of the self-study plan impacts on overall attainment.

Student engagement in 2015/16

In the 2015/16 study it was clear that there were patterns in student study behaviour. The structured implementation of Mastering Engineering, deadlines for both formative and summative assessment, in class support from lecturers and particularly having credit attached to assignments was observed to motivate the students.

The patterns we found were:

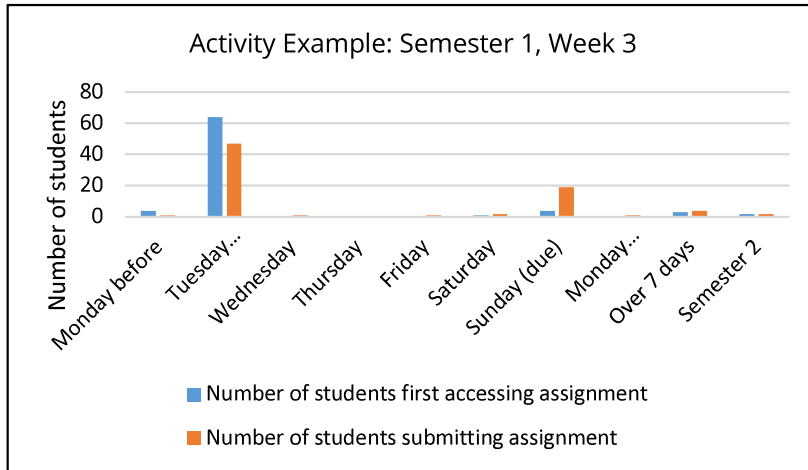
1. Students mostly first accessed their assignments on Tuesday, in the computer lab session **and then submitted them either the same day or just before the deadline on a Sunday** - (Sunday 11.59pm)
2. Assessments were typically first accessed and then submitted after one week. They chose not to work on it throughout the week. It appears students were keen to know they *could* access it but chose to submit within the deadline for completion.



The time between accessing an assignment and submitting is shown above as an average across the class.

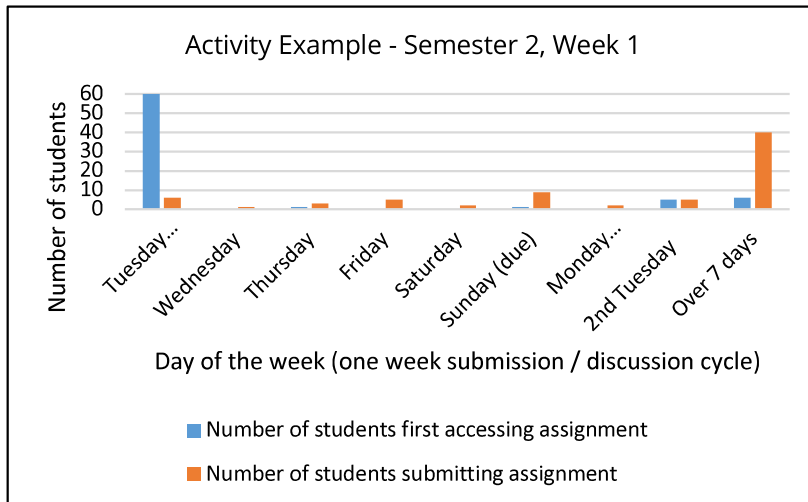
When did students do their work?

It is common to see work completed on a Sunday due to the deadline set (Sunday 11.59pm). Many also used the Tuesday problem class in a computer lab to complete their work. Late completion is not common, assuming one 'unusual' week in example 2.



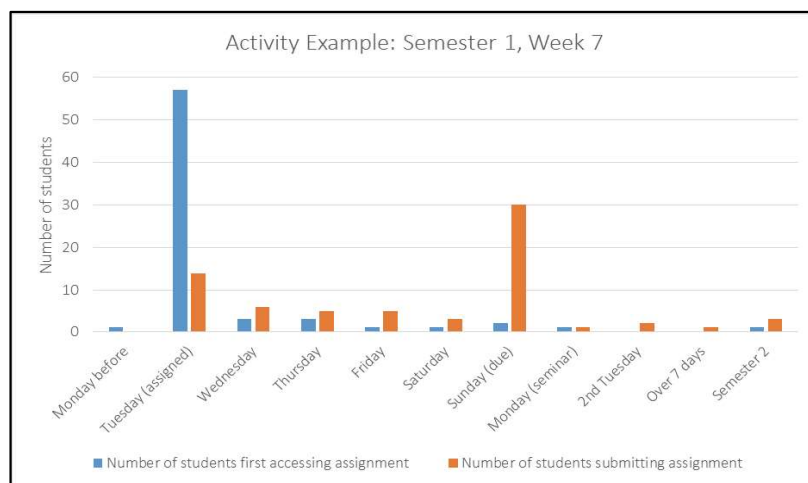
Example 1: Highest participation.

Students complete assignments in their problem class (Tuesday) or on the day work is due (Sunday).



Example 2: Longest assignment completion.

Students took an unusually long time to complete this assignment, with a slight peak on Sunday when work was due. Despite the discrepancy here (over 7 days goes beyond the deadline) there is peak of access on Tuesday and of submission on Tuesday or Sunday



Example 3: Typical week.

Average 3 days to access and submit assignment. Quite average participation and scores this week.

For more detailed trends please go to the full study (See *References*.)

Student Experience:

In this section, we recap the findings from the survey undertaken as part of the 2015/16 study and add feedback from the 2018/19 cohort. Dr Dobson found that students generally reacted positively to Mastering Engineering.

Overall, students answering the survey agreed that Mastering Engineering provided clear benefits for their study whether by motivating them or by supporting their learning in an easy, accessible way. Their results show that Mastering Engineering provided:

- **Engaging learning experience**
- **Enjoyable and varied activities**
- **Support for students so they felt prepared for class**
- **Accessible and easy use**

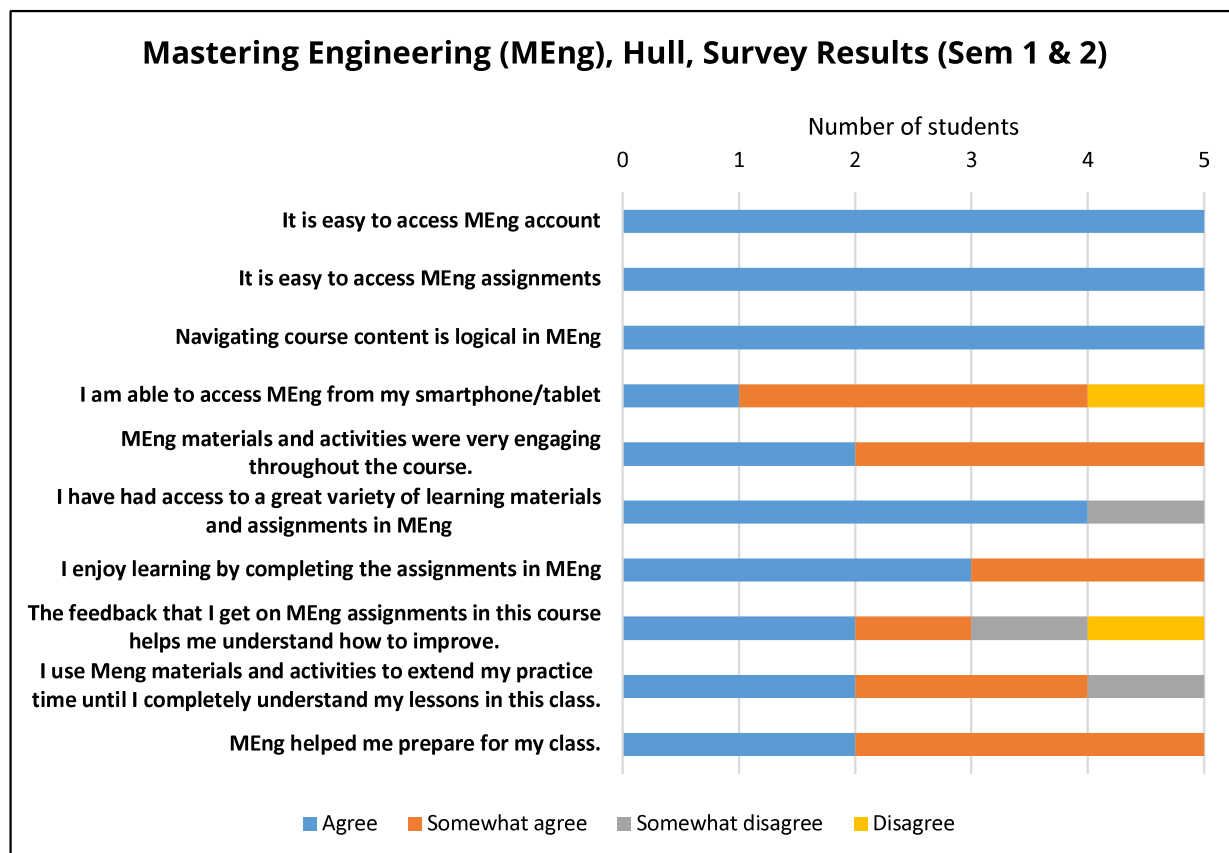
Although the response rate for this survey was low, there are five students represented in comments, their responses appear to align with comments from the class in their module feedback (also below).

8.2 out of 10 'How likely are you to recommend Mastering Engineering to another student?' (from 0-10)

100% of students thought that Mastering Engineering had impacted the learning on the course "a lot".

60% of students were very satisfied with the content available for practice within Mastering Engineering.

The students were asked to rate their level of agreement with a series of statements about their experience:



Module feedback 2018/19

By way of a comparison, it is clear from their feedback three years on from the previous study that students on this course still respond well to the use of Mastering. Comments reveal that they continue to say that it is:

- **Helpful**
- **Motivating**
- **Accessible**

Here are just a few of the positive student comments from the 2018/19 Module Evaluation Survey conducted by the university.

Student Comments

"Mastering Engineering software has been extremely helpful and encourages you to do the work every week as it is graded."

"Mastering Engineering is also a very helpful resource when I'm struggling on a question."

"Mastering is really helpful as it gives easy access to practice questions and the textbook."

Part 4

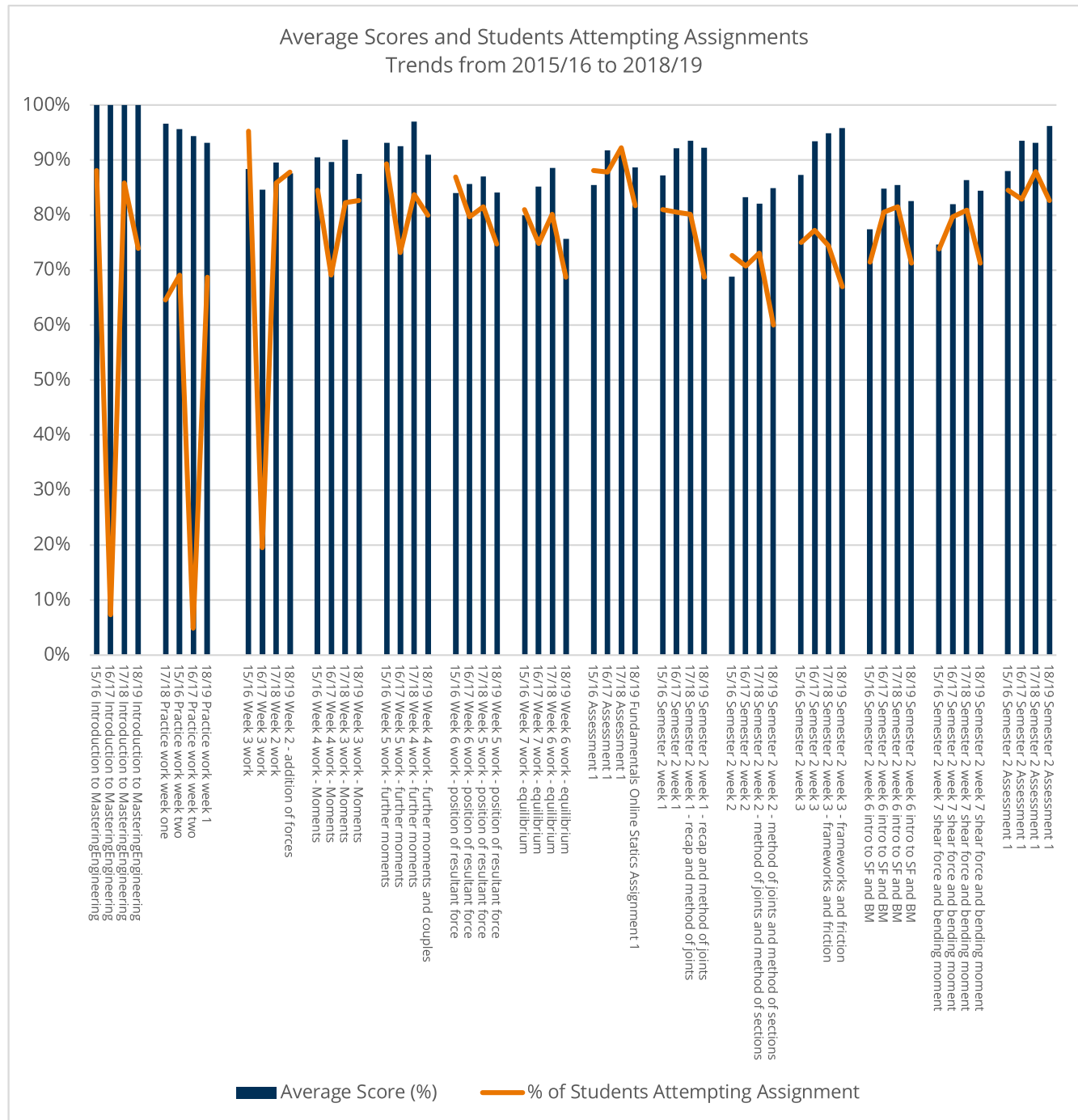
Trends over 5
academic years

Trends: 2015 to 2019

Mastering Engineering has been integrated into the Fundamentals of Mechanical Engineering module in a similar way each year since it was introduced. We have compared course data over the years to explore how Mastering Engineering has impacted on learners over the years and identified the themes and trends.

Average Score and Participation

The chart below shows average scores and average participation rate week by week in Mastering over four academic years. Deeper analysis of this chart follows, in which we dig into the implications of the results.



Student Performance

Comparing **annual average scores**, we can see that they have remained **consistent year on year**. Looking at the average over four years, you would expect future students to continue to score around 89% (88.86%).

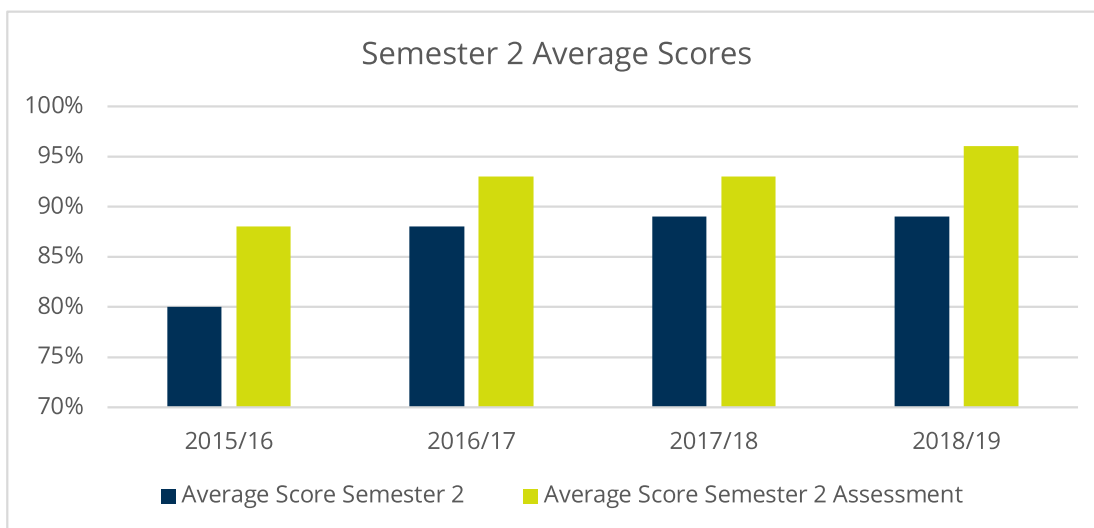
Academic Year	Annual Average (mean)	Semester 1	Semester 2
2015/16	85.82%	89.76%	80.56%
2016/17	89.58%	90.62%	88.20%
2017/18	91.22%	92.70%	89.24%
2018/19	88.83%	88.44%	89.36%

Weekly variation: The chart on the previous page also shows areas of the course which students tend to find harder year on year. In the **early topics they tend to score quite well** and then, as time goes on, they find the **later topics harder**. This is reassuring as an academic; it's what you would expect from a course where you are building up from simpler to more complex topics.

Visibility of these scores **allow an instructor to guide and monitor their students**. For example, lecturers can highlight these areas to encourage further study or provide extra revision support on these topics.

Variation by semester: The chart also indicates **trends in performance by semester** across the 4 years:

- Scores in Semester 1 are consistently good, average score above 75%.
- In the year 2015/16, students' average scores were lower in Semester 2. However, in subsequent years they seem to have visibly improved. Students scored 8% higher in 2018/19 than in 2015/16.



- Previous correlations between system and overall score on both exam and coursework afford confidence in the students' potential achievement on the course:
Exam Strong-medium correlation Semester 2: $r=.41$, $p<.01$
Coursework Strong, positive correlation Coursework $r=.73$, $p<.01$

Participation

Looking now at participation (see the orange line on the graph on page 20) there was a **good level of participation** in most weeks over the four years. Looking at the annual average, participation stayed broadly consistent until a drop in 2018/19. If we work out the average over the first three years, you could have expected students to continue to participate 2018/19 at around 80.37% not at the actual 74.22%.

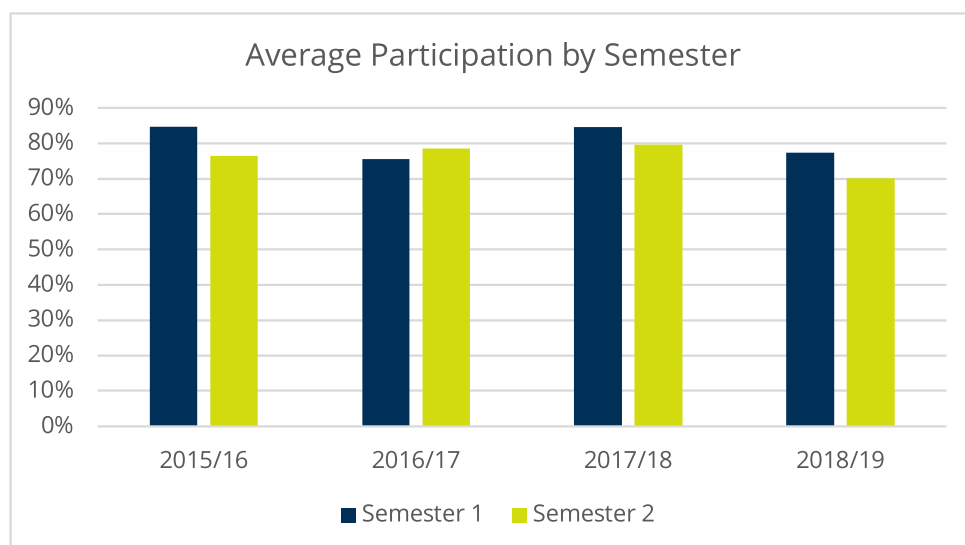
This in part reflects the annual fluctuations in attendance/engagement that have been observed by Dr Dobson on the course. It is encouraging, however, that this has not impacted on student performance (page 20). If we had taken the first three years and used those scores to predict an average score for 2018/19, we would have expected students to score 88.87%. They scored 88.83% which is exactly on trend.

Academic Year	Annual Average Participation Rate (mean)
2015/16	81.14%
2016/17	77.10%
2017/18	82.87%
2018/19	74.22%

Notes on table: Clear outliers showing very low participation at the start of years 2016/17 and 2017/18 have been removed when calculating the annual average participation rate. Our numbers are for assignments 'attempted', *not* 'completed'.

Variation by semester

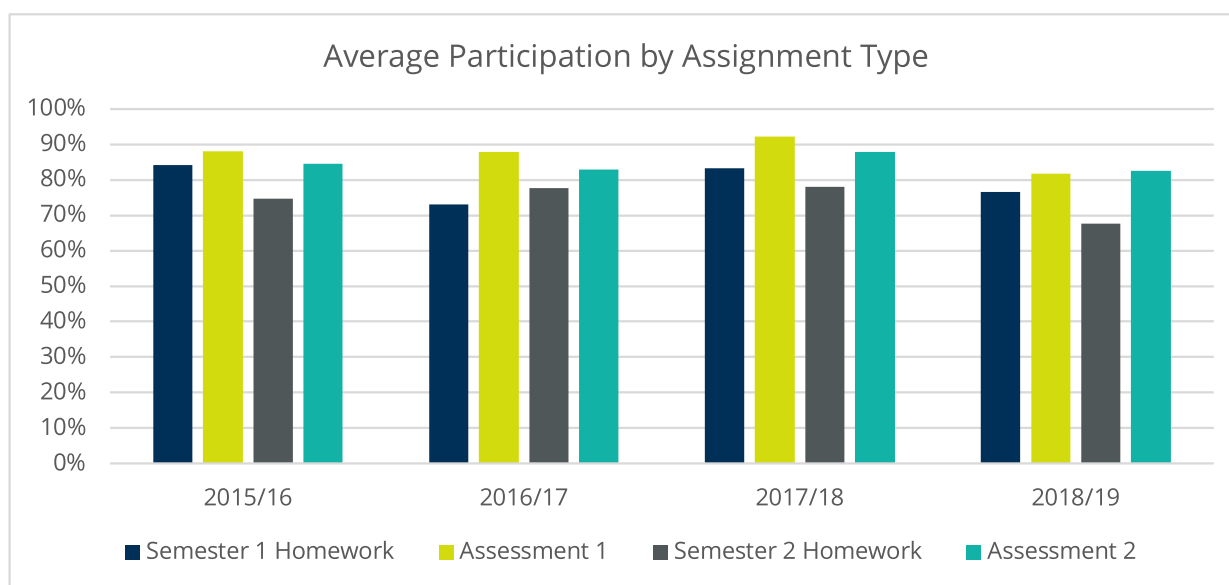
Whilst 2018/19 shows **some decline in participation by semester**, the trend across four years reveals a welcome consistency on average. Maintaining engagement across the year is often seen to be one of the biggest challenges, especially where good structures, integration, credit and performance checks are not in place. We note that the lower participation in Semester 2 could be due to attrition – a few students don't progress into Semester 2 but they appear on the Mastering Engineering student roster for the whole year.



- Semester 1 is consistent year on year, ranging from **75% to 84%**.
- In a number of weeks during Semester 1 over the four years, participation is **above 90%**.
- In Semester 2, average participation rates tend to drop, ranging from **70% to 79%**.

Variation by type of assignment

We observed trends in the average student participation based on the type of assessment – **Homework** assignments which were worth less course credit compared to **Assessments** which contributed more to the overall module mark.



Student average **participation peaks for Assessment 1 and for Assessment 2 year on year**. These two Mastering assessments have higher credit and see the highest average participation – ranging from 81% to 92% – when compared to the series of homework assignments in the same semester.

This demonstrates that:

- integration into a course structure makes a positive difference to student usage
- credit for completion of Mastering assignments (and the level of that credit) significantly and positively impacts student engagement.

Student Experience

Module evaluation surveys were conducted at the end of each semester over the five years, using a Likert scale with five points: *Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree*.

Year on year, the average of the student responses for this module was always at the **Agree/Strongly Agree** end of the scale. Consistently the highest average (mean) rates of agreement were given for these questions:

- I have been able to contact staff when I needed support (Av. **4.64** in 2019/20 Semester 2)
- The module is well organised and is running smoothly (Av. **4.58** in 2019/20 Semester 2)
- Learning materials (e.g., Canvas, books, handouts, notes, study guides, teaching materials*) for this module have effectively supported my learning (Av. **4.5** in 2019/20 Semester 2)

*Covers Mastering Engineering, which is accessed via Canvas

A different year: 2019/20

What changed?

In 2019 the University of Hull changed its module assessment requirements, and lecturers were discouraged from having too many assessments in each course. The University also stipulated that students should be able to re-sit all credit-bearing assessments.

Consequently, Dr Dobson's changed her module assessment strategy as summarised below.

Previous to 2019:

- five Mastering Engineering homework assignments each semester each worth **1%** credit
- a more significant Mastering Engineering assessment worth 10%
- a written assignment worth 10%
- additionally, an exam and other subject work.

2019/20 onwards:

- All Mastering Homework Assignments and the Assessment now have **just one due date**, at the end of the Semester.
- first five shorter Mastering Engineering homework assignments worth **3%** each
- the Mastering Engineering assessment is still worth 10%
- the 10% written assignment has been *removed*
- additionally, an exam and other subject work

Changes as a result of COVID-19

In spring 2020, the coronavirus pandemic resulted in a national lockdown for the UK, with all universities forced to move everything online around the 16th of March.

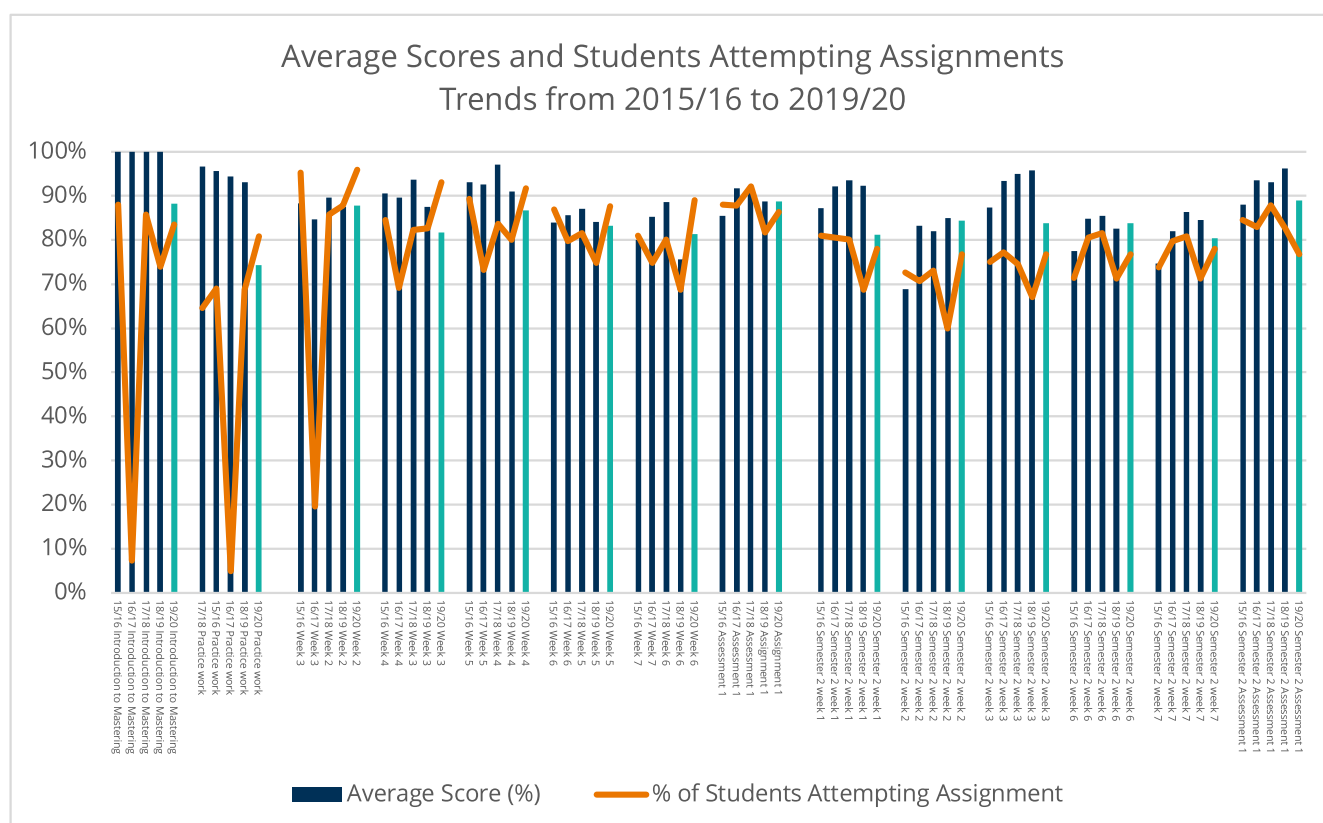
In light of this, changes were made at the University of Hull and Mastering Engineering Assessments became more important to the final course mark:

- Mastering Engineering assessments worth **45% of the course credit**
- The **final exam was removed**.
- The original single due date was extended by two weeks to 13 April 2020.
- The university then specified that students could submit up to two weeks after the deadline (end of April).
- Failure to submit by then resulted in an automatically granted extra two weeks based on mitigating circumstances (mid-May).
- Once that date had passed students were still allowed to submit up to 4 June 2020.

When analysing the results of the 2019/20 cohort, we considered the structural changes to the assessment and the impact of COVID. We re-interviewed two students specifically to find out more about their experiences of the move to online during the pandemic and their return to university for Year 2.

Participation

When we consider the most recent year of Mastering Engineering usage (see turquoise bars on the graph below) we see new peaks in students submitting their Mastering assignments. Broadly **participation is up** versus the previous years (perhaps unexpectedly given the decline in 2018/19 participation). In **7 out of 14 assignments it surpasses any previous highest participation level** for that assignment.



Academic Year	Annual Average Participation Rate (mean)
2015/16	81.14%
2016/17	77.10%
2017/18	82.87%
2018/19	74.22%
2019/20	83.76%

Dr Dobson has tried to mitigate against possible negative impacts on student behaviour: *“I make the homework assignments worth a small amount of credit, to encourage students to do them.”*

Key findings

- It seems reasonable to conclude that **increasing the course credit from 1% to 3% per assignment did motivate students**. This incentive has likely contributed to the levels of average participation which are at their highest for 5 years at **83.76%**.
- With the move to online due to COVID-19, it's possible that **students found themselves with more time** available to do their online Mastering Engineering assignments. An **extended deadline** perhaps allowed those students who may have missed the original deadline to participate.

Student Performance

While having a single deadline (and the subsequent extensions of the assessment deadline due to COVID-19) seems to have contributed to a higher average participation rate, student **scores tended to be lower than previous years**. (There are four exceptions to this where they scored the same or just a bit higher than the 2018/19 cohort.).

On reflection, Dr Dobson considered this to be because their learning was not cumulative. Students were not working steadily week-by-week to build their knowledge. In addition, the lecturer was unable to use tutorial sessions to explore any areas students had found challenging in the previous week.

Academic Year	Annual Average (mean)	Semester 1	Semester 2
2015/16	85.82%	89.76%	80.56%
2016/17	89.58%	90.62%	88.20%
2017/18	91.22%	92.70%	89.24%
2018/19	88.83%	88.44%	89.36%
2019/20	83.86%	83.73%	84.04%

The final assessment and the impact of COVID-19

We observed that for this cohort their average participation in the **Semester 2 Assessment 1** was nearly **6% lower than the previous year**: 76.71% vs 82.61%.

How might this be explained?

The national lockdown prompted by the COVID-19 pandemic started at the end of Semester 2; there was only one lecture remaining for this part of the module which was delivered online. As part of the transition to fully online assessment, it was decided that this Semester 2 Mastering Assessment would **count for a larger portion of marks** and that students would have **longer to complete it**.

The deadline for completion was extended twice to ensure that all students, whatever their location, access to the internet or personal circumstances, had a fair chance to complete the module.

One might have expected that more students would have attempted the Final Assessment and, with more time available to revise and prepare, that they might have scored as highly as previous cohorts. In reality it appears that **the pandemic and the anxiety it caused had a further negative impact on this cohort's behaviour with regards to their university studies.**

“[With the one deadline at the end of the semester] it gives you loads of time to do it but then obviously it's much better to do it weekly. I like the structure of it just because it's far better doing it every week...leaving it to the end things aren't fresh in your mind. But it's good in that it takes off a lot of pressure. If you have a really busy week you can catch-up the following week.” – Student

Student Feedback

In 2019/20, we interviewed five students from the cohort. Some of their feedback on Mastering Engineering, and this part of the module in general, is shown below.

Student Comments

The benefit of deadlines

*"A student will think 'The less work, the better.' But actually, I would have liked more. If we had two a week or three a fortnight, rather than one a week...**more regularly would be better; people wouldn't leave it to the last minute.**"*

*"Because there are no weekly deadlines ...it really makes a difference if **your lecturer every week is checking that you've done it** rather than just saying 'It's there if you want to do it'."*

Credit encouraging participation

*"Having the **credit each week is really important** – if that was scrapped, a lot less people would do the work. Having a grade each week gets people going back to it."*

"If you put the work into Mastering you know straight away you've got a few extra percent on your module already."

Feedback and progress

*"It lets you know what you've got right or wrong. You've got that feedback straightaway that **lets you know where you are on the course.**"*

*"It's **helped me learn the course much faster** than I thought I would."*

*"It **helped my skills understanding**. I could go back to look at earlier things to help me with the harder questions. [...] The **hints were really useful**. You could break down the bigger questions into smaller stages...if you got it wrong, you could see exactly where you went wrong instead of going right back to the start."*

*"I could go through the questions **at my own speed**. [...] It makes it really manageable."*

Flexibility of access

*"It was **convenient**, you didn't have to do it all in one sitting."*

*"The fact that you can **log in anywhere** is really good. You can work alongside your course mates even if they can't make it onto campus that day."*

Supporting learning and increasing student confidence

*"When you get one wrong answer, but you can still get 97% it definitely **brings your confidence up**. Especially **when you get it wrong a couple of times and then you get it right – that feels really good**.... Mastering has helped a lot with how I enjoy mechanics."*

*"For me Mastering was **essential** for doing well on the exam."*

*"It provides all the diagrams and it's **easy to visualise the engineering problems**. I like the way it structures the questions ...with 5 steps... **It builds up on questions – it makes you do it step-by-step**. ...You can see at what point you've gone wrong."*

*"It made me **feel like I was on a similar footing to my peers** [those who had done physics A Level]."*

Conclusion

Conclusion

Mastering Engineering is an integral part of the undergraduate engineering course at the University of Hull. In a changing university landscape and with changing student behaviours, it continues to:

- promote student engagement
- provide added value to students through flexible access to online learning materials
- allow lecturers to detect patterns of student understanding in different topic areas
- allow lecturers to monitor their students' achievement and ensure they are continuing to progress, especially in more difficult topics
- offer support and encouragement to any students that are not engaging early in the course
- mobilise student participation in learning activities throughout the course.

This study indicates that when Mastering Engineering is well integrated by staff and students, it produces consistently positive results and positive student feedback over time. Key elements of this success appear to be that it is:

1. well integrated using a clear, consistent structure
2. the online resource is clearly linked to lecture content / teaching time and is timetabled effectively
3. assignments are set for credit
4. lecturers monitor student achievement, intervening to support where necessary.

“[We are] improving engagement and being able to detect people that are not engaging early. We feel that it's beneficial to the students and the staff.”

– Dr Catherine Dobson, Head of Engineering, University of Hull

Learning lessons in the art of delivering effective online assessment

Learning lessons in the art of delivering effective online assessment

With five years of experience delivering the same module – and the same content – with Mastering Engineering, Dr Dobson has reflected on the key things she has learned about effective implementation of online assessment. She summarises what she would do with a blank sheet if designing a course with online assessment as a key component, based on her own experience and backed up by students' experiences.

Motivating participation with credit

As noted earlier in the study, attendance at face-to-face lectures was observed to be decreasing year on year, while the level of student participation in the Mastering homework stayed fairly consistent. Across a number of similar educator studies, we have seen that credit is one of the biggest motivators for student participation and this is borne out at this institution too.

“If it's not credit-bearing, it doesn't seem as important or as urgent, so students are less inclined to do it.”
– Dr Catherine Dobson

When considering how to motivate students with continuous credit and yet not being able to set additional assessments, Dr Dobson reflected on a study completed at Queen's University Belfast⁴, where students were *required* to complete the practice homework before being able to access the assessment: *“That would be one way of encouraging the students to engage in the practice without assigning credit for a higher number of assessments.”*

In the words of one student we interviewed, this credit is really what makes it such a compelling piece of work to engage with.

“Why would you not do the online work, when it has credit? You get to chip away at your grade throughout the year.” – Student

Encouraging regular participation with deadlines

Over the first four years of usage, weekly deadlines ensured students worked and developed their understanding of the course content consistently throughout the module. Moving to one deadline hasn't impacted participation overall, in fact it's been higher than in previous years, however it seems as though the overall student learning experience *has* been impacted.

“With one deadline they just left it and didn't attempt it week-by-week as I wanted them to, helping them to learn cumulatively.” Dr Dobson has seen that this regular study leads to better learning outcomes: students are building their knowledge and practising problems throughout the course, rather than cramming at the end to pass the exam.

Students themselves told Dr Dobson, 'We like deadlines because otherwise we just won't do it.'

“When you get work set every week it forces you to engage a bit more. ...I’d say it definitely helps with getting people to engage with the work. If you don’t do the work, you won’t really have the practice you need to understand the next week’s lecture.” – Student

“Anything that’s going to have weekly small assignments is always going to run better than one large assessment at the end. It makes it so much easier to keep track of your work and keep on top of it.” – Student

In the years prior to 2019/20 Dr Dobson found that the review classes alongside Mastering worked really well. *“There was the opportunity to go over the previous week’s mastering homework and show students how to solve the problems that they struggled on. The students who attended found it really useful – that was often when I would see the penny drop – and they would go on to do better in the next homework.”* That is only possible with weekly deadlines; another reason to have those regular deadlines in place.

Making Mastering an integral part of the course

The online component of the course delivered through Mastering needs to be very clearly integrated into the course overall. Dr Dobson has a number of recommendations on how best to do this:

1) VLE structure

Set up the online assessments that students will be doing throughout the whole course *before* the start of term and ensure that this structure is visible and easily accessible on the VLE. Clarity and planning is key here.

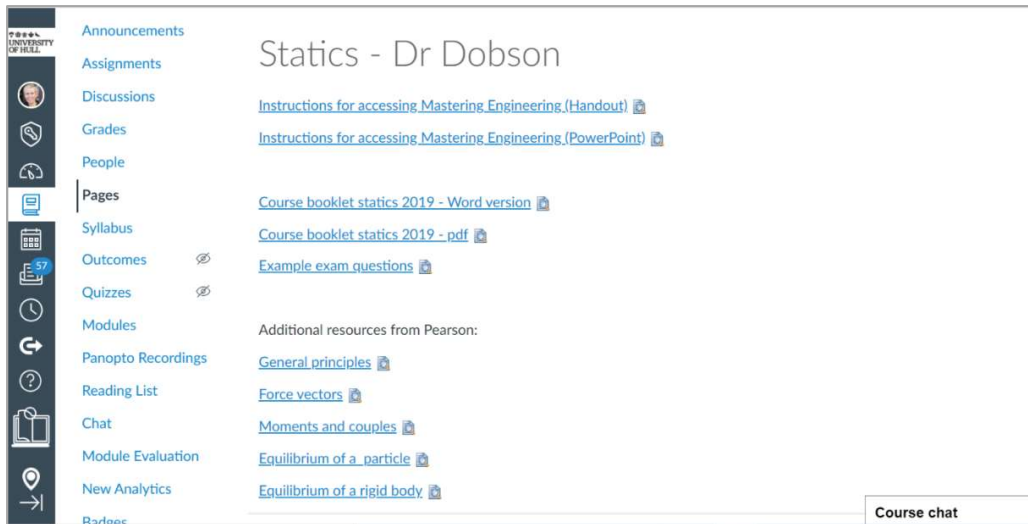
The screenshot shows a VLE interface with a sidebar on the left containing navigation options: Assignments, Discussions, Grades, People, Pages, Syllabus, Outcomes, Quizzes, Modules, Panopto Recordings, Reading List, Chat, Module Evaluation, New Analytics, and Badges. The main content area displays a text block followed by a table of assignments.

This work is all set and submitted in Mastering Engineering. After week 1 all work counts towards the final module mark, 5 x 3% homeworks followed by a 10% online assignment (hence totalling 25%). Work will be released week by week, and there is an absolute deadline for all the work to be submitted, which is 2pm on Thursday 21st November. However, as the weekly work is set to consolidate the knowledge of the work covered in that week’s lectures, it is strongly suggested that you complete the work each week by the dates suggested below. This is detailed below:

Title	Topic	Suggested completion date	Module Weighting
Introduction to Mastering	Use of Mastering Eng.	03/10/2019	0 – practice only
Practice work week 1 Maths basics		03/10/2019	0 – practice only
Week 2 work	Addition of forces	10/10/2019	3%
Week 3 work	Moments	17/10/2019	3%
Week 4 work	Further moments	24/10/2019	3%

Course chat

Draw students’ attention to **specific support resources** that will help them with their study in general and the online assessment in particular. Dr Dobson links directly to videos and PowerPoints from Mastering on a clearly organised course resources page on the VLE.



2) Workbooks and lectures

As part of this module students receive a printed workbook which contains all the **lecture slides**, for them to fill in and take notes alongside, and also the **problems that they will be doing on Mastering each week**. Dr Dobson finds that having them in the workbook meant that students can see clearly how the homework aligns to each lecture and how much work will be involved. Also, it *reminds* them to do the homework and provides them with a space to write down their problem workings so that everything is in one place and in the correct order to support their revision.

“Students say that they’ve kept the books and refer back to the workbooks years later.” – Dr Catherine Dobson

This clear, blended integration is crucial to student motivation. Where Mastering is used on another module, but is not clearly connected to lecture content, students reported to Dr Dobson that they were more confused about it and less inclined to complete the work. This served to highlight the value of Dr Dobson’s approach for their continuous learning.

“You can tell how meticulously she [Dr Dobson] plans. Everything that she puts on Mastering is there because we need it; you know it’s always going to be related somehow.” – Student

3) Problem classes

Each week after the first lecture students had a problem class, in which they were encouraged to **start that week’s Mastering homework** straightaway, with the lecturer and PhD students available to support. Dr Dobson says, *“They can get started on it, we’re all on hand so we can get them going. I think they appreciated that.”*

Our analysis in 2015/16 showed that students tended to do the most work on Mastering in that problem class and in the final hour before the weekly deadline, so this is another useful suggestion for fully integrating the online assessment into the pedagogical structure of the course. In 2019/20 students still had tutorial classes where PhD students were available to go through homework problems.

“The PhD students were really good, they guided you through without giving you the answers.” – Student

“I went to the tutorial every week to get help on any questions I was struggling with.” – Student

4) Revision resource

The clear structure of the course set out in the booklet means that Dr Dobson can advise students on the best way to revise for the final exam: *“Read the lecture notes, do the problems that we did in class again, re-do all the Mastering problems and then look at previous exam papers. They can then revise in an organised way.”* By further integrating Mastering into the learning design of the course students are even more motivated to make good use of it.

“I found it really good for revision. I could go back through any one topic and just do a set of problems specifically based on that. [...] It gave me that confidence to say ‘know I can answer that question.’” – Student

Communication

Monitoring student participation and communicating regularly with the whole class, as well as with specific students, is vital to driving engagement:

“I would check Mastering and see how many people had engaged and I would verbally remind them in class. Anyone who hadn’t engaged, I would email individually.” – Dr Catherine Dobson

“Sometimes there are announcements from the lecturer saying that some people aren’t doing their work. She’s very pro Mastering, people that want to do well are straight on Mastering. It makes it a lot clearer and everything is in one place. It’s brilliant because we wouldn’t be so keen on doing it if Dr Dobson didn’t put it forward.” – Student

COVID-19 – the immediate impact and long-term effects

A seamless shift to online assessment

The students in this cohort were already familiar with regular online assessments and were therefore less phased by other module assessments being moved to online – they felt more prepared for it. It was also convenient for the academics who could either run additional or adjusted versions of their existing online assessment set-up.

“Without Mastering you could feel very swamped with emails going back and forward with lecturers. At least with this, lecturers have got a platform to say ‘Work through it and let me know if you have any problems.’ ...As long as you’ve got internet, you’re good to go. It’s really helpful.” – Student

“For the [Semester 1] assessment in Mastering it was easy to do because we were prepared for it – the format was the same and I knew what to look for in the question.” – Student

“In the current situation [the pandemic] it’s good that we have Mastering so we can do the online learning.” – Student

The future of assessment

Universities had various approaches to delivering assessment during the national lockdown, ranging from giving full or additional module credit for coursework already completed (either online homework assignments or paper-based written work) to delivering time-limited exams within a 4-hour window. A number of institutions, including Hull, decided that in this unique situation a ‘no detriment’ policy was the best way to support students with the sudden move to online assessment wherever they were. Dr Dobson considered that these extended deadlines actually made it too vague for students, *“the deadline kept moving so they didn’t know how to plan their work – most people seem to be guided to work to a deadline, so as that keep shifting the impetus was lost.”*

Following this Dr Dobson (along with institutions and academics across the UK) has reflected on assessment and what the future may look like in terms of the quantity and type of assessment provided: *“I think there will be a lot less assessment and it will be a lot stricter on assessing a learning outcome once. I wonder about the future of exams: an exam is good way of assessing certain knowledge, but I don’t think they will be used as widely.”*

Students also discussed their thoughts on ongoing assessment versus end of module exams, including exam nervousness, the weighting of coursework and the real-life application of assessment:

“I’m a coursework person. I think the weighting [credit] we’re given is fair, although I’d like it to be higher because I think basing it [our success] on just our exam isn’t hugely accurate.” – Student

“I was worried about the maths exam, but it was a lot easier being online, because you could do it anytime within a week and you could use your lecture notes.” – Student

“I feel like I’ve done better not having an exam and having an assignment-based module. [...] Exams make me nervous. With an assignment I’ve got all the notes in front of me and I’m organised and I know where to look and how to get to my solution. [...] It’s more real-life.” – Student

Creating a sense of belonging

When students are together on campus, they form friendship groups within their cohort and often work on Mastering problems together – Dr Dobson believes this collaboration is crucial for engineering as a subject, where there are also formal group learning activities on a number of modules. *“We need to be using an array of online tools and to get the balance between online large-group lectures and smaller group or individual sessions. It’s going to be a lot of work for academic staff and it’s also important to avoid too much overuse of video conferencing software.”*

Dr Dobson admits that it’s really hard to replicate that face-to-face, collaborative problem-solving experience online, *“No matter how good the technology and how tech-savvy we think students are, this is a challenge. We need to look at guiding them because, so far, they’re trying to figure it out themselves without really knowing how.”*

“If you have a problem it’s hard to explain to a tutor over the phone or over an email. I still contacted my course mates via Facebook, but it was difficult; we were sending photos and highlighting where we think we were going wrong.” – Student

One student talked specifically about that need for balance and how the online learning experience can present additional problems:

“There needs to be fine balance between online and face-to-face – it’s hard to engage online all the time. [...] It’s hard to find the motivation. [...] I’m less anxious about being curious and asking questions in person – it’s harder in the online interface. I miss the human interaction.” – Student

Replicating the problem classes online

When campus was closed, and everyone was in national lockdown, students couldn’t attend face-to-face problem classes, but Dr Dobson still wanted to provide the same kind of support. She scheduled an hour per week when the PhD students were available to contact via the Canvas discussion boards – this encouraged the students to only contact the PhD students when they were being paid for their time, rather than emailing them randomly throughout the week. Dr Dobson found; *“From the feedback I got, I think students made good use of this.”*

Summary of lessons learned for online assessment

For anyone getting started with building online assessment, Dr Dobson’s main advice is:

“You need to know what you want to achieve but you can start small setting just a few problems for the students and building up. If you have strict regulations, devise a strategy to work around but within that, so that you can assign some credit and make it the best learning experience for the students. Don’t have the online platform and homework as an aside, it has to be central to the course.”

To conclude, Dr Dobson outlines what ‘good’ looks like for online learning and assessment:

“Clear, well planned out assessment strategy. Having a schedule that the students are aware of, so they have a good overview of where the course is going. Providing credit so the students assign value to the homework and therefore benefit from the learning. Weekly deadlines to drive regular engagement.”

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