



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, and 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 4 years of Mastering Engineering use on the same module.

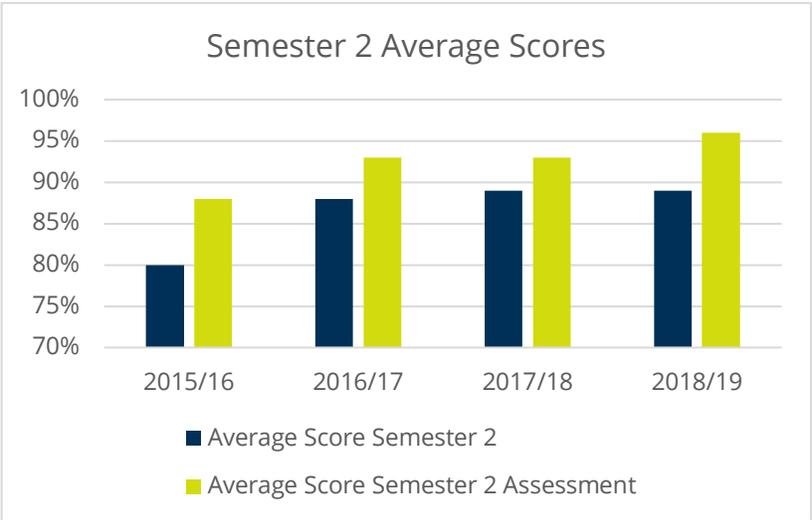
We start with a contextual update on the UK higher education landscape, the University of Hull and the Department of Engineering. We then review the 2015/16 study before moving on to look at the course development over 5 years and considering future indications. We then draw everything together in a conclusion.

### Statistical analysis from 2015/16 demonstrated that:

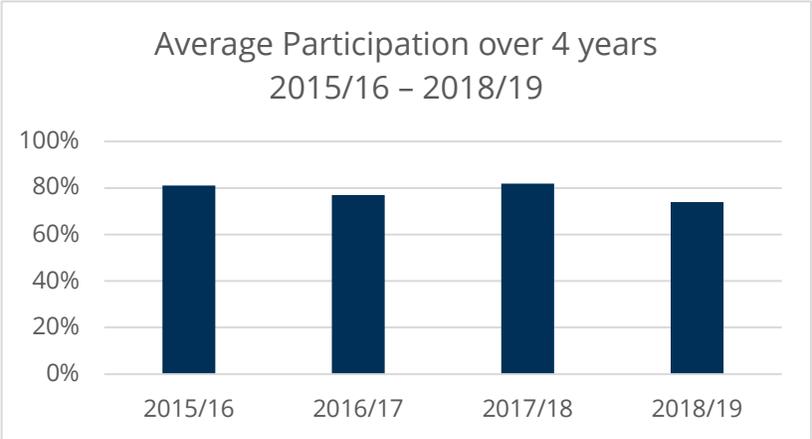
- 1. The better a student did on Mastering, the better they did in their Exam**  
Strong – medium correlation Exam Semester 1:  $r=.80$ ,  $p<.01$ ; Exam Semester 2:  $r=.41$ ,  $p<.01$
- 2. The better a student did on Mastering, the better they did in their Coursework**  
Strong, positive correlation 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 5 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 3 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 4 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 meaning there are 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 longer-term impact on international applicants?
  - with so many institutions innovating and teaching in new, digital ways, will this 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 position<sup>2</sup> which, whilst now recovering, leads to a pervading sense of uncertainty that is driving change at an institutional and departmental level, and 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 have 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 Engineering department

*"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 value 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 the 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**)

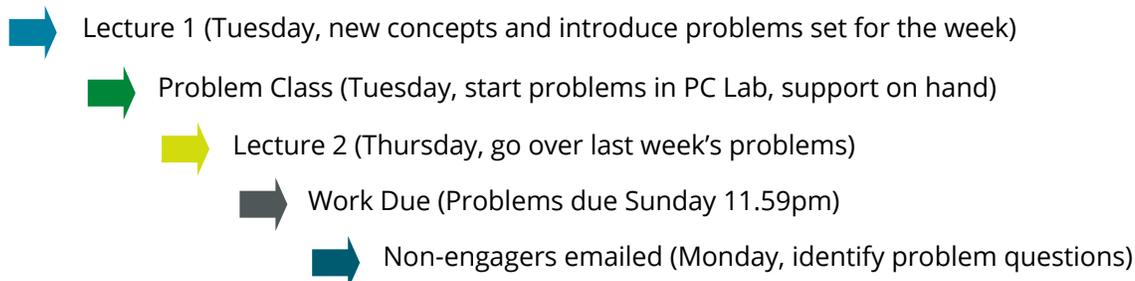
In 2015/16 we published a detailed study<sup>1</sup> on the effects of using Mastering Engineering to address these challenges. (See *References*.)

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 statics 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 a homework assigned and then discussed in tutorials. It is used for practice and summative assessment.

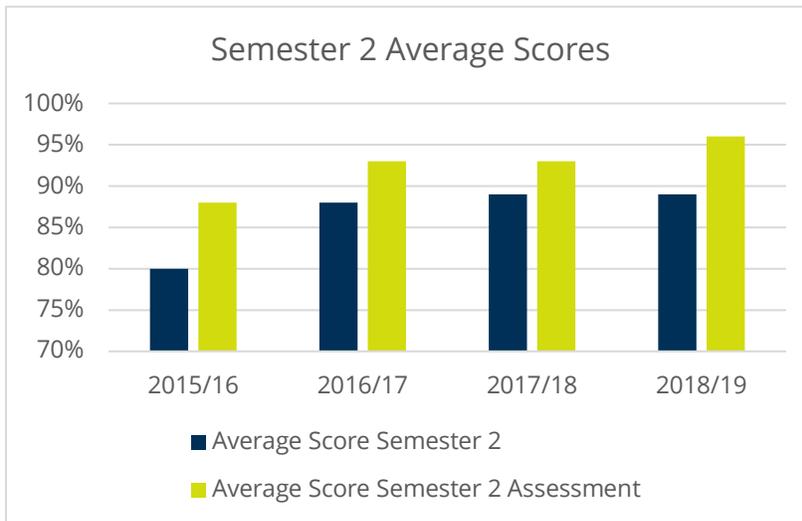
Each week the students followed the same structure:



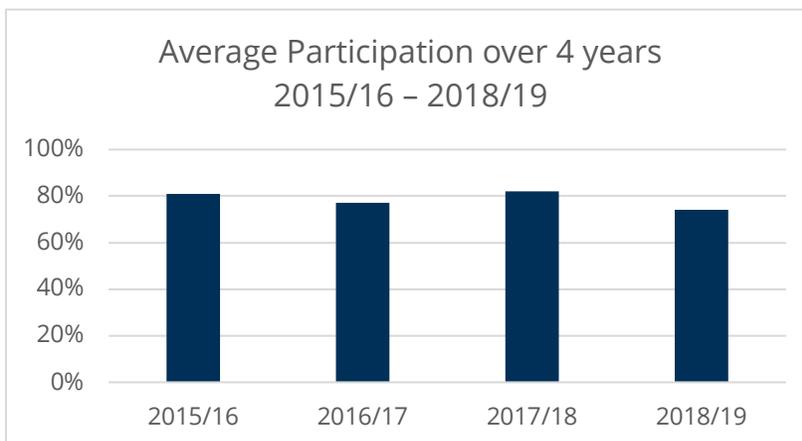
The course assigned credit and had a clear structure and an engaged teaching team who monitored, supported and discussed the weekly work set on Mastering Engineering.

## 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

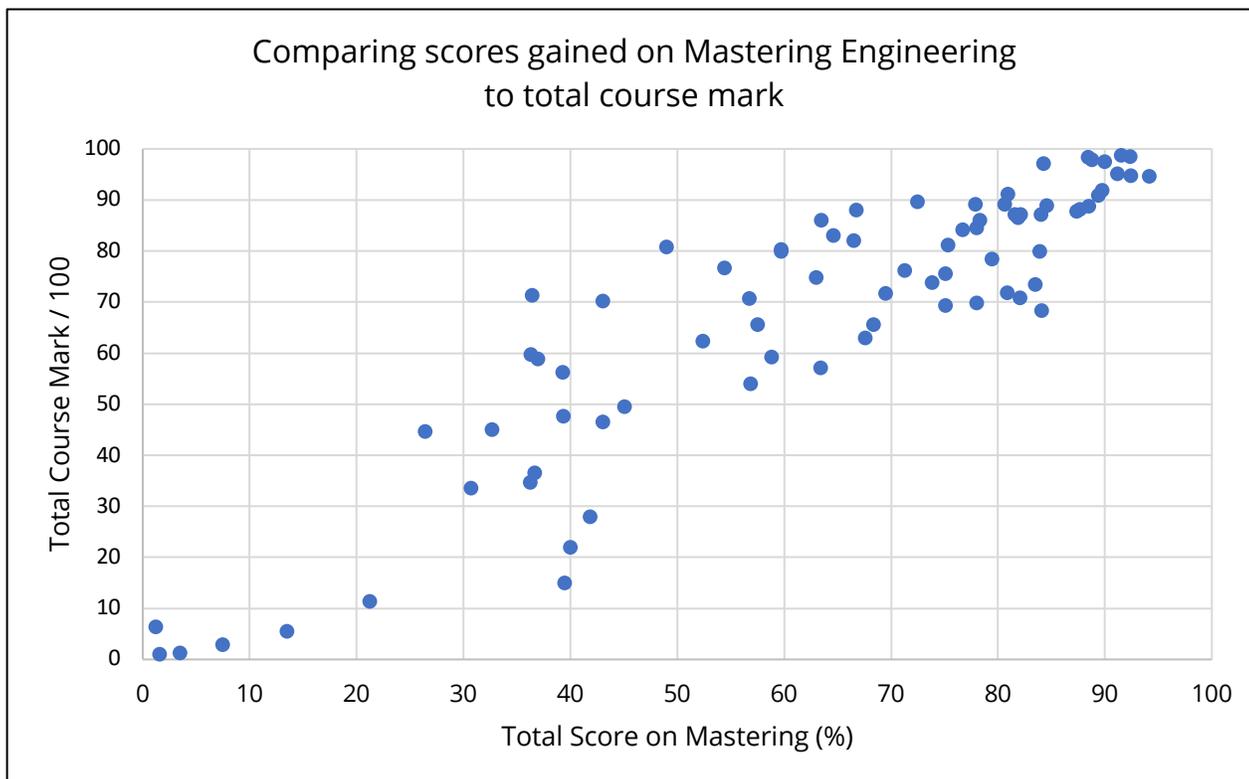
## Student performance in 2015/16

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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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.

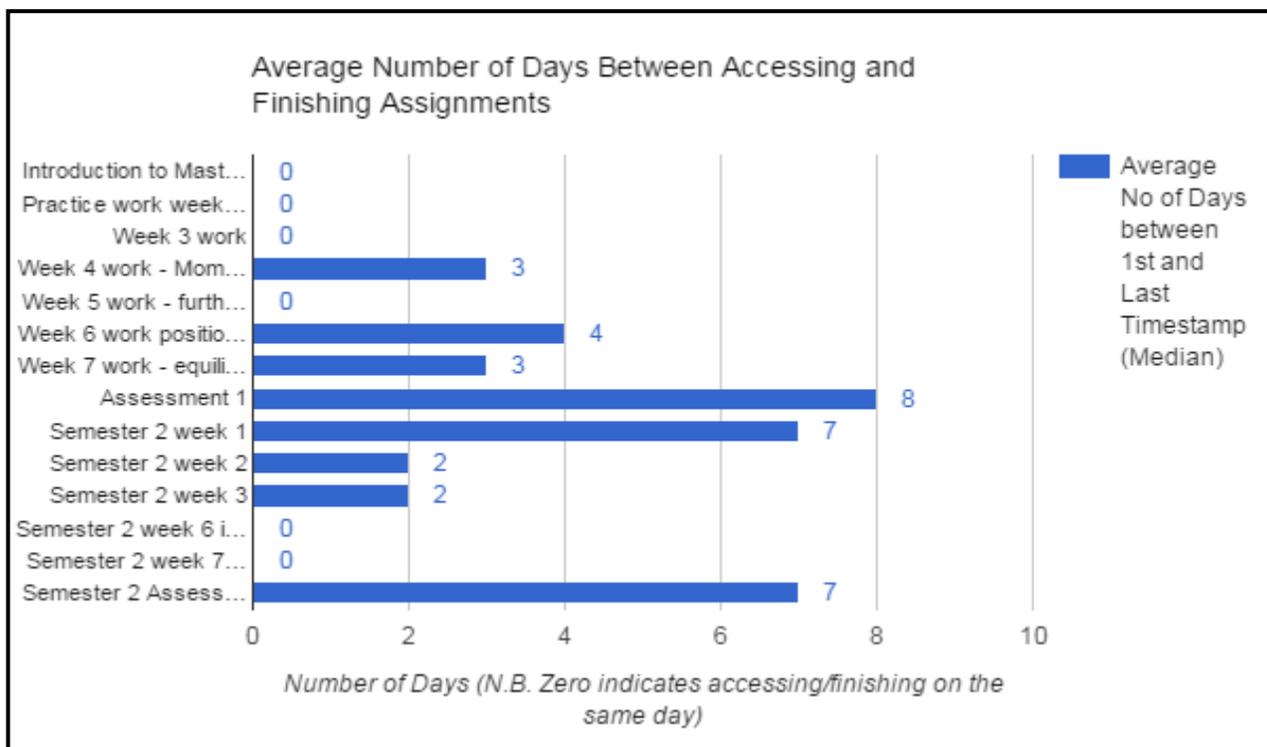
In similar studies<sup>3</sup> into MyLab resources, it has been shown that completing up to just 25% of the self-study plan impacts on overall attainment.

## 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:

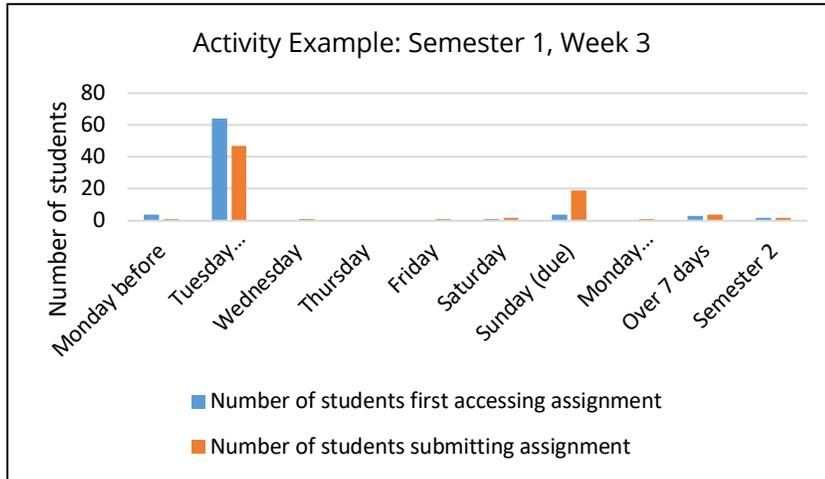
1. Students mostly first accessed their assignments on Tuesday, in the computer lab session **and then submitted them either the same day or just before the deadline on a Sunday** – (Sunday 11.59pm)
2. Assessments were typically first accessed and then submitted after one week. They chose not to work 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.

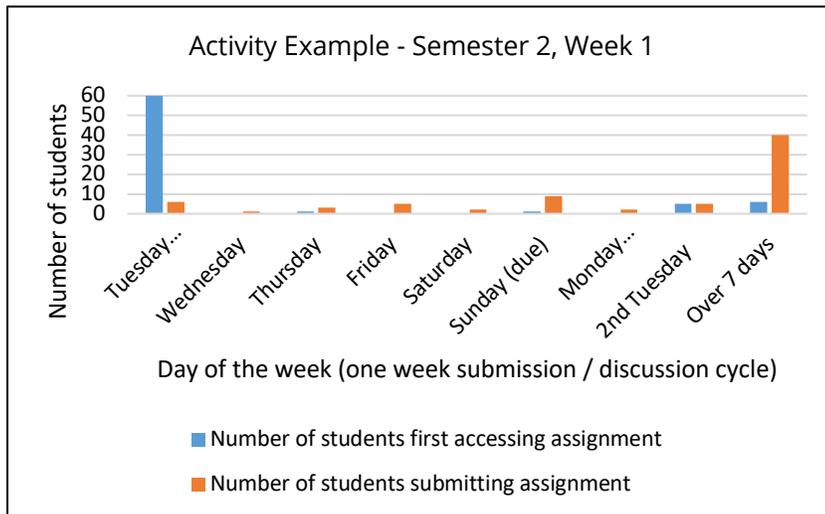
## When did students do their work?

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.



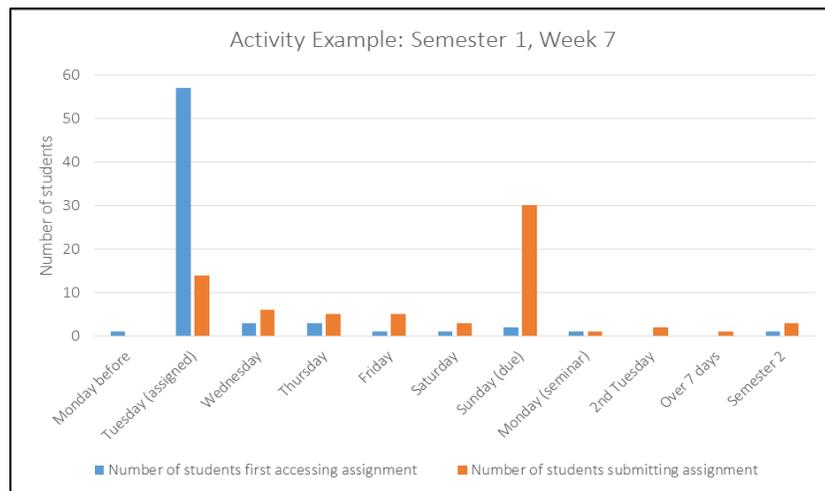
### Example 1: highest participation.

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. Although the response rate for this survey was low, there are 5 students represented in comments, their responses appear to align with comments from the class in their module feedback (also below).

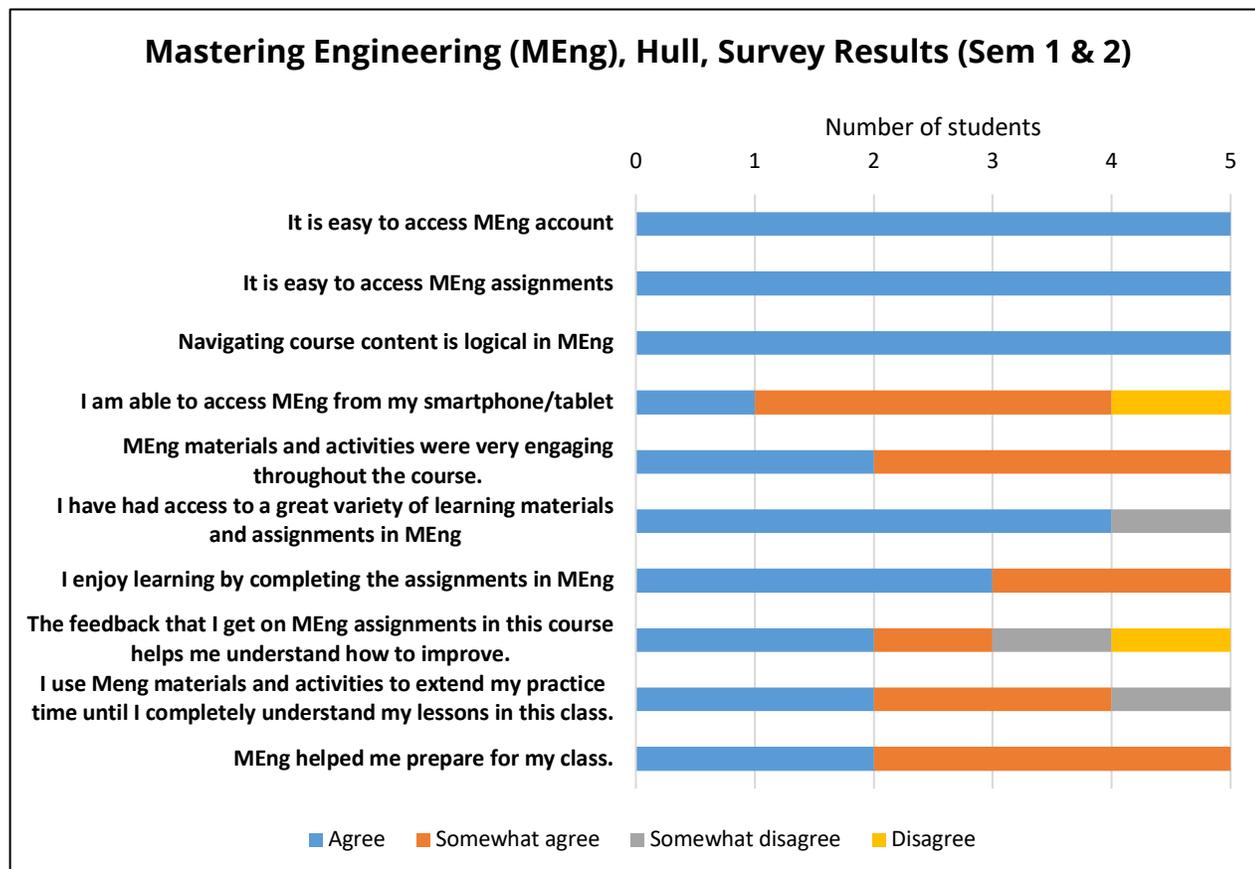
- **Engaging activities**
- **Enjoyable and varied activities**
- **Support for students so they felt prepared for class**
- **Accessible and easy use**

**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 3 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

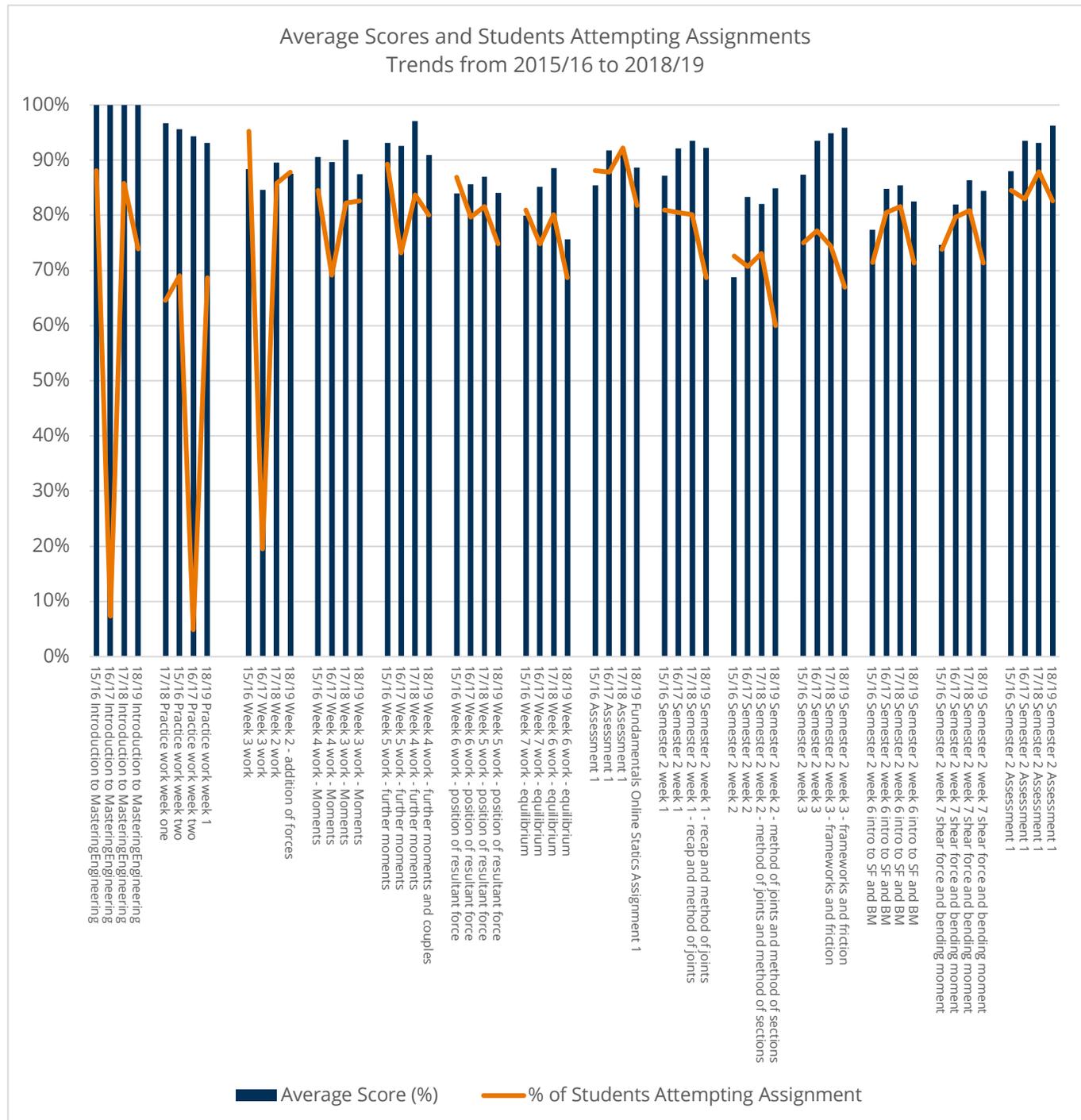
## Trends 2019/20

## 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 Engineering over 4 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%).

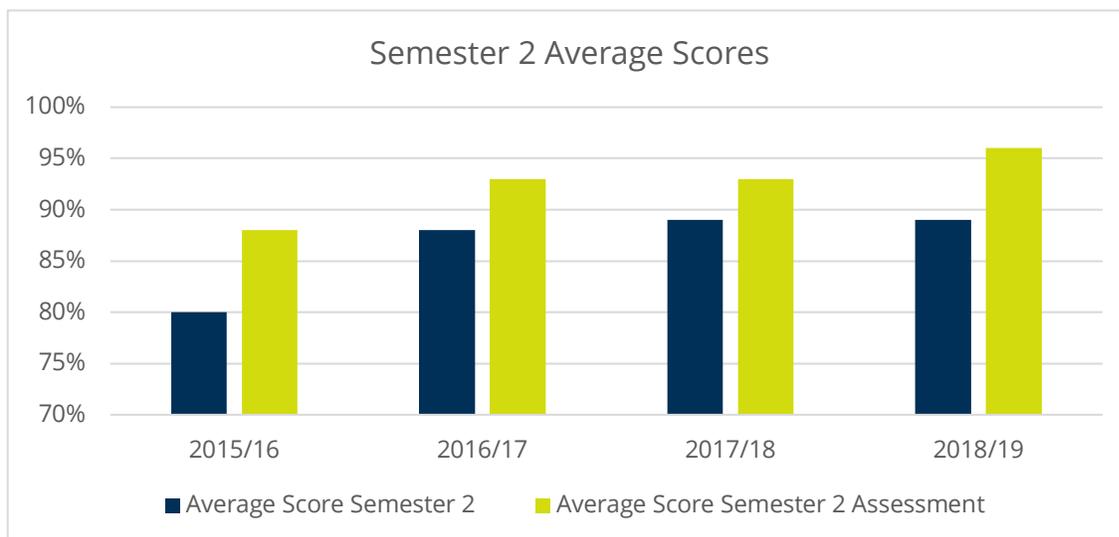
Academic Year	Annual Average (mean)	Semester 1	Semester 2
2015/16	<b>85.82%</b>	89.76%	80.56%
2016/17	<b>89.58%</b>	90.62%	88.20%
2017/18	<b>91.22%</b>	92.70%	89.24%
2018/19	<b>88.83%</b>	88.44%	89.36%

**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 4 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%.

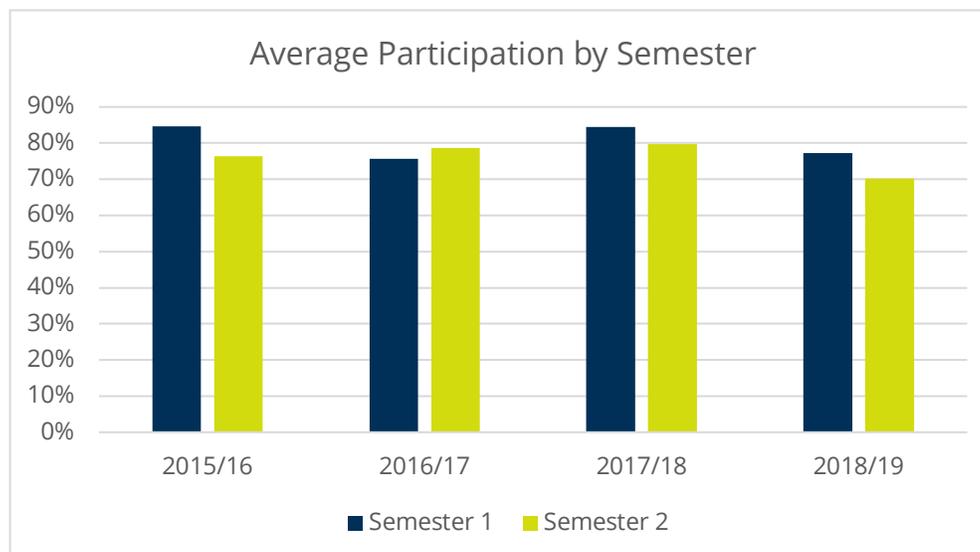
This in part reflects the annual fluctuations in attendance/engagement that have been observed by Dr Dobson on the course. It is encouraging, however, that this has not impacted on student performance (page 20). If we had taken the first three years and used those scores to predict an average score for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

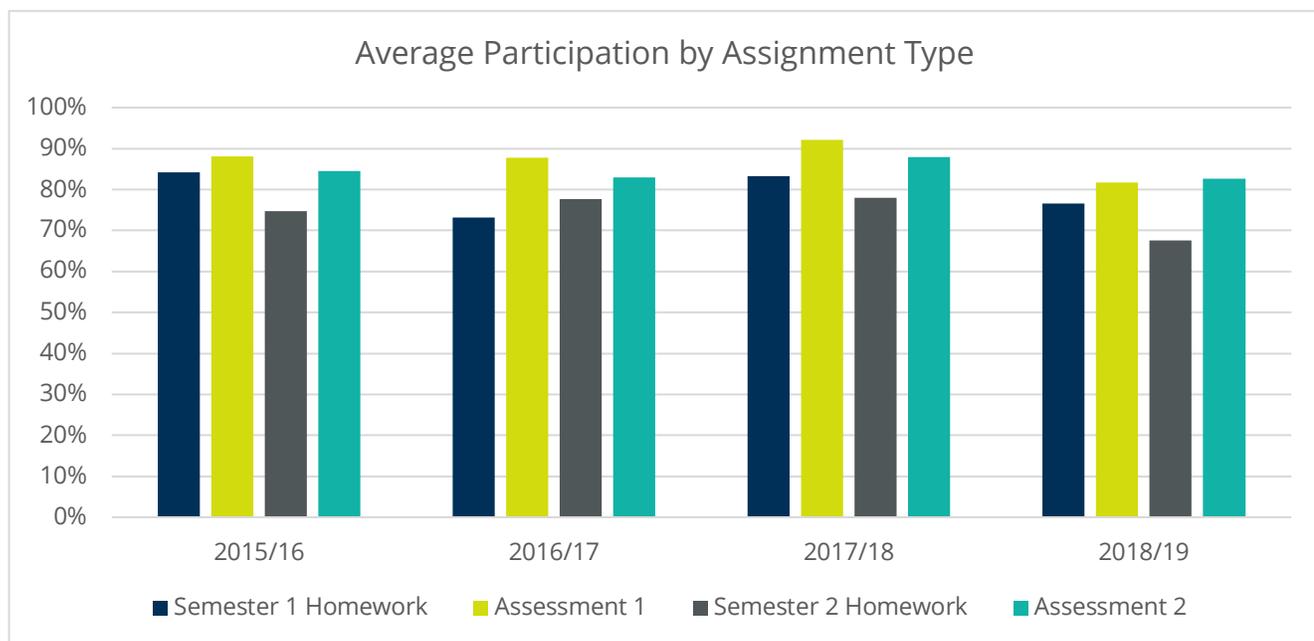
Whilst 2018/19 shows **some decline in participation by semester**, the trend across 4 years reveals a welcome consistency on average. Maintaining engagement across the year is often seen to be one of the biggest challenges, especially where good structures, integration, credit and performance checks are not in place.



- Semester 1 is consistent year on year, ranging from **75% to 84%**.
- In a number of weeks during Semester 1 over the 4 years, participation is **above 90%**.
- In Semester 2, average participation rates tend to drop, ranging from **70% to 76%**.

## 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 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 significantly and positively impacts student engagement.

## Early insight into 2019/20

Early indications for 2019/20 (see turquoise bars on the graph below) show peaks in students accessing their Mastering assignments; **participation is up** (perhaps unexpectedly given the decline in 2018/19 participation) versus the previous years.



Looking at participation this increase in credits available appears to have worked. We see that participation is back at previously observed high levels, with an **82.57%** average participation rate for 2019/20 Semester 1:

<b>Academic Year</b>	<b>Annual Average Participation Rate (mean)</b>
2015/16	81.14%
2016/17	77.10%
2017/18	82.87%
2018/19	74.22%
2019/20 Semester 1 only	82.57%

# 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
- mobilises 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

## References

**1** <https://www.pearson.com/uk/educators/higher-education-educators/success-stories/2017/06/university-hull-mastering-engineering-uk.html>

**2** Source: <https://www.thecompleteuniversityguide.co.uk/hull/performance>

**3** This study is due to publish mid 2020 and will be found under MyLab Math and MyLab Accounting at the success stories site: <https://www.pearson.com/uk/educators/higher-education-educators/success-stories.html>