'Incentivised reading'- Using an online VLE to measure engagement and attainment in student learning.

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Abstract

Virtual Learning Environments (VLEs) can be used as a resource repository but also as an environment to encourage independent student learning. Customised online assignments that can be assembled by the lecturer can be found in teaching resources such as Mastering Biology, developed by Pearson Publishers. In this study, student engagement in both summative and formative assignments was measured, and student attainment and qualitative feedback on the use of Mastering Biology was collected.

During the period 2010-2017, the online VLE Mastering Biology was used to create online summative assignments and promoted to the students as 'incentivized reading.'

The results showed high student engagement in summative online assessment (94±3.2%) but lower engagement in formative online assessment (34±10.9%) and DSM assessment (36±3.5%) across all years. Student attainment increased after the introduction of Mastering Biology, in coursework (+13.2%), exams (+12.5%) and total module scores (+10.6%). Importantly, student feedback was also very positive about the implementation of Mastering Biology.

This study suggests that students display high engagement with the summative online assessment. Lower engagement in formative assessment could be due to differences in student motivation. Lack of engagement in this assessment could be used to identify disengaged students and intervention and extra support could be given.

Keywords: Student engagement, online assessment, VLE, motivation, low-stakes assessment

INTRODUCTION

Learning technologies have developed significantly in recent years and have now come to include anything from basic IT equipment such as computers to more specific software or hardware including apps and interactive equipment (Andrade, 2012). Technology-enhanced learning (TEL) concerns the use of these technologies in education at all levels.

Blended learning is a modern approach to teaching which is understood to be a combination of face-to-face and technology-based learning, which can take place both inside and outside of the classroom (Friesen, 2012). There are different definitions of blended learning, but in this context, it refers to blending classroom instruction with directed but independent online studying. Blended learning is considered to encourage constructivist learning, as students have to become more active in their learning, rather than the passive learning they may experience during lectures at university (Biggs, 2003).

One of the elements that can be used in blended learning is a Virtual Learning Environment (VLE). This is an online system that is used in a variety of ways to support student learning, such as acting as a repository for resources but also as a place to complete learning activities and communicate with students (JISC, 2010). VLEs are now commonplace in most schools, colleges and universities and are believed to enhance student learning (Urwin, 2011). A 2016 Report by the Universities and Colleges Information Systems Association (UCISA) on Technology-enhanced Learning (TEL) states that out of 106 responding UK Institutions, 100% of them currently use a VLE. The main VLE used was Blackboard (45%) followed by Moodle (43%). The main drivers for developing the use of VLEs are to enhance the quality of learning and teaching, to meet student expectations and to improve student satisfaction (UCISA, 2016).

There are many benefits to using VLEs in education such as flexibility of access (anytime or place), addressing different learning styles, collaborative learning and improved motivation and engagement (BECTA, 2004). A survey conducted in 2013 asked 248 students to rate the value of their VLE access on their studies; did it have a positive impact on their studies, prove to be a valuable aid and improve the quality of their learning? The outcome was a statistically significant response in favor of the use of VLEs (Barker and Gossman, 2013). However, does it increase engagement? Student engagement is a challenge to measure but often quoted as an important issue in Higher Education (Trowler, 2010). Student engagement has been defined as "participation in educationally effective practices, both inside and outside the classroom, which leads to a range of measurable outcomes" (Kuh, 2007). Students in higher education should be interested enough in their subject to want to read more about it in their free time, but not all students adopt this mentality. Therefore, it is essential that we develop tools and practices to measure student engagement and ultimately improve it.

Students' motivation for learning has a great impact on their achievement and success in higher education. Activities that encourage intrinsic motivation are those that students engage with for no reward other than interest and enjoyment (Vockell, 2006). These activities should be challenging, invoke curiosity, encourage competition and be recognized as an achievement by the student. A research study looked at how students assess and value different methods of learning, from traditional lectures to cooperative (working with others) and active (independent) learning. They found that students valued assessment-related activities the highest, regardless of the method of learning. They valued exam preparation activities (co-operative learning), pre-test activities (active learning) and lectures (traditional learning) as the top three most important activities from a selection of eight. This provides further evidence that some students learn by the extrinsic motivation to pass an exam, rather than for their enjoyment (Machemer and Crawford, 2007). The authors concluded that students value anything that is perceived to improve exam performance (although their study measured student perception rather than performance), citing Huxham's contention that *"student evaluations on their own, do not provide sufficient grounds for changing teaching practice…what students want may not be what is pedagogically best"* (Huxham, 2005).

The ability to have access to a bank of interactive online assessment materials, linked to the course textbook, or customized assignments that can be assembled by the lecturer is essential for the development of a VLE; these resources can be found in teaching materials such as Mastering Biology, developed by Pearson Publishers (Pearson, 2017). Access to the online platform is provided via an access code included

in the purchase of the recommended course textbook. The VLE resource allows academic staff to create personalized online courses, containing assignments for students to complete. The resources within the VLE are written and provided by Pearson, but the assignments are assembled by the academic user, to be bespoke to the course they are teaching. The students receive a unique course code from their lecturer which links them to the required course content. The content of the assignments ranges from simple multiple choice questions (MCQ) through to more complex animations, drag and drop and interactive activities and quizzes. This can be used for formative or summative assessment.

A more recent addition to the functionality of Mastering Biology is a feature called Dynamic Study Modules (DSM). This is an app-based technology in the form of 'dynamic flashcards' that are designed to help students achieve 'mastery' on a topic. Students view MCQ-based questions on chapters from the specified textbook and answer them with a confidence rating (e.g., how confident they are in their answers). On repeat attempts of the same quiz, students will only see questions that they got wrong the first time, or were not confident on. This way, they do not waste time on topics they know, but spend more time on the topics they find harder. Whilst designed as a phone app primarily, the questions can still be accessed through a web browser interface. Both these methods of assessment have been integrated into the delivery of a module on molecular cell biology.

This study aimed to measure and monitor student engagement and attainment and to gather students' feedback on the usefulness of this VLE resource in this course. The objectives were:

1. To collect quantitative data on student engagement by analyzing grade book details on students' participation in individual assignments. This was calculated as a percentage of the cohort answering at least one question within in each assignment, in each year. Assignments were considered as either compulsory (summative), non-compulsory (formative/revision) or Dynamic Study module (DSM, also summative).
2. To collect quantitative data on student attainment by analyzing the mean student performance in Mastering Biology each year and compiling a breakdown of the average marks for the Mastering Biology component, all coursework, all exams and the overall module mark over the monitoring period.
3. To collect qualitative data on students' views and opinions about the use of Mastering Biology in the form of survey questions written by the author of this paper. There is an opportunity for the academic to edit or add to the Pearson-created questions, so the author embedded feedback questions into the last assessed assignment. This was to elicit the usefulness and popularity of Mastering Biology with each cohort of students.

METHODOLOGY

Study cohort

The VLE resource Mastering Biology (Pearson) was used in the first year and first term molecular and cellular biology module, taken by students on a range of degree courses in the School of Biological Sciences (University of Essex, UK). The assessment was introduced in 2009-10 so eight academic years' worth of data was collected during the monitoring period and the total number of students was 1709. Student

numbers on the module varied from year to year (161-249) but averaged across the monitoring period as approximately 214 students.

Assessment and weightings

The module is assessed by exam and coursework (33.3% MCQ exam, 33.3% written exam paper and 33.3% coursework equally weighted). The first official summative assessment of this module was at the beginning of term two, in the form of an MCQ exam and there was anecdotal evidence to suggest that students did not engage with the majority of the study material until the vacation just before this exam period. So online assignments that reinforced the topics covered in lectures were created and marketed to students as 'incentivized reading'- that is, after lectures, they were expected to read particular sections of the course textbook to help them complete the online assignments. As part of the package that was purchased alongside the access code, students received a hard copy textbook and online access to the electronic version of the same book. Students were advised that they should refer to the textbook and that although this was not a test, they should work alone. There was a deadline of two weeks to complete each assignment, and assignments were spread out evenly over the entire term. Assignments were designed to take approximately 1-2 hours to complete (this was based on previous activity data within the system). The number of assignments has changed over the monitoring period (ranging from between five and ten), but the content has been largely unchanged.

Summative assessment of Mastering Biology was a small part of the coursework grade for this module (10%), which equates to 3.3% of the overall module grade. In 2014-15 DSM assessment on four chapters was added, and weighted as 1% of the overall module grade. Formative assignments were also available, mostly as a revision resource during the vacation period, and just before an examination period.

Data collection and analysis

Student participation and attainment was monitored via the online grade book, and work was automatically marked and graded. At the end of the term, the data was exported from the online grade book into Excel and statistical analysis performed using GraphPad Prism 6.

RESULTS

A total of 1709 student registered for Mastering Biology access on this module during the monitoring period (eight years) and all students in every cohort had access to this resource. The summative online assessment was incorporated into the module assessment with an overall module weighting of 3.3%. DSM chapter quizzes were introduced in 2014-15 with an overall module weighting of 1%. At the beginning of this study, there were ten compulsory assignments, one per week across the term. In 2013 the number of assignments was reduced to five, one every two weeks. This was achieved by combining two assignments into one, while the content remained the same across the monitoring period. This was to reduce the number of deadlines for students.

Measuring student engagement

Student engagement in compulsory (summative) assignments

Across the monitoring period, student engagement in compulsory assignments was high, ranging from an average of 88-98% students attempting a minimum of one question on each compulsory assignment per year, with a mean of 94±3.2% engagement across all summative assignments and all years. The data shows that when assignments are made compulsory, the majority of students will attempt to complete the work (Fig. 1- dashed line).

Student engagement in optional (formative/revision) assignments

Formative assignments were provided as extra resources for revision practice during the vacation period, and just before the examination period. Students were told that these resources were optional but highly recommended as a useful practice for the exams. Student engagement in the formative assignments was significantly lower than the compulsory assignments (ANOVA, $p<0.0001$), ranging from an average of 19-51% of students attempting a formative assignment per year, with a mean of 34±10.9% engagement across all formative assignments and all years (Fig. 1- dotted line).

Student engagement in Dynamic Study Module (DSM) chapter quizzes

DSM Chapter quizzes were provided as both extra resources for revision practice and highly recommended, but with an added incentive of a maximum of 1% of the module mark available for any students that complete them. The use of DSM was not purely based on student requirement for a smartphone, as the DSM chapter quizzes were also accessible via the web browser interface. Student engagement in the DSM Chapter quizzes was also surprisingly low, ranging from an average of 32-39% of students attempting a DSM Chapter quiz per year, with a mean of 36±3.5% engagement across all DSM assignments and all years (Fig. 1- solid line).

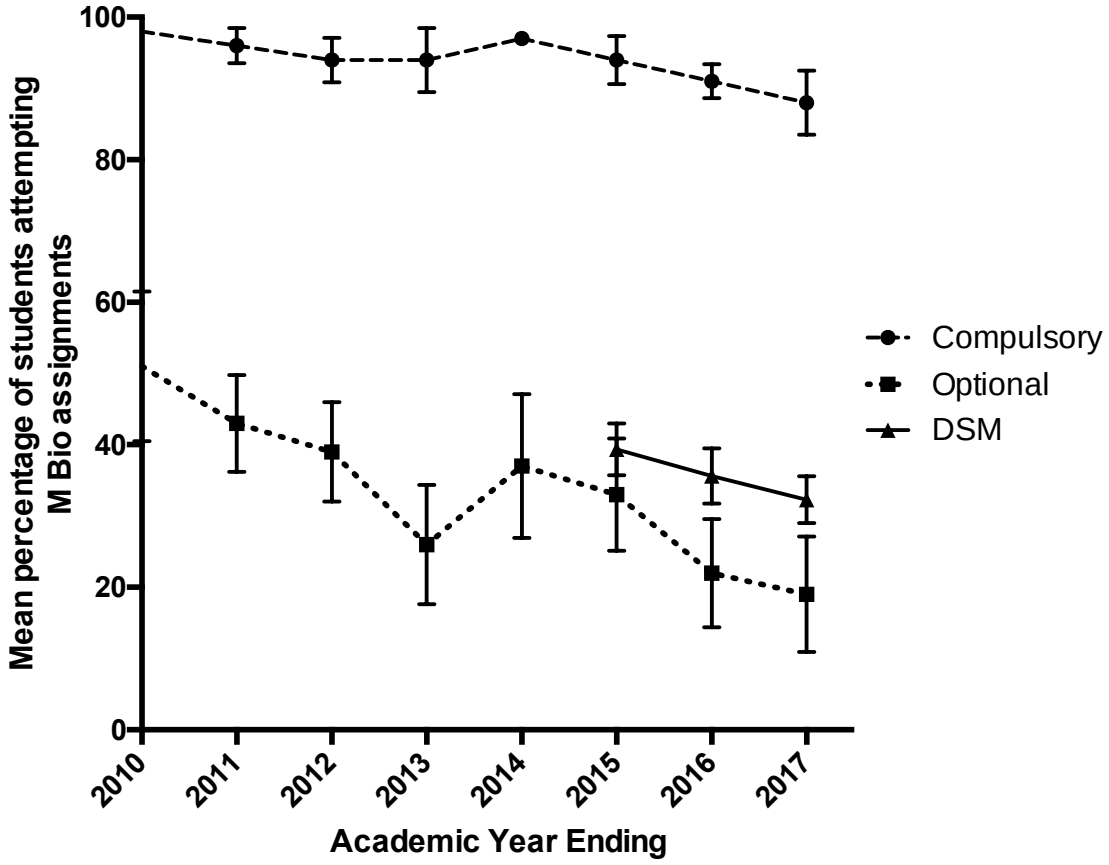

Figure 1: Mean student participation in compulsory (summative: dashed line), optional (formative: dotted line) and Dynamic Study Module (DSM summative: solid line) assignments, by year (+/- SD). Number of students attempting each assignment was counted and converted to a percentage score of total students registered on the course each year. The mean and SD values of these average participation scores for each assignment was then calculated. Compulsory assignments were weighted as 3.3% of the overall module score. DSM Chapter quizzes were introduced in 2014-15 and were weighted as 1% of the overall module score (n=1709).

Measuring student attainment

Student attainment was calculated firstly as a mean score of performance in all the compulsory assignments, by year (±SD) (Fig.2). This value was weighted as approximately 3.3% of the overall module grade (this varied slightly over the monitoring period as weightings were adjusted for other reasons). The range of mean Mastering Biology scores across all years and all assignments was 74-86% and the total average score across all assignments and all years was 80.4±4.4.% Attainment and engagement were closely linked,

e.g., the more summative assignments a student had completed, the more likely that they would have achieved a higher overall score for Mastering Biology. Student attainment in non-compulsory (formative/revision) assignments was not collected.

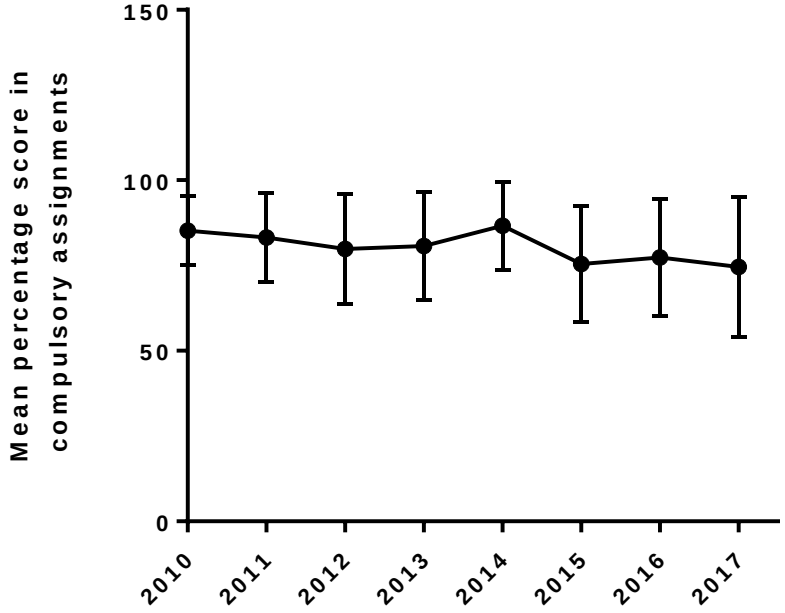

Figure 2: Mean (±1SD) student attainment in compulsory Mastering Biology assignments from 2009-2016. Number of assignments varied from five to ten in this period, but the amount and content of work stayed the same throughout.

Student attainment was also calculated as an overall module mean score by incorporating MCQ and exam scores. Mastering Biology scores were a component (10%) of coursework scores for this module. These values were plotted alongside MCQ, and written exam mean scores (each weighted as 33% of module grade), plus overall module mean scores for the monitoring period (Figure. 3).

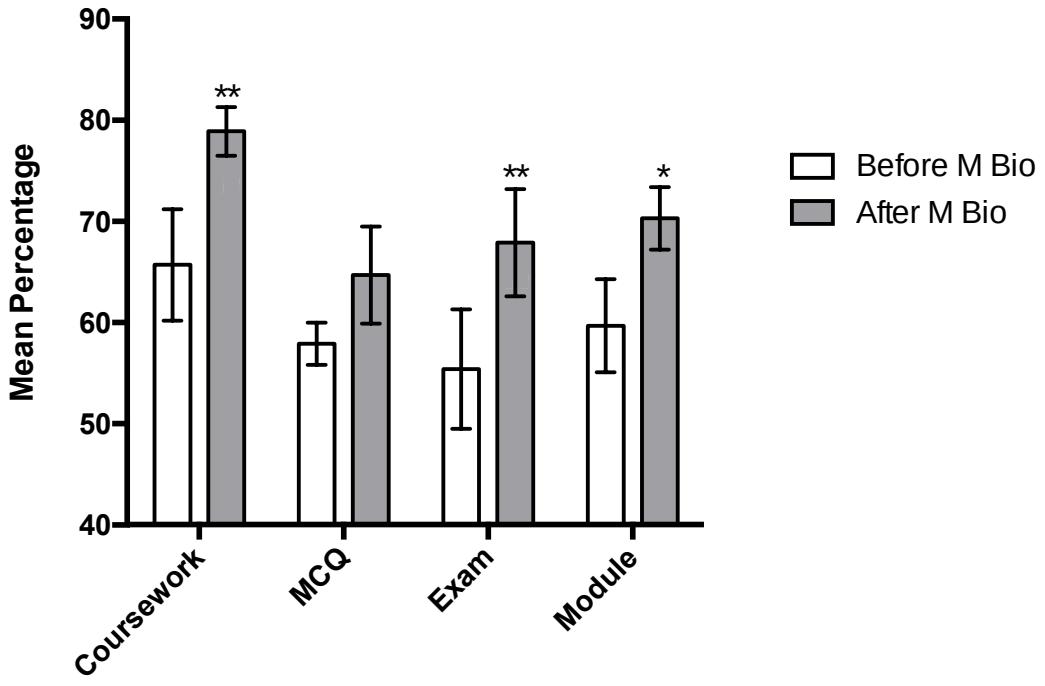

Figure 3: Comparison between mean (±1SD) coursework, MCQ exam and written exam and overall module scores from 2009-2016, before and after the introduction of Mastering Biology. Years 2008-09, before Mastering Biology (M Bio) was introduced (white). Years 2010-17, after Mastering Biology (M Bio) was introduced (grey). Coursework, MCQ and exam grades are equally weighted to give the overall module score. All data for 2016-17 is not available yet (exam mean) so this year has not been included. A 2-Way ANOVA was conducted *=$p<0.05$, **=$p<0.005$.

The coursework score significantly increased from an average of 65.7% in 2008 and 2009 to 79.1% when Mastering Biology was introduced in 2010 (2-Way ANOVA $p<0.005$). After 2010, the mean coursework mark range was fairly consistent (77-82%), with a mean of 78.9±2.4% (between 2011 and 2016). A comparison of the MCQ exam mark before and after the introduction of Mastering Biology indicates an increase from a mean score of 57.9±2.1% (from 2008-09) to 64.7±4.8% (from 2010-16), but this was found to be not significant. A comparison of the written exam mark before and after the introduction of Mastering Biology indicates an increase from a mean score of 55.4±5.9% (from 2008-09) to 67.9±5.3% (from 2010-16) ($p<0.005$). The overall module score increased from 59.7±4.6% (in 2008-09) to 70.3±3.1% (2010-16) ($p<0.05$) after the introduction of Mastering Biology. In summary, coursework, written exam and overall module mark increased significantly, following the introduction of Mastering Biology.

Student feedback on Mastering Biology

A total of ten qualitative questions were included at the end of the last compulsory assignment from 2010-11 onwards, although no marks were assigned for answering them. Since 2010-11, 1136 students have

responded to the survey. The questions were created to gather students' opinions on Mastering biology, so included topics such as; "*did you find the Mastering Biology work enjoyable*; *would you recommend it to a friend*; *would you have completed the work if it was not compulsory*; *did you think it was value for money"*; amongst others, some of which are presented and described here. In general, the average responses are fairly consistent over the years.

Over the eight-year monitoring period, Table 1 shows that nearly two-thirds of students (62.5%) replied that they have enjoyed these online assignments and found them interesting and helpful. That equates to over 1068 students. Only 2.2% of students believed they were a waste of time and didn't enjoy them, equating to approximately 37 students.

Table 1. Qualitative student feedback: Have you enjoyed completing the online assignments this way? (Mean response as a percentage ± SD, over period 2010-2017)

Yes they have been interesting and helpful	Yes but there have been some technical frustrations	Yes they have been ok, but I found them hard to answer	No, I did not enjoy them and thought they were a waste of time
62.5 ± 3.2	19.1 ± 3.6	16.7 ± 1.8	2.2 ± 1.7

Over the monitoring period, Table 2 shows that more than three-quarters of students (76.1%, 1300 students) agreed that the online assignments had helped them to learn more than just from the lectures alone. 22.0% of students agreed that the online assignments had helped them to understand the lecture material better, but they failed to learn anything further. Less than 2% (34 students) thought that they had not learned or understood anything more than from the lectures alone.

Table 2. Qualitative student feedback: Do you think you have learned more through the online assignments, than through the lectures alone? (Mean response as a percentage ± SD, over period 2010-2017)

Yes they have helped me to understand the lectures, and I have learned more this way	They have helped me to understand the lectures, but I did not learn any more new information	No, I have not learned or understood anymore then I would have from the lectures alone
76.1 ±7.2	22.0 ± 6.2	1.9 ± 1.8

Over the monitoring period, more than half of all students (57.7%, 986 students) agreed that they would probably complete some of the assignments if they were not compulsory, but not all of them (Table 3). 37.1% of students believed that the online assignments had been so helpful that they would have completed them all, even if they did not get coursework marks for them. Less than 7% (119 students) agreed that they only did this work because it was made compulsory.

Table 3. Qualitative student feedback: If the online assignments did NOT count towards coursework marks, do you think you would have completed all the assignments anyway? (Average response as a percentage ± SD, over period 2010-2017)

Maybe I would have completed a few but probably not all of them	Yes they have helped me to understand the lectures more so would probably complete them all	No, I would not have done any extra work if it did not count towards coursework grades
57.1 ±17.1	36.7 ± 15.9	6.2 ± 2.5

DISCUSSION

This study aimed to collect and analyze quantitative data on student participation in assignments (as a measure of engagement) and student attainment in the assignments, other module components and the module as a whole. Also, qualitative data were collected and analyzed to elucidate the students' perceptions of the usefulness and popularity of Mastering Biology.

Student Engagement

Student engagement in compulsory assignments is very high across all assignments and years. In comparison, engagement in optional assignments is much lower. This supports the 'Self-Determination Theory' (SDT) in which two types of motivation are defined (Ryan and Deci, 2000). Intrinsic motivation is described as *'doing something because it is inherently interesting or enjoyable'*; whereas extrinsic motivation is described as *'doing something because it leads to a separate outcome'* (in this case, module grades). While ideally, students will engage in extra independent work because of their interest in the subject, this study suggests that allocating a small percentage of marks to encourage students (hence 'incentivized reading') to participate in the independent work is required. A maximum of 3.3% of the overall module grade is allocated to the Mastering Biology online assessments, and if they complete all assignments, they can score well on this component. In this study, the Mastering Biology work was not very discriminatory regarding academic ability as students that complete assignments usually score highly in them (Fig 2), but full participation in it can indicate an engaged student. Therefore, lack of engagement in this compulsory work at an early stage could predict a disengaged student. Interventions or extra support may be of use here. An interesting finding was the low engagement in the DSM Chapter quizzes; these were also compulsory, but this suggests that 1% weighting was not enough to encourage full engagement. So-called 'low stakes assessment' refers to forms of evaluation that do not heavily impact on students' final grades, for example, these app-based 'mastery-learning' quizzes (Oswego State University of New York, 2017). There is a current shift in Higher Education regarding the balance of the assessment. It has been suggested that students are over-assessed and that less summative and more formative assessment would be more beneficial. This could enable the use of a wider and more varied range of assessment tools such as peer or self- assessment, and group work to develop a better and more enjoyable understanding of their

learning (HEA, 2012). This study suggests that summative work is still important for encouraging engagement.

Student Attainment

Fig.3 shows data on the impact of Mastering Biology on coursework, MCQ, and written exam scores. While the increase in mean coursework score following the introduction of Mastering Biology (+13.2%) can be attributed to students scoring higher on Mastering Biology than the previous coursework alone, this cannot be the reason for the increase in mean MCQ exam (+6.8%) and mean written exam (+12.5%). It is hard to attribute this to any one factor, but most other factors concerning the content and delivery of the module remained the same across this entire period (such as lecturer, learning objectives, course textbook, practicals and exams). The mean differences between coursework and written exam components of the module were shown to be highly significant, plus the differences between the overall module score were found to be significantly greater after introducing Mastering Biology. Previous research on independent learning in schools has shown that important factors include the establishment of an 'enabling environment' (Meyer et al., 2008). This may not be entirely transferable to the HE sector, but certainly, the use of information and communication technology (ICT) (and VLEs) to do this is important. This assessment method aligns with traditional models of learning, such as Kolb's experiential learning theory model, in that attending the lecture is the 'experience, ' and after this, the online assessment includes reflection, abstract conceptualization and active experimentation (Kolb, 1984). Revisiting lecture notes shortly after the lecture, followed by 'self-testing' is a well-known pedagogic practice (Brown et al., 2014) and this example, using 'low stakes' compulsory assessment slightly enforces student engagement a little more.

Another benefit to using this type of VLE for independent learning is that it can help support students that have different learning styles and preferences. Lecturing does not suit all students as some prefer learning visually (visual learners), or actively (kinesthetic learners) as well as by listening (auditory learners) (Barbe et al., 1979). The benefits of Mastering Biology is that it supports all learning styles as the assessment involves a wide range of formats, including animations, narrated videos, active 'drag and drop' style questions and reading. Students can work at their own pace and dip in and out of the assessment within the two-week window, actively using the textbook to support their learning.

Student Feedback

One of the main reasons for continuing to use Mastering Biology is due to the positive student feedback. Tables 1-3 show pooled responses from a sample of feedback questions. Many students enjoy using the resource and find it interesting and helpful (Table 1) and also believe that they have learned more than through the lectures alone (Table 2). Over half of the students acknowledge that the compulsory assessment is a driving factor for completing the assignments, and may not have completed them all if they were not assessed (Table 3). Developing independent learning skills during university is very important, but motivation can vary widely across students. Some students are intrinsically motivated, seeking out information and setting their own goals, whereas extrinsically motivated students will engage with learning because it is a means to an end, and the incentive is marks, prizes or avoiding failure (Harlen and Deakin

Crick, 2002). Regardless of the driving force for completing the assessment, student feedback each year has been very positive. Not shown here, but annual University module feedback surveys also reveal high student satisfaction with this element of the module, with regular free text feedback comments such as "*loved Mastering Biology", "… was brilliant", "…intellectually stimulating", "…very useful for revision", "…helped me understand topics more".*

CONCLUSION

In conclusion, there are growing calls for reducing summative assessment in HE and increasing formative assessment, but there is still room for both. This study shows that 'low stakes' summative assessment can be used to engage students as long as the weighting of the assessment is significant enough. Providing access to online support tools such as Mastering Biology can help students to understand the lecture material better and may even improve their understanding, and for those students intrinsically motivated, the additional resources can be much appreciated.

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