

# Evaluation of a Laboratory VLE from the Student Perspective

*Have new interactive online resources and auto-grading impacted the student learning experience?*

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## 1. Abstract

In May 2017, the School of Chemistry at the University of Glasgow, in collaboration with Learning Science Ltd., began a project to design a blended learning experience. This virtual learning environment allows students to explore interactive technical simulations online, before in-lab practical work begins. It also introduces post-lab auto-graded reports using students' own data. Combined, these dynamic virtual lab resources promote learning through practice, and provide instant and personalised feedback for each student.

This initiative attempts to address student feedback regarding traditional word-processed lab reports, assessment and feedback. Assessment was considered by students to be inconsistent, lacking detail, and was too slow. Through our dynamic online reports we aim to improve the consistency and timeliness of feedback delivered to students, and hence improve the learning experience.

Led by three Final Year chemistry project students (Jack Bullon, Jason Eriksen, and Catherine McKenna), we have evaluated the impact the new VLE has had on the student learning experience. We have focused on gathering feedback from students who have been supported with these online resources, and those who have not (for comparison). The implementation of these online resources in Chemistry at Glasgow has increased engagement of students with the practical course, improved student confidence in the lab, and greatly enhanced student perceptions of assessment and feedback, and of the learning opportunities provided during the synthesis labs.

We hope this successful project can act as a case study, to help demystify design and implementation of effective electronic resources, and ultimately to encourage uptake across disciplines.

## 2. Introduction

As lab coordinator for the Organic 3 Lab in the School of Chemistry, last year I introduced pre-lab films to illustrate difficult practical techniques before experiments began. These were very well received, with nearly all students using the resources. However, many students from last year's cohort (2016/2017) also reported feeling that assessment of lab reports was slow, lacked sufficient feedback, and was very inconsistent. Last year (and historically) marking of reports was completed by post-graduate demonstrators, and the demonstrators were not provided with specific training on delivering effective feedback to students. In an attempt to address these student concerns from last year, I worked in collaboration with Learning Science Ltd. to deliver online pre-lab simulations of techniques, and additionally, to create online, auto-graded lab reports. These resources were developed for both for the Organic 3 Lab (approx. 100 students) and the Synthesis 1 Lab (approx. 600 students). These new resources were also designed to align directly with the University of Glasgow's E-learning Strategy 2013-2020, which states that the "learning experience will be enhanced by physical and virtual infrastructure of the highest quality and excellent learning resources that are targeted to address our diverse learning community's needs and to provide them with flexibility in what, how, when and where they learn".<sup>1</sup>

This year (2017/2018), each of the lab experiments was accompanied by an interactive online report, in which students received real-time feedback on their actual data, their errors, and how these may have occurred. Students then had the chance to rectify errors and arrive at the correct answer, losing some (but not all) of the available marks. The reports were then submitted online (through Moodle) and auto-graded, removing the possibility of inconsistent marking, and allowing students to build on feedback immediately, rather than waiting more than a week to receive feedback on their work (as was the case previously).

We were now interested in whether these online post-lab reports, and the new pre-lab simulations would improve student experience in the Organic 3 (and Synthesis 1) Lab, specifically compared to last year, when reports were word-processed and marked later by demonstrators. In the traditional assessment process, students received their grade and (minimal) feedback a week after completing the report, and evidence suggests that this is too late to be particularly useful to learning.<sup>2</sup> There has also been work published to demonstrate the successful introduction of online technology into HE Chemistry lab assessment, leading to deeper learning and enjoyment for students.<sup>3</sup> Considering this, our main research questions were: does instant feedback and the chance to address errors during the new online report improve student confidence? Does auto-grading convince students that marking is fair? Does the attractive, intuitive interface of the online reports improve student enjoyment of the

assessment process? Do students feel that they are learning and improving effectively through this new VLE?

There is precedent to demonstrate the positive impact of online pre- and post-lab resources on the learning of chemistry students in UK HE. The recent study by Shallcross *et al.* demonstrates that these materials help build student confidence, deepen learning, support safety awareness, and prepare students for practical techniques.<sup>4</sup> However, online write-ups and auto-grading (of the kind we have implemented in Glasgow) have not previously been published within a Scottish chemistry HE context. This gives the project an aspect of novelty, with the results providing a case study for the University of Glasgow, and more widely within Scotland and the UK. However, this level of novelty also produced challenges to implementation and has meant that careful consideration of methods to investigate impact, ethical issues, and dissemination of findings was essential.

### **3. Implementation and Practical Challenges**

I received the support of the School of Chemistry to implement the project and report findings, which was crucial in acquiring funding for development of the online assessment platform with Learning Science Ltd. However, I did face challenges in forming a successful collaboration between academia and industry. Initially, some staff within the school were unsure of the merits of online auto-graded lab reports, and of the potential benefits to students and staff. Learning from examples of good practice in industrial-academic partnerships,<sup>5</sup> I consulted with academic staff to explain the purpose of the project, what it could deliver, and how that might impact on them, as well as on students. I then invited a representative from Learning Science Ltd. (Dr. Iain Thistlethwaite) to talk to staff about the company, and to demonstrate some resources they had previously developed for other UK HE institutions.

Another challenge was to deliver the online resources in the timescale, ensuring they worked effectively and aligned with the intended learning outcomes for the course. However, although the project did require a great deal of initial work to implement, the online resources have, in the long-term, reduced hours spent marking in the lab. This has allowed staff to concentrate on facilitating learning of practical techniques, which are at the heart of organic chemistry experimentation.<sup>6</sup>

In terms of investigating the impact of the new online resources on the student learning experience, this work has been student-led by three Final Year project students (Jack Bullon, Jason Eriksen, and Catherine McKenna) with supervision by myself and Dr. Linnea Soler. Jack, Jason, and Catherine developed multiple strategies to investigate the impact of the new

VLE, with a primary focus on gathering anonymous feedback from last year's cohort of students (who experienced the traditional lab assessment) and from the new cohort (who were assessed using the online auto-graded method).

#### **4. Assessing Impact – Research Methodology**

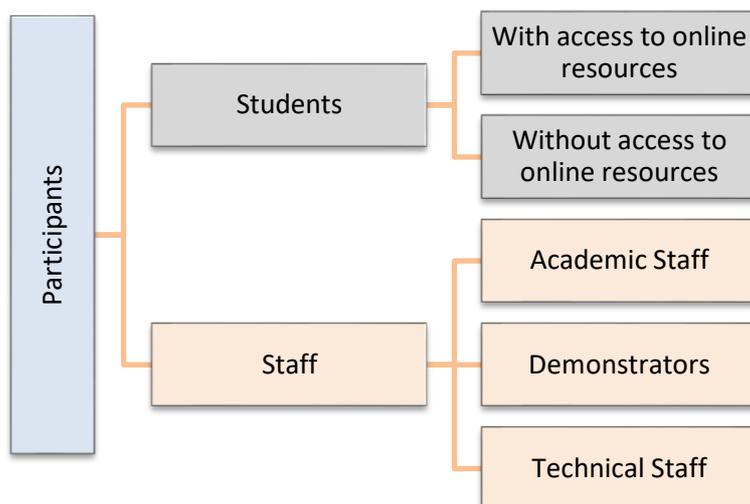
The aim of the research was to investigate the impact of introducing the VLE on the student learning experience within the Synthesis 1 and Organic 3 chemistry labs. The process of gathering data was mainly in the form of anonymous surveys and focus groups (qualitative and quantitative). Ethical approval was granted for all the research that was carried out.

Following guidelines from the Equality Challenge Unit, research was conducted in an equal and diverse way.<sup>7</sup> To ensure that the research that was carried out adhered to ethical principles, the surveys and focus group coordinator ensured prevention of data fabrication and encouraged an environment of trust and mutual respect between researchers and participants. This trust and mutual respect encourages the participant to be honest and open, which in turn results in more reliable data.

In the anonymous surveys, the Likert Scale, ranging from “Strongly Disagree” to “Strongly Agree” was used in the surveys as a framework for answering questions.<sup>8</sup>

##### **4.1 Participants**

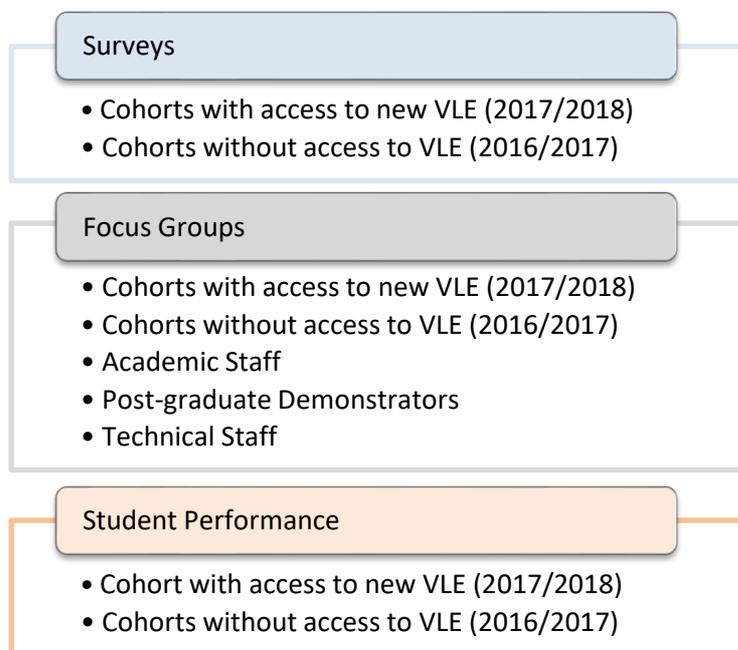
Because the focus of the study was the student learning experience, it was important to include feedback from students with access to the new online resources (2017/18 cohort) and students without access to these resources (2016/17 cohort). In addition, to gain a more holistic understanding of impact, lab staff (academic staff, post-graduate demonstrators, and technical staff) were also invited to participate in the study. The staff were asked about their perceptions how the introduction of the online resources may have influenced student confidence and practical abilities. **Figure 1** summarises the range of participants involved in the study.



**Figure 1** – Participants involved in the study to assess the impact of the new online VLE

#### 4.2 Primary Data Collection

Primary data, from first-hand experiences, were collected for this research. **Figure 2** shows an outline of the various primary data sets collected. In addition to investigating the student learning experience, student performance from each cohort was also analysed (for both the Synthesis 1 and the Organic 3 labs). Student performance was compared between cohorts supported by the new VLE, and those without access to the online support materials.



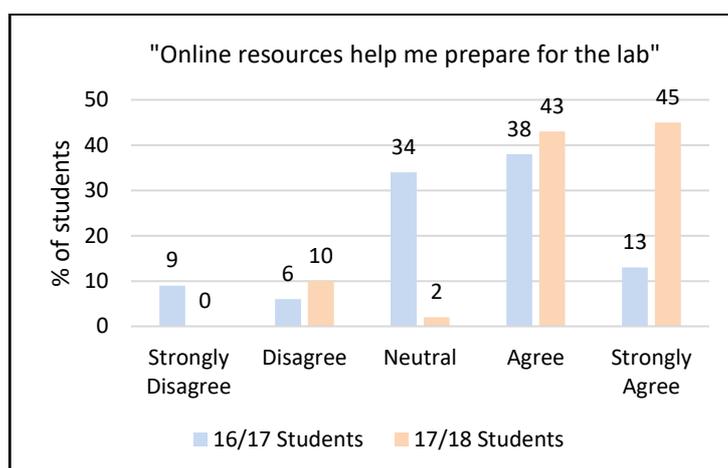
**Figure 2** – Primary data sets collected in the study

## 5. Key Results

In this section some of the key findings from the study are presented and discussed for the Organic 3 Lab. Similar trends have also been observed for the Synthesis 1 Lab. Student response rates for the Organic 3 Lab anonymous surveys were 62% for the 2016/17 cohort (no access to the new VLE support) and 59% for the 2017/18 (access to the VLE resources).

### 5.1 Pre-Lab Resources

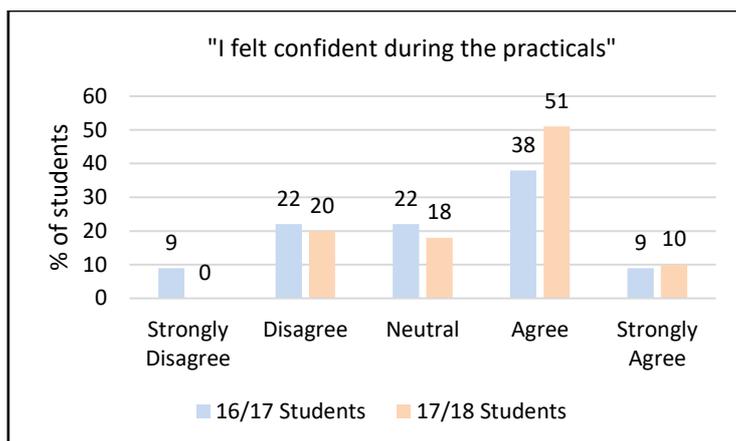
Survey questions relating to the pre-lab resources provided in the Organic 3 Lab covered several areas of interest; student preparation, practical confidence, engagement, and student experience. **Figures 3-6** demonstrate the changes in student perceptions around these topics, from 2016/17 to 2017/18, when the new VLE was introduced with interactive pre-lab simulations in addition to technical videos. These data are also supported by qualitative responses extracted from focus group data analysis.



**Figure 3** – Responses on lab preparation from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the pre-lab resources for the Organic 3 Lab

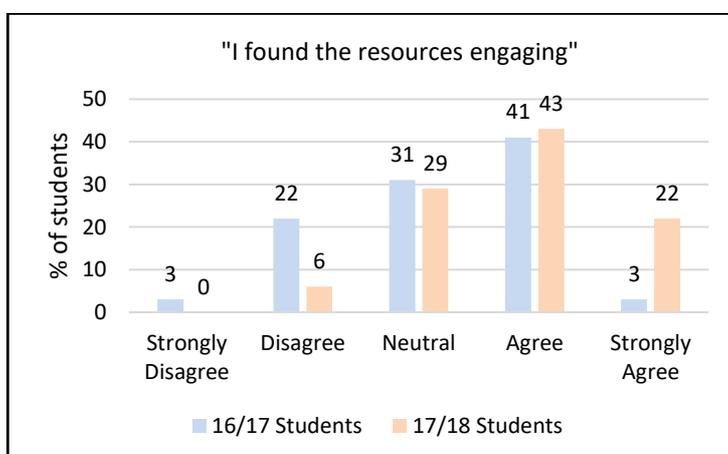
**Figure 3** demonstrates that students who accessed the pre-lab simulations (2017/18) felt they were provided with more practice than those with access to technical videos alone (2016/17) and that the new interactive online resources helped students feel more prepared for the lab (88% in 2017/18 compared to 51% in 2016/17).

These findings are supported by qualitative responses (both student and staff) from the focus groups. One student from the 2017/18 cohort commented that, “where there are new techniques, the simulations can really help prepare”, while post-graduate demonstrators reported that “students know how to set-up equipment better this year (2017/18) compared to last year (2016/17) and are better at identifying equipment”.



**Figure 4** – Responses on practical confidence from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the pre-lab resources for the Organic 3 Lab

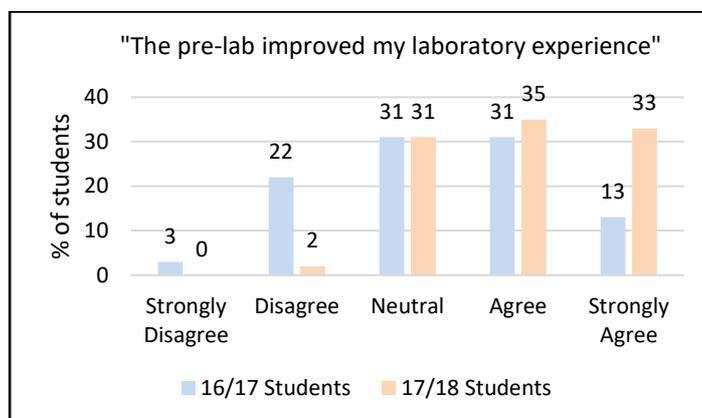
**Figure 4** highlights that the majority of students (61%) who accessed the pre-lab simulations (2017/18) felt confident in the lab, while a minority of those with access to technical videos alone (2016/17) felt confident (47%). In the focus groups technical staff also commented that they “see more confident students this year (2017/18)”. However, 20% of students from the 2017/18 cohort still did not feel confident in the lab, highlighting an area where further development is possible and future improvements could be made.



**Figure 5** – Responses on engagement from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the pre-lab resources for the Organic 3 Lab

**Figure 5** illustrates that a quarter of students (25%) with access to pre-lab videos alone (2016/17) did not find these resources engaging, while only 3% of this cohort found the videos highly engaging. This is in contrast to the student cohort with access to the interactive simulations (2017/18), for which only 6% of students did not feel engaged with the resources, while 22% reported that the simulations were highly engaging. One 2017/18 student commented that, “they [pre-lab simulations] pass information in a very concise and interactive

way, it's not just a block of text to read, I like them" again indicating that the simulations facilitate fuller student engagement than videos alone.

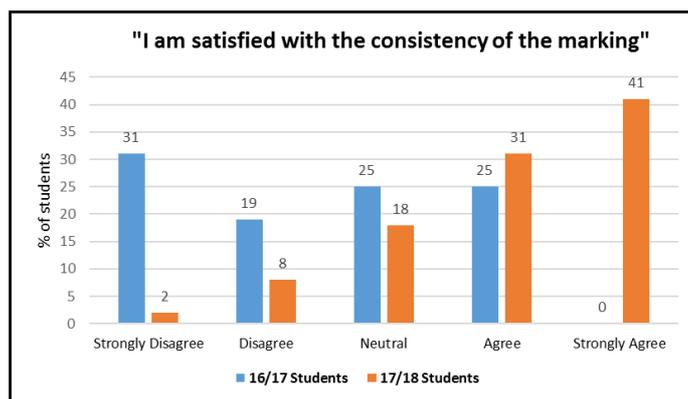


**Figure 6** – Responses on lab experience from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the pre-lab resources for the Organic 3 Lab

**Figure 6** shows that a quarter of students (25%) with access to pre-lab videos alone (2016/17) did not feel that the resources improved their lab experience, while 44% of this cohort found the videos improved their experience. This is in contrast to the student cohort with access to interactive simulations (2017/18), for which only 2% of students did not feel that the resources improved their experience, while the majority (68%) reported that the simulations did improve how they experienced the lab.

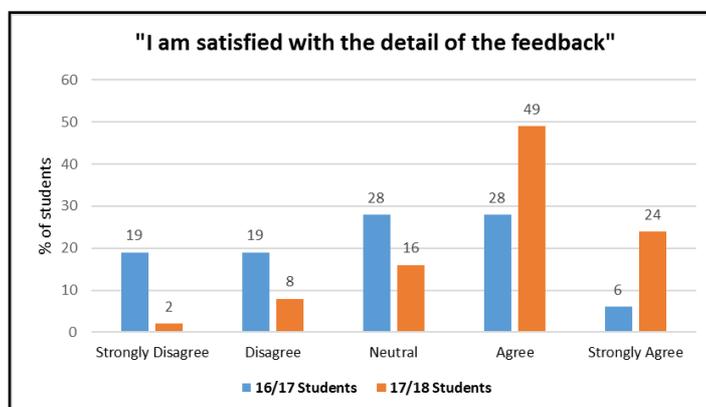
## 5.2 Post-Lab Reports

As for pre-lab resources, post-lab survey and focus group questions were designed to assess changes in student perceptions from the 2016/17 cohort (using traditional word-processed report writing and demonstrator marking) to the 2017/18 cohort (supported by the new online auto-graded reports and immediate feedback). Questions were constructed to explore how students felt about marking consistency, feedback content and timeliness. **Figures 7-9** demonstrate the changes in student perceptions around these key topics.



**Figure 7** – Responses on marking consistency from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the Organic 3 Lab

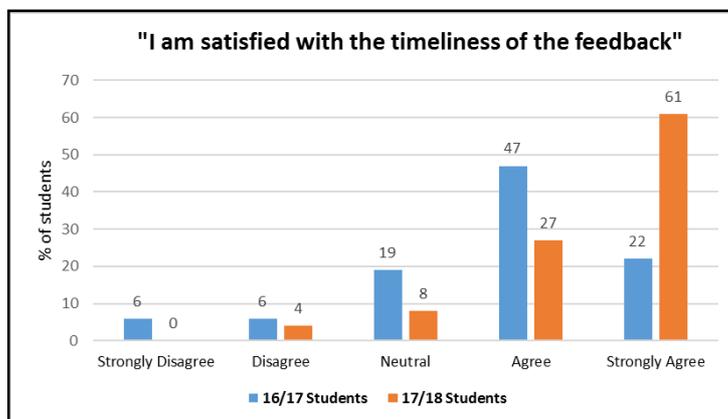
**Figure 7** demonstrates that only a quarter of students (25%) using the traditional post-lab report (2016/17) were satisfied with the consistency of marking, while 50% were not satisfied. This is in contrast to the student cohort using the auto-graded online reports (2017/18), for which the majority (72%) were satisfied with marking consistency and only 10% were dissatisfied. This is a clear improvement in student perceptions of marking consistency in parallel with the introduction of the online reporting and marking process. Again these data were supported by focus group comments, with one student from the 2016/17 cohort reporting that for the traditional reports, demonstrator marks were “inconsistent and unclear”.



**Figure 8** – Responses on feedback content from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the Organic 3 Lab

**Figure 8** illustrates that more students were dissatisfied with the level of detail provided by feedback (38%) than were satisfied (34%) in the cohort using traditional post-lab reports (2016/17). In contrast, significantly more students were satisfied with the detail of feedback associated with the auto-graded online reports (83%), than were dissatisfied (10%). This is a marked improvement in student perceptions of quality of feedback on introduction of the auto-graded online reports. These data were supported by focus group comments, with one student

from the 2016/17 cohort reporting that for the traditional reports, “there wasn’t enough feedback”.

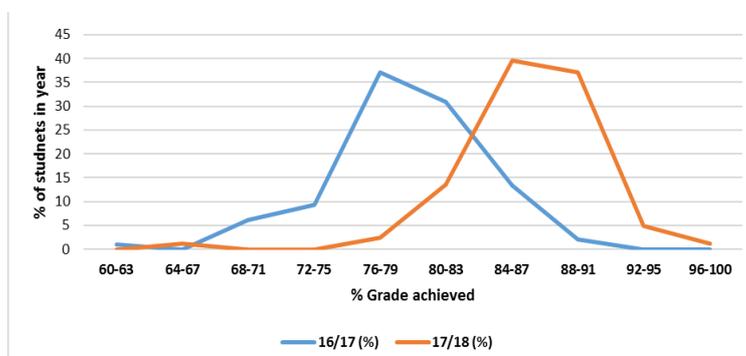


**Figure 9** – Responses on feedback timeliness from the 2016/17 cohort (blue) and the 2017/18 cohort (orange) after completing the Organic 3 Lab

**Figure 9** shows that while 69% of students in the 2016/17 cohort were satisfied with the timeliness of feedback (received one week after report submission) this value increased to 98% satisfaction for the 2017/18 cohort (received immediate feedback). These data were supported by focus group comments, with one student from the 2017/18 cohort suggesting that, “feedback is more relevant straight away”, while another felt that, “if you get it [feedback] a week later you have other priorities”.

### 5.3 Student Grades

Student grades for the Organic 3 Lab were compared for the 2016/17 cohort (using traditional report assessment) and the 2017/18 cohort (using online auto-graded reports with immediate feedback). The results of this analysis are shown in **Figure 10** below.



**Figure 10** – Organic 3 Lab grades for the 2016/17 cohort (blue) and the 2017/18 cohort (orange)

**Figure 10** shows that the median grade achieved for the 2017/18 cohort (86%) is higher than that achieved for the 2016/17 cohort (79%), while the range of marks has remained consistent between the two years. This suggests that the introduction of the pre-lab simulations and online auto-graded reports has led to an improvement in the overall summative attainment for the Organic 3 Lab.

## **6. Conclusion and Future Work**

Analysis of the data collected during this study has clearly demonstrated that introduction of interactive pre-lab simulations (in addition to technical videos alone) has positively impacted the student learning experience, increasing engagement with pre-lab resources, improving understanding of experiments, and increasing confidence and competence in the lab.

Similarly our work has shown that introduction of online post-lab reports with immediate marking and feedback has markedly improved student perceptions of the assessment and feedback process, particularly marking consistency and feedback quality. This has been achieved by providing students opportunities to address errors immediately, and build confidence in their performance week by week.

These improvements in the student learning experience in 2017/18 compared to 2016/17 have been accompanied by an increase in the overall summative attainment for the Organic 3 Lab. However, there is room for further development and improvement of the VLE, and we are currently incorporating more theory and safety-focused material based on student feedback. Students also stated that other university disciplines would benefit from implementation of these e-learning resources. In fact, the findings of this impact study are currently being used to support the development of similar resources in other lab courses within Chemistry, and potentially across other disciplines within the University of Glasgow.

## 7. References

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