Using Mobius for automated assessment

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Abstract

A trial of Mobius was performed in a revision class for the module MTH2011: linear algebra. Students were given a revision class to introduce them to this software. Information on the level of student interaction with Mobius before and after this class is provided, along with an analysis of a survey of students that students completed during the class. We also investigate how the introduction of Mobius impacted student performance in the final exam for the module.

1 Introduction

Mobius is a cloud-based software that can automatically mark student work in mathematics. Mobius integrates with MAPLE - a computational algebra package - and uses this package to mark student work. Consequently, it is possible with Mobius to write an infinite bank of practice questions for students as Mobius, unlike a CANVAS quiz, "understands" mathematics.

We received £5000 from Faculty at the end of 2022 to trial Mobius in two mathematics and one physics module. We intend to replace the assignments that students would hand in and then have them marked by PhD students with Mobius quizzes in these modules in academic year 2023/4. However, before the start of the new academic year, we first wanted to run a mini-trial of the software with students in academic year 2022/3. We thus developed Mobius questions for the module MTH2011 and ran revision classes to introduce students to the software on the 21st and 25th of April, 2023. A feedback survey was performed at the end of these revision classes to compare student attitudes to Mobius and the weekly problem sheets we intend to replace in 2023/4. Forty eight students completed the survey.

2 Results

2.1 Level of Engagement

Mobius is a cloud-based platform. It provides detailed analytics that tell you when students engage with the platform. Figure 1 gives a timeline that indicates how students engaged with the platform in the lead up to the exam. Over the period indicated in figure 1 88 active users

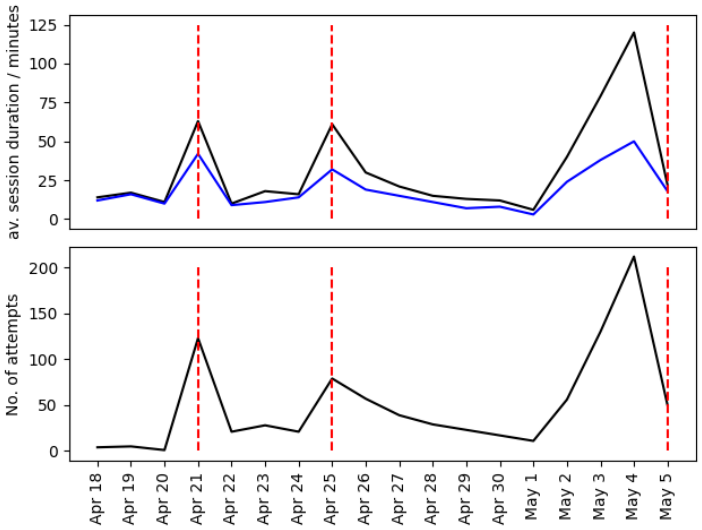

Fig. 1. Student enagagement with Mobius in the period before their exam on the 5th May. The black line in the top panel shows the average length of the student's sessions as a function of date. The black line is calculated by taking the total length of all sessions in a day divided by the total number of sessions on that day. The total number of sessions that students started each day is shown in the bottom panel. To calculate the numbers indicated by the blue line the average length of each users Mobius sessions on the given day was computed. The overall average was then calculated by taking these averages and dividing by the number of distinct users. Red dashed lines indicate the dates of the two revision classes Apr 21st and 25th and the exam (May 5th).

completed 474 assignments. This corresponds to an average of 5.39 assignments per student. The average length it took for a student to complete an assignment was 57 minutes. We can thus conclude that these students spent an average of five hours and ten minutes using Mobius in the lead up to their exam.

Figure 1 also shows when students were most active on Mobius. You can clearly see that there were three peaks in student activity. The first two peaks correspond to the days on which there were revision classes. The final peak then occurs on the day before the exam. These results indicate that using a platform such as Mobius in a purely online setting is likely to be unsuccessful. Students still need traditional, in-person classes to encourage them to dedicate time to using the software.

Further evidence of the utility of Mobius' analytics is provided by figure 2. Each point in this figure corresponds to one of the 20 questions in the assignment that students were set. The x-coordinate of the point indicates the number of correct attempts at that question, while the y-coordinate indicates the number of incorrect attempts. This figure suggests that, if there had been the opportunity for a follow-up revision class, the focus of that class should have been the questions that appear in the top left corner of this plane. It is easy to determine, which questions these are from the Mobius analytics platform.

Figure 3 shows how students performed in the four question in the module's exam. The topics covered in the four exam questions were the same as the topics in the the four Mobius

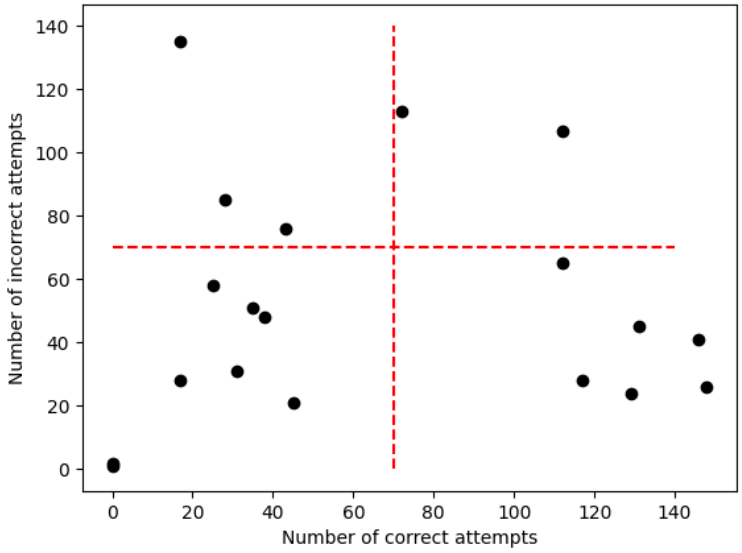

Fig. 2. Scatter plot showing the number correct and incorrect attempts for each of the 20 revision questions that were set to students. Such data can be used when providing feedback on topics that need to be revised.

revision assignments that students were set. However, there was no correlation between the marks students obtained on a particular exam question and the time spent on, number of attempts or average grade for the corresponding Mobius assignments. It is thus unclear whether using the analytics offered in figure 2 is a sensible course. Lecturers still need to use their best judgement when designing classroom activities.

The blue histograms in figure 3 show the distributions of student marks in 2022 when Mobius was not available to students, while the brown histograms show the distributions of marks in 2023 when it was available. In 2023 the average marks for questions 1 and 3 were almost identical to what they were in 2022. The average marks for questions 2 and 4 were 3.5 and 2.6 marks higher in 2023 than in 2022. The right panels of figure 3 indicate that the marks for questions 2 and 4 increased because of a substantial decrease in the proportion of students who scored less than 10 for these questions. Furthermore, the left panels of figure 3 show that there were similar decreases in the proportions of students scoring very poorly on questions 1 and 3. The reason the average mark for these questions did not change was because fewer students scored above 20 for these questions in 2023 than did in 2022. In other words, it would seem that the 2023 intake contains fewer very able students than the 2022 cohort or that the marker was less generous with the highest marks.

When marking the papers we felt that students were better at problems that involved applying a procedure in 2023 than they were in 2022. It seems likely, therefore, that the reduction in the number of students getting less than 10 marks for a particular question that we observed in figure 3 was driven by improvements in the student's ability to tackle the procedural problems from questions 2 and 4 of the exam. We had hoped that introducing

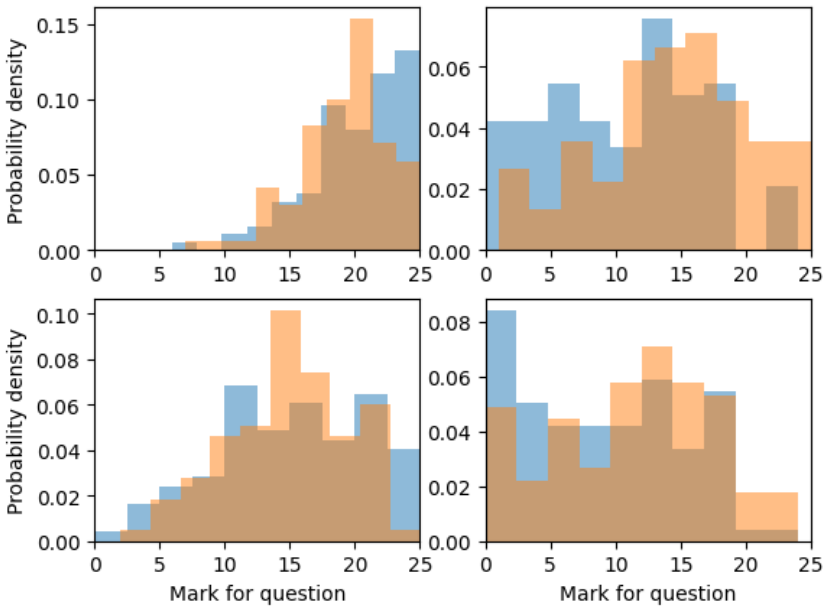

Fig. 3. Histograms of student marks on the four questions in the exam paper. In all four panels the blue curve shows the histogram for the 2022 paper, while the brown curve is the histogram for the 2023 paper. Histograms of marks for questions 1, 2 3 and 4 are shown in the top left, top right, bottom left and bottom right panels of the figure respectively.

Mobius would help students in learning to tackle exactly this type of problem. The exam results would thus suggest that Mobius is helping the less able students in exactly the way we imagined and hoped it would.

2.2 Student voice

Figure 4 shows a breakdown of the answers students provided to the quantitative parts of the survey that they were given. There was universal agreement from students that Mobius was useful. All students noted that they would use the software when revising. Furthermore, only one student objected to this software being introduced earlier in the course, and even they wrote in the comments that it would have been "somewhat useful last term" but "only for revising."

Figure 4 shows that almost all the students in the revision class handed in their assignments last semester. Furthermore, although there was some appetite for replacing the paper assignments with Mobius quizzes, most students would prefer to maintain the assignments that were handed in.

It is interesting to look at students' written comments about the feedback they received on assignments and Mobius. To analyse these comments, we categorised them as either positive, neutral or negative (this breakdown of the raw comments is available on request). Figure 5 shows that student comments on Mobius were universally positive. Furthermore, many students could list specific things they liked about the Mobius quizzes, e.g., immediate feedback, infinite question banks and hints. Meanwhile, comments on the feedback for homework were mixed.

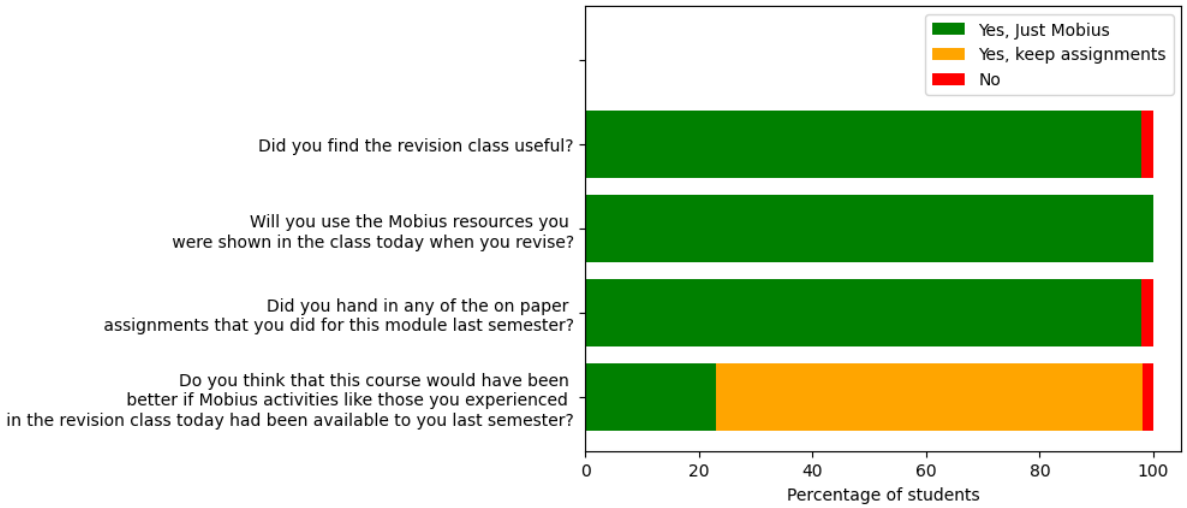

Fig. 4. Student answers to questions multiple choice questions. The survey questions are given on the left of the figure. The first three questions were yes/no questions. Students were given the option to answer "Yes, Mobius is better than handing in assignments", "Yes, but handing in assignments is still useful", and "No" to the final question.

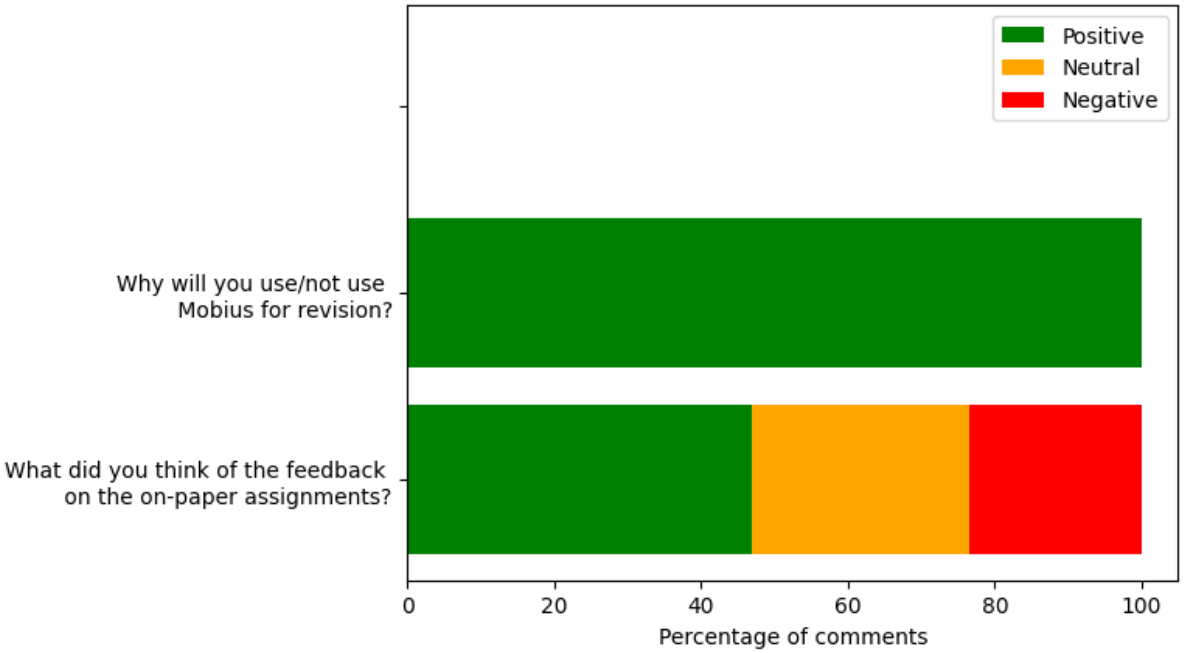

Fig. 5. Analysis of student answers to questions with descriptive answers. The questions that were asked are shown on the left of the figure. We categorised student answers as positive, negative or neutral by having one person read through all answers.

Many students, who wished to use Mobius and homework assignments in parallel, negatively commented on the feedback they received from the markers. At variance with the positive feedback on Mobius, students were also not particularly specific when discussing what was good about the feedback on the written assignments they had received. They often observed that the feedback had been "helpful" or "constructive" without elaborating.

Interestingly, students wrote that releasing model answers to questions is beneficial. In fact, some students seemed to be assuming that the provision of these model answers was what we meant when we talked about providing feedback. For these students the fact that PhD students were paid to mark their work was immaterial.

Students similarly observed that the weekly assignments were helpful as they reviewed the work they had done for the assignments when revising. These comments suggest that students are concerned that if they were to use Mobius for assignments, they would have no written solutions to problems to revise from. Lecturers using Mobius thus need to think about how to ensure that students have written solutions that they can revise when it comes to exam time. It is perhaps worth having students hand in a log book that describes the problems they have solved from Mobius during the semester and awarding a mark based on the quality of the argument in the log book.

One comment also points to a need to clarify further the role played by the lecturer. The student wrote, "Mobius is good if you can figure out where you went wrong, but if you don't have traditional feedback, you have no idea what the problem is." Careful thought is required to ensure that those students who have "no idea" ask for help from the lecturer. Students must understand that they will only ever get the type of help that helps them when they have "no idea" when they ask for it. It usually is very difficult for lecturers or student markers to make head or tail of the derivations that students who are completely stuck hand in for assessment. A good way to ensure that these students get the help and feedback they need is to get them to engage with Mobius in a classroom setting.

3 Conclusions

The initial introduction of Mobius in a revision class setting was a resounding success. Students engaged heavily with the platform in the build-up to the exam for the module and were near-universally positive about introducing this software in the module next year. We also found indirect evidence that the introduction of Mobius had helped them perform better in the final exam.

Students were considerably less enthusiastic about the current system of handing their work in and having it marked by a PhD student. However, there are several things that we have identified as important for making the remainder of this pilot project a success:

1. Students supervision when using Mobius is essential. Students engage most with Mobius when there is a reason for them to engage (i.e. when there is a class where it employed

or in the lead up to an exam). Our results suggest that it is unlikely that students will use this "AI tuition" to replace traditional teaching. An approach that that uses traditional, in-person teaching to provide students with the motivation for using these non-traditional tools is thus essential.

2. Students still find worked solutions to example problems useful.

3. Students need to be encouraged to keep a written record of the work that they have done during the semester. This record can perhaps be kept by asking students to submit a log book.

4. Lecturers must communicate to students that they can and should ask for help solving problems set through Mobius.

We finish by noting that this pilot was only possible because Mobius gave us a 20% discount on the cost of 200 licenses and an additional 100 licenses for free.