

Delivery of Integral Calculus at Maseno University: Is STACK Really Playing an Integral Part?

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Abstract—Integral Calculus II is a second-year undergraduate course offered by the Department of Pure and Applied Mathematics at Maseno University. It is one of the 20 foundational courses with a high enrolment of about 800 students drawn from the school of Mathematics, Education, Science, and Business. Because of the large number of enrollments in these foundational courses, and the small number of teaching staff, instructors face challenges in providing immediate personalized feedback that can guide learning. Systems for Teaching and Assessment which use Computer Algebra Kernel, STACK, a computer-aided assessment plug-in that provides a sophisticated assessment in mathematics-related disciplines, was used to deploy Continuous Assessment Tests (CAT) in the course for 370 students. This paper reports on the findings of the course based on a comparison between student test scores in STACK and in the final course exam.

Keywords—STACK, online assessment, learning with STACK, using technology in formative assessment

1 Introduction

Systems for Teaching and Assessment using Computer Algebra Kernel (STACK), is a computer-aided assessment plug-in for the Moodle Learner Management System that provides a high-order e-assessment in mathematics-related subjects. It is widely used in the deployment of formative and summative assessment tests in a number of contexts around the world [1]–[4].

The School of Mathematics, Statistics, and Actuarial Science (SMSAS) at Maseno University enrolls more than 500 students to its six undergraduate programs each year. The school also offers foundational mathematics courses to students from other schools within Maseno University. As a result, having more than 800 students in these courses is very common. The SMSAS has a small staff of 19 full-time lecturers and 6 part-time lecturers to supplement teaching. Each lecturer is responsible for teaching and assessment of their courses, and without extra support in the form of teaching assistants. It is thus challenging to conduct a formative assessment in courses with large enrollments and give feedback in a timely manner. It is even more difficult to give personalized feedback to help students in the learning process. This in turn impacts

negatively on students' learning of mathematics especially when computational skills are a concern.

Since 2019, the SMSAS has developed and used STACK in the continuous assessment of its students in various courses. This was made possible with the support of IDEMS international, a not-for-profit organization with great interest in innovation and education of mathematical sciences in developing countries, through the training of lecturers in developing STACK resources.

From November 2021 to January 2022, STACK was used in the teaching and formative assessment of MMA 215, Integral Calculus, an undergraduate mathematics course that had an enrollment of 370 students. For 10 weeks, students were given two weekly quizzes, Mastery and Test quizzes. Mastery Quizzes were available the entire semester specifically for practice purposes while, Test Quiz (a randomized version of the Mastery) was only available within 7 days of opening. Students had to score a 75% passing grade on the Mastery Quiz for the Test Quiz to open. The teaching of the course was done face to face during the 14-week long semester. Online resources to supplement teaching and learning were provided through the Maseno University Moodle Learner Management System. Assignments and Continuous Assessment Tests were done online using STACK quizzes which were authored with the support of IDEMS International. The methodology, results, discussion and conclusion are presented in the subsequent sections.

2 Methodology

Each week, students were required to attempt two quizzes: Mastery quizzes and Test quizzes. Questions for these quizzes were authored using STACK by Maseno University lecturers with the support of IDEMS International. By design, Mastery quizzes were intended to help students practice and master the content taught that week. Once opened, mastery quizzes remained open till the end of the semester and had unlimited number of attempts with the highest grade being recorded. Students would get feedback to the quizzes immediately after completing each attempt and were encouraged to use the feedback to make another attempt. The randomization feature of STACK questions ensured that each attempt was sufficiently different with similar concepts being stressed upon.

Test quizzes were designed to test students' understanding of the concepts covered in that week, and students' confidence in solving problems on the content. These quizzes contained similar questions or different randomized versions of some questions from the mastery quizzes of the same week. They were available at the start of each week and closed at the end of the week with a restriction of only one attempt. To access test quizzes, students needed to have scored at least 75% on the mastery quizzes to demonstrate that they had sufficiently mastered the content. Feedback to the Test quizzes was given after the quizzes were closed. On average, each weekly quiz had 5 different problems. One week before the final exam, students were given a practice quiz which was a summary of questions from weekly quizzes and covering important aspects of the course. The practice quiz did not contribute to the final score of the course.

Scores to the weekly quizzes contributed to 30% of the final score in the form of Continuous Assessment Tests (CATs). Mastery quizzes and Test quizzes contributed

equally toward the CATs score. The final exam contributed 70% of the final score and was done on paper. Since mastery quizzes were kept open till the end of the semester, and the highest score on each quiz was recorded, the hope was that students would use them to prepare for the final exam.

3 Results and discussions

To pass the course, students needed to have a minimum of 40% in the cumulative score for the course. In Figure 1, the diagonal red line highlights the passing grade for the course. In the scatter plot, students above the “red line” passed the course while students below the red line failed the course. From the analysis, it is evident that students who did well on the main exam also performed well on the weekly quizzes.

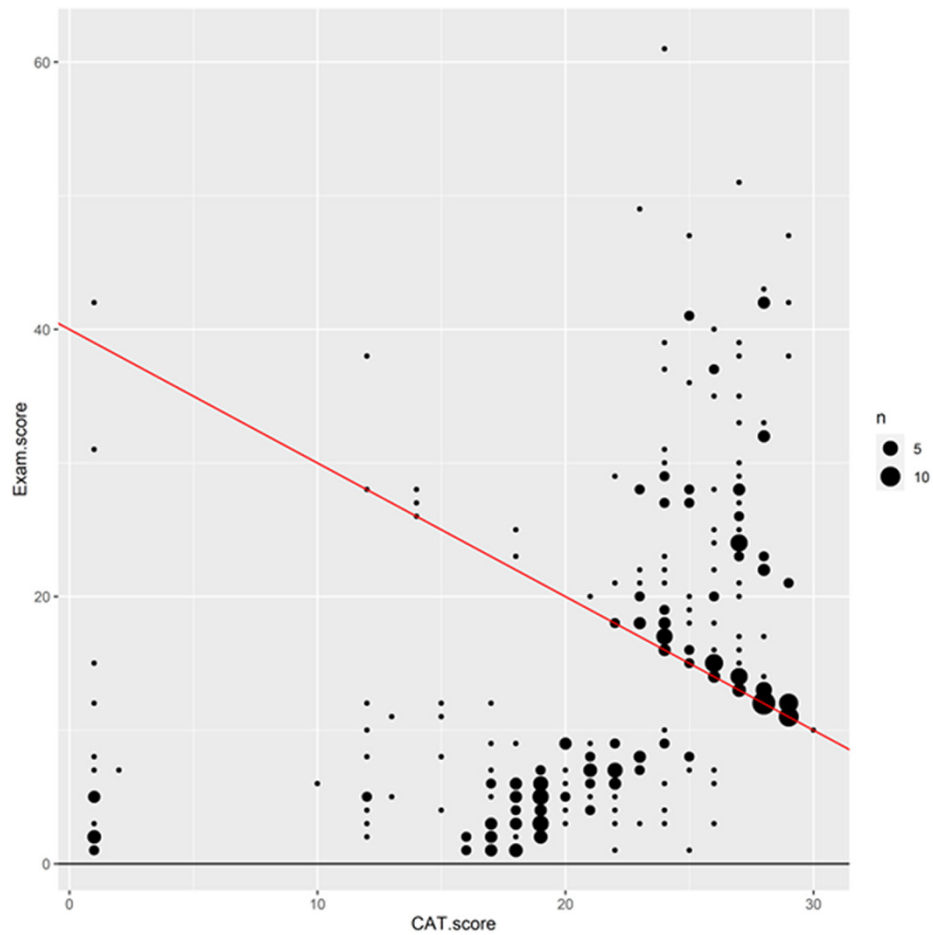


Fig. 1. Graph showing student performance in the exam against performance in weekly STACK quizzes

It is also evident that a large percentage of students performed well on the quizzes but still failed the course. This would imply that the weekly quizzes did not help them prepare for the main exam, or there might have been “cheating” on the weekly quizzes. An analysis of the final exam revealed a disconnect between the weekly quizzes and the final exam questions. Most questions on the final exam required students to apply techniques of integration learned in class to solve problems based on “real-life” situations. Application-type questions were however lacking in the weekly quizzes, and this might have contributed to the failing of the exams for students in this category.

Some students who were slightly below the course passing grade were bumped up to reach the passing grade. This was done at the discretion of the course lecturer. This explains the gap between the course passing grade and the clutter just above the cut-off line. An interesting outlier is the few students with a score of less than 5% on the CAT score and above 20% on the exam. Our hypothesis is that these students had a challenge completing the weekly quizzes but did a good job preparing for the final exam.

Access to devices remains a challenge to most students from poor backgrounds at Maseno. Additionally, access to the university Wi-fi spots is also a challenge to most students, which compels them to purchase internet from local service providers, in order to access the online STACK assignments. We believe that these factors could have also played a role in influencing the outcome of the study, to some extent though.

4 Conclusion

Based on our findings for this course, there was a significant disparity between the final exam score and scores from the weekly STACK quizzes which was the CAT for the course. Since students use the weekly quizzes for revision and to prepare for the final exam, we recommend that the final exam be consistent with the continuous assessment. This was the first time STACK quizzes were used in the teaching and formative assessment of Integral Calculus at Maseno. It is important and necessary to broaden the scope of STACK questions for the course to include application-type questions, to test a higher degree of understanding on the part of the students.

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