Annual Departmental Assessment Report

Department or Program: Mathematics
Academic Year of Report: 2020/21
Department Contact Person for Assessment: Jonathan Brundan

Section 1: Learning Objectives Assessed for this Report

Due to the exceptional nature of the year with on-line teaching only, we have not made any serious attempt to assess our on-line offerings. We have focussed instead on broader issues including the use of computers in undergraduate courses, and opportunities for student writing in the form of extended essays/projects in our major.

Section 2: Assessment Activities

In the winter term, a faculty survey was circulated. The aims were two-fold.

The first goal was to gather more information about how computer-based mathematical software (Python, Sage, Mathematica, Maple, MatLab, R, …) is used throughout the math major. Currently, this is something that has developed in a haphazard way, with different professors using different software (if any), and we would like to have some more systematic coordination of it in the parts of the math major curriculum where it is relevant. This issue seems increasingly pressing with the introduction of the new data science major.

The second part of the faculty survey was a general open-ended question to find out about specific areas of faculty concern regarding our math major classes and curriculum.

Section 3: Actions Taken Based on Assessment Analysis

Following the survey, a meeting of the Undergraduate Affairs Committee was held in Spring term, which was well attended by many faculty and some undergraduates. The meeting was a general discussion focussing on the use of computers throughout the math major, and also on the possibility of incorporating more writing through end-of-term papers or other assignments into upper division classes, perhaps in lieu of more traditional final examinations.

Part of this discussion was concerned with the use of the LaTeX software, used widely by mathematicians for typesetting mathematics. LaTeX is already being introduced to our undergraduate students starting in several of our math labs, and it is also used in some CS classes too. There are slightly mixed reactions from faculty as to whether this is really a necessary thing for our students to learn, and it is certainly not necessary when incorporating mathematical writing into our teaching, but it does seem a useful tool which is already being used successfully with students in a range of classes.

Undergraduates in the meeting reported favorably on their experiences with math labs, especially as a first place to experience using LaTeX and Python, i.e., those computer-based skills which we want to develop throughout our curriculum.

Recommendation 1: The department should focus on using just Python/Sage/R and other packages based around Python in classes that involve some computer-based aspect (such as Math 351, Math 397, Math 457, Math 458). We believe this is the most widely used software currently, both in math and in related applied subjects (e.g., machine learning). We currently

have a 200 level math lab which gives students some initial experience in using Python, and CIS 122 (which involves Python coding too) is one of the requirements for the math major.

Recommendation 2: Faculty should consider alternative forms of assessment such as end-of-term papers in upper division classes, especially in multi-term sequences or other courses which are not such essential pre-requisites for future classes. The main goal moving forward is to give students more experience of writing mathematics as part of the math major. Software for writing mathematics such as LaTeX is recommended, and we hope students will continue to experience this for the first time in math labs. It would be helpful for the department to create a "Beginner's Guide to LaTeX" document which could be used by students across a range of classes. In addition we are going to seek to introduce the idea of a "Proof Portfolio" in our bridge requirement classes, starting with Math 231 and perhaps Math 307. This should consist of a small but interesting and varied selection of proofs which students should write carefully using LaTeX, going through some drafts and revisions graded by the course instructor.

Recommendation 3: An issue with math labs was raised in the meeting: math labs are intended for freshmen and sophomores and become a problem when juniors and seniors ready for much more advanced material are taking them in order to meet their graduation requirements. To address this, we should change these courses so that enrollment in math labs is limited to freshman and sophomores.

Section 4: Other Efforts to Improve the Student Educational Experience

The focus of this report has been specifically issues that affect upper division classes in the mathematics major. Our department also teaches a large number of lower-level service courses at the 100/200 level; we include 251/252/253 (Calculus) in this category. These are courses which are critically important to the university as a whole, and the department is making ongoing efforts to address issues such as student retention and equity gaps in these courses. In the past two years we have switched to an OER (Open Educational Resource) textbook for Calculus, and this year we implemented stage 1 of a multi-year initiative to develop materials for flipped-classroom versions of our calculus classes and also provide enhanced training to the GE teachers involved in these courses. Stage 1 was an initial pilot that pulled the majority of Winter 251 classes under the umbrella of one lead instructor who recorded video lectures and was responsible for curriculum design, with the students meeting in discussion sections twice each week for flipped-classroom learning experiences. This pilot was very successful, and we intend to follow up with an in-person version of this next Fall.

Section 5: Plans for Next Year

One issue raised several times during the survey was some concern about Math 307, which has a significant amount of flexibility built into its syllabus. The role of Math 231 vs. Math 307 in our curriculum will be considered further next year. Both classes count for our "bridge requirement." With the introduction of math labs into our major, the original goal of Math 307 (for students to experience discovering proofs for themselves) has perhaps been diluted. Math 231 currently has a more formal curriculum and may be serving our students better in learning mathematical language. It was also noted that Masters' degrees for teaching often require discrete mathematics for admission, and students on that pathway are not so well served by taking Math 307 as a result. Since Math 231 is a major service course for CIS, any changes should be discussed with them too.

We should implement the "Proof Portfolio" idea in the Math 231 curriculum and perhaps Math 307, and put together a "Beginner's Guide" to LaTeX which can be distributed to students. We

should also look at the math labs themselves, perhaps narrowing the topics covered from 6 to 4, with two of those 4 definitely incorporating some Python/Sage and some writing in LaTeX.

We would also like to investigate the possibility of reworking the Math 341/342 curriculum slightly in the next couple of years to incorporate a small amount of Python/Sage usage too, perhaps making the CIS 122 a co-requisite with Math 341. This would be a relatively minor change to the Math 341/342 curriculum, but would help students to consolidate their computer skills enabling them moving forward successfully to more advanced classes. This should be discussed with stakeholders in the new Data Science major. In the longer term, it may be worth considering adding a third term of linear algebra, perhaps separated for students on the "standard track" and on the "pure track" since for the former students more computational experience would be useful, whereas the latter students probably need to see abstract linear algebra before they take 400 level pure sequences.

Another suggestion for assessment next year is to think about better mechanisms to get feedback from graduating math majors, perhaps with some form of exit survey. We have implemented such things in the past, and the main problem is to get enough considered responses. Possible questions for such a survey in the next cycle should address aspects such as the success of math labs, the bridge requirement, and the use of mathematical computer software.

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Chair of the Undergraduate Affairs Committee/Assessment Committee
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