Department of Mathematical Sciences
2022 Assessment Report

12/15/2022

MISSION STATEMENT

The Department of Mathematical Sciences at the University of Montana is dedicated to excellence in teaching, research, and service in mathematics, statistics and mathematics education. We teach mathematics at all levels, we advance the mathematical sciences through our research, and we serve the university, state and nation by sharing our mathematical expertise through outreach, consultation and collaboration.

In teaching, we seek to provide students with the training in mathematics, statistics, and mathematics education necessary for success in their careers. The instructional mission of the department is to provide: 1) a quality program of mathematical specialization at the undergraduate and graduate levels leading to B.A., M.A., M.S., and Ph.D. degrees, 2) the mathematical background for students preparing for careers in fields other than mathematics, and 3) quantitative literacy to undergraduates in the framework of general education.

In research, we attempt to extend the frontiers of knowledge in mathematics, statistics, and mathematics education by producing quality research with original results, by supervising students' research at the graduate and undergraduate levels, and by conducting interdisciplinary research with researchers in other fields. Our research mission complements our teaching mission.

The department is committed to service to our colleagues, the people of the state of Montana and our nation. An important responsibility is to provide mathematical resources for researchers and graduate students in other disciplines at the university. Other examples of service include outreach programs for K-12 teachers and students, leadership and advice on K-12 and college mathematics education issues, outreach to American Indian Nations and collaboration with tribal colleges and universities, assistance in regional and state mathematics competitions, service on University committees, involvement in national mathematical organizations, and editing and refereeing for professional journals. In our public presence we hope to foster understanding of the power of mathematics and its role as a fundamental mode of human thought.

The department's mission is closely aligned with the mission of the University of Montana as given in the University mission statements.

DEPARTMENT ALIGNMENT WITH PRIORITIES FOR ACTION

1. Teaching

In teaching, we seek to provide students with the training in mathematics, statistics, and mathematics education necessary for success in their careers. The instructional mission of the department is to provide:

- A quality program of mathematical specialization at the undergraduate and graduate levels leading to B.A., M.A., M.S., and Ph.D. degrees.
- The mathematical background for students preparing for careers in fields other than mathematics.
- Quantitative literacy to undergraduates in the framework of general education.

Our Teaching objectives are fully aligned with and in support of *Priority 1: Place student success at the center of all we do*, and *Priority 2: Drive excellence and innovation in teaching, learning, and research*.

Some noteworthy items that align particularly well with the Priorities for Action:

- Increased use of <u>learning assistants</u> in introductory mathematics classes
- An increased emphasis on <u>active learning</u> in many of our classes
- <u>Mathematics Learning Center</u> to help students in introductory mathematics classes
- The interdisciplinary <u>Certificate in Big Data Analytics</u>, offered jointly with the College of Business and the Department of Computer Science, gives students an introduction to Data Science.
- The MA in Teaching School Mathematics is a <u>fully online</u> professional degree for practicing teachers. It is designed around teachers' schedules, which means that teachers can earn the degree while they teach across the state. This item also supports *Priority 4: Partner with place*.

2. Research

In research, we attempt to extend the frontiers of knowledge in mathematics, statistics, and mathematics education by producing quality research with original results, by supervising students' research at the graduate and undergraduate levels, and by conducting interdisciplinary research with researchers in other fields. Our research mission complements our teaching mission.

Our Research objectives are fully aligned with and in support of *Priority 2: Drive excellence and innovation in teaching, learning, and research*.

All of our many research activities are in support of *Priority 2*, while several also support *Priority 4: Partner with place*. The research opportunities we provide for both undergraduate and graduate students also support *Priority 1: Place student success at the center of all we do*. Some noteworthy items that align particularly well with the Priorities for Action:

- Research publications in respected peer-reviewed journals both in the mathematical sciences and in interdisciplinary areas.
- Books published by scientific publishers.
- Millions of dollars in grant funding from various agencies, including major grants from the National Science Foundation.
- Training the next generation of researchers in mathematics through our Ph.D. program.
- We have a robust program for undergraduate research with several undergraduate research groups.

3. Service

The department is committed to service to our colleagues, the people of the state of Montana and our nation. An important responsibility is to provide mathematical resources for researchers and graduate students in other disciplines at the university. Other examples of service include outreach programs for K-12 teachers and students, leadership and advice on K-12 and college mathematics education issues, outreach to American Indian Nations and collaboration with tribal colleges and universities, assistance in regional and state mathematics competitions, service on University committees, involvement in national mathematical organizations, and editing and refereeing for professional journals. In our public presence we hope to foster understanding of the power of mathematics and its role as a fundamental mode of human thought.

Our Service objectives are aligned with and in support of *Priority 2: Drive excellence and innovation in teaching, learning, and research*, *Priority 3: Embody the principle of "Mission First, People Always"*, *Priority 4: Partner with place*, and *Priority 5: Proudly tell the UM story*.

Some noteworthy items that align particularly well with the Priorities for Action:

- Service to the profession through peer-review and involvement in professional organizations at the state, national and international level.
- Our Data Science Program partners with local businesses and contributes to economic growth. (More information under 4.(a) below)
- Many local and state-wide outreach activities aimed at K-12 students and teachers, e.g., Math Circles, State Math Contest, Mathcounts coaching, UM High School Mathematics Awards, and more.
- Consulting activities for researchers and students at UM.
- Outreach to, and partnership with, tribal colleges.

4. Innovative or Noteworthy Programs/Initiatives that Support the Priorities for Action

(a) *Data Science Program:*

The Data Science educational activities in our department are preparing a qualified workforce for hi-tech industries both in the State of Montana and in the USA. Building on the existing Big Data Analytics certificate for undergraduate students (offered jointly with the Departments of Computer Science and Management Information Systems), the department developed a new M.S. in Data Science degree. We also offer a concentration in Statistics and Data Science for the BA in Mathematics, and we are exploring the possibility of a joint BS degree in Data Science with the Department of Computer Science. We have also launched a successful experiential learning program in Data Science, running collaborative project courses with local, national and international companies, see https://umt.capsource.io/projects/help-build-the-open-source-prediction-network/, https://umt.capsource.io/projects/forecasting-website-lead-gen/ and https://umt.capsource.io/companies/eco-enterprise/. These give our students a taste of life on the industry-side of things, while they learn software and systems specific to the company, and apply their analytic techniques to real-life data. To further help our students secure jobs upon graduation, we have partnered with Missoula based ATG to run informational sessions, and a workshop on Salesforce, the CRM software they use. Recruiters from Fast Enterprises (a national company with ties to Missoula) have also run interview and resume workshops for students in our program. Local high-tech companies need workers, and we are always working to build the pipeline, and bring more of this kind of industry to Missoula.

(In support of *Priority 2: Drive excellence and innovation in teaching, learning, and research*, and *Priority 4: Partner with place*)

(b) *Master of Arts in Teaching School Mathematics:*
The department is committed to improving K-12 education across the state. In service of this commitment, the department offers a professional degree just for teachers, the Master of Arts in Teaching School Mathematics. Because teachers are often not able to take two years off to move to Missoula in order to complete a residential degree, the degree is fully online. Moreover, courses are scheduled around teachers' schedules, which means that teachers can complete the degree while they are teaching. Finally, the courses are specialized for teachers. Recent research has revealed that the most successful teachers possess a special form of math knowledge: "math knowledge for teaching." The courses are designed around this cutting-edge research, which ensures that the courses are relevant to teachers and lead to improved educational experiences for K-12 students across the state.

(In support of *Priority 1: Place student success at the center of all we do*, *Priority 2: Drive excellence and innovation in teaching, learning, and research*, and *Priority 4: Partner with place*)

(c) *Research-Based Instructional Practices and Open Educational Resources:*
The department is committed to improving all aspects of teaching and learning. Toward this end, instructors have made multiple innovations including incorporating research-based instructional practices and open educational resources (OER).
  o Research-based instructional practices: Instructors have incorporated *collaboration and active learning* at all levels of the curriculum. For example, STAT 216 is a large-enrollment course (250+ students per semester). This was formerly taught as a "large lecture", but now students are engaged in collaborative activities each day. To support this, the course is held in the ALI Auditorium, which seats 300 students in small group tables. Instructors have also incorporated *authentic assessments*, beyond traditional high-stakes exams. For example, in the M13x sequence (M132, M133, M234), instructors use performance-based assessments and portfolios to assess student learning. These instructional practices are supported by *learning assistants*. The department, especially the precalculus sequence (M121, M122, M151) has been a pioneer in the use of learning assistants to support active learning, and by now nearly all of the 100-level introductory courses involve learning assistants.
  o Open educational resources: Instructors are committed to using and producing open educational resources. In M307, for example, instructors adopted and heavily modified an OER textbook that supports active learning.
  These innovations are good for all students. They may be especially powerful for students from social groups that have been traditionally marginalized in the mathematical sciences.

(In support of *Priority 1: Place student success at the center of all we do*, and *Priority 2: Drive excellence and innovation in teaching, learning, and research*)

STUDENT LEARNING OUTCOMES and MEASUREMENT TOOLS

The undergraduate mathematics major is intentionally very flexible, giving students the opportunity to develop, in conjunction with their advisor and their faculty mentor, a program of studies suitable for their particular interests and goals. The department offers a significant number of capstone courses at the 400-level, and each major must take at least three of them. The department's assessment of the student learning outcomes is based on an individual assessment of all math majors in these advanced courses.

Student Learning Outcomes:

1. **Calculus.** Students will learn the standard results of calculus, and will be able to use them in a variety of applications.

2. **Proof and logical reasoning.** Students will develop clear analytical thinking skills as demonstrated by rigorous reasoning in mathematical arguments.

3. **Writing and communication.** Students will develop the ability to clearly communicate mathematics in writing.

4. **Specialized knowledge at an advanced level.** Students will learn the standard results of one or more specialized area of mathematics at a level appropriate for advanced undergraduates.

Measurement Tools:

The student learning outcomes for math majors will be assessed in each of the 400-level math courses aimed at math majors, namely

> M 412, 414, 429, 431, 432, 439, 440, 445, 461, 462, 472, 473, 485, and 491, and
> STAT 421, 422 and 452.

Each math major takes a minimum of three of these courses, and often more. Every faculty member teaching one of these courses selects three of the four learning outcomes, and separately assesses the performance of each individual math major in the course with respect to the selected learning outcomes on a scale from 0-10, using the departmental assessment rubrics developed for each learning outcome (see appendices), and submits this information to the departmental Undergraduate Committee. The latter compiles these individual assessment reports in two ways: both by individual math majors (using data from several years, where available) and by the individual learning outcomes (for math majors who graduated during a given academic year). Based on this, the Undergraduate Committee then assesses the student learning outcomes, and determines, where applicable, which corrective actions need to be taken to improve performance.

RESULTS and MODIFICATIONS

The following tables show the assessment results for the Student Learning Outcomes. Here "very good" corresponds to a score of at least 8.0, and "satisfactory" to a score between 6.0 and 7.9, on the 0-10 scale used in the rubrics (see the appendix).

Learning Outcome 1 – Calculus

Students will learn the standard results of calculus, and will be able to use them in a variety of applications.

Performance of Graduates	AY 2014-15 (n=27)	AY 2015-16 (n=17)	AY 2016-17 (n=25)	AY 2017-18 (n=10)	AY 2018-19 (n=10)	AY 2019-20 (n=14)	AY 2020-21 (n=19)	AY 2021-22 (n=12)
Very Good (>= 8.0)	59%	71%	56%	90%	80%	43%	47%	67%
Satisfactory (>= 6.0)	33%	29%	36%	10%	20%	57%	42%	33%
Needs Improvement	7%	0%	8%	0%	0%	0%	11%	0%
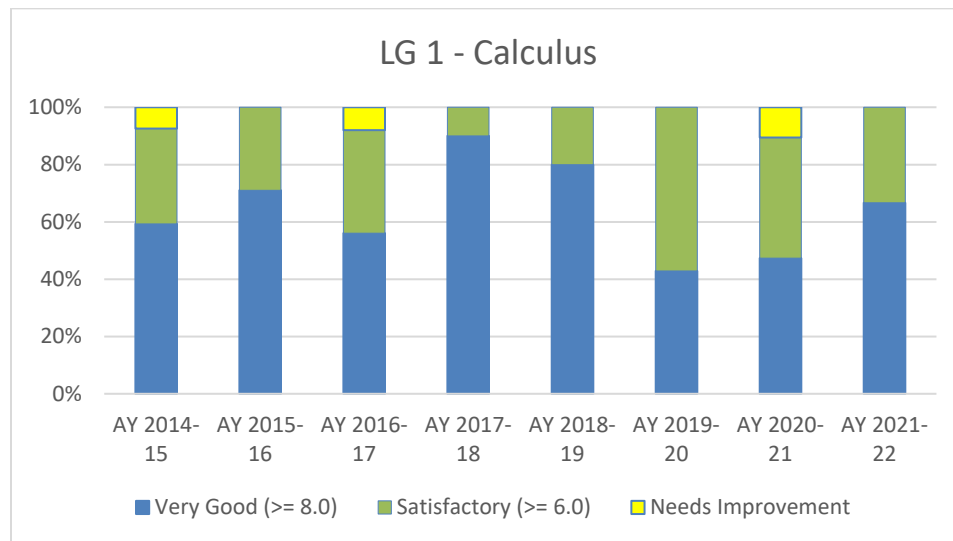
Learning Outcome 2 – Proof and Logical Reasoning

Students will develop clear analytical thinking skills as demonstrated by rigorous reasoning in mathematical arguments.
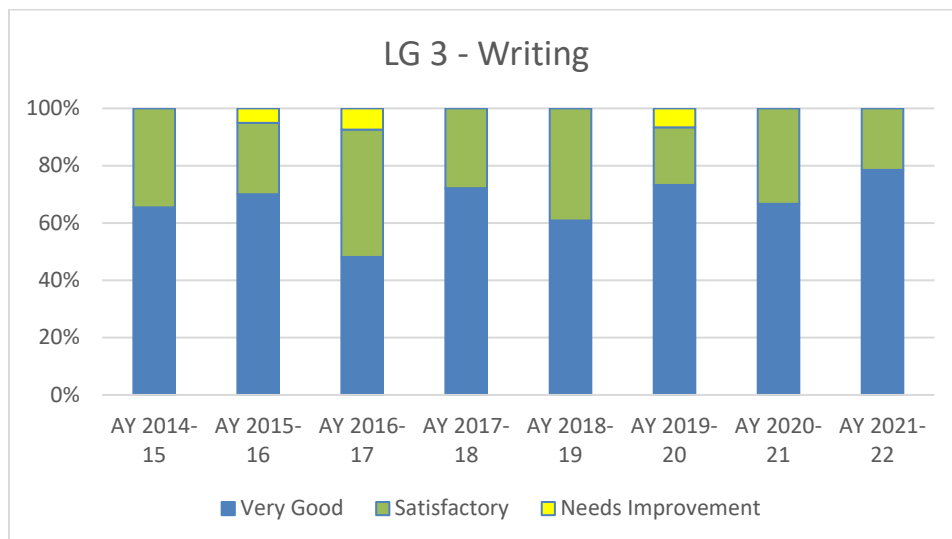
Performance of Graduates	AY 2014-15 (n=29)	AY 2015-16 (n=20)	AY 2016-17 (n=27)	AY 2017-18 (n=18)	AY 2018-19 (n=24)	AY 2019-20 (n=15)	AY 2020-21 (n=21)	AY 2021-22 (n=14)
Very Good (>= 8.0)	45%	65%	52%	67%	63%	60%	52%	71%
Satisfactory (>= 6.0)	48%	30%	33%	28%	33%	33%	48%	29%
Needs Improvement	7%	5%	15%	6%	4%	7%	0%	0%
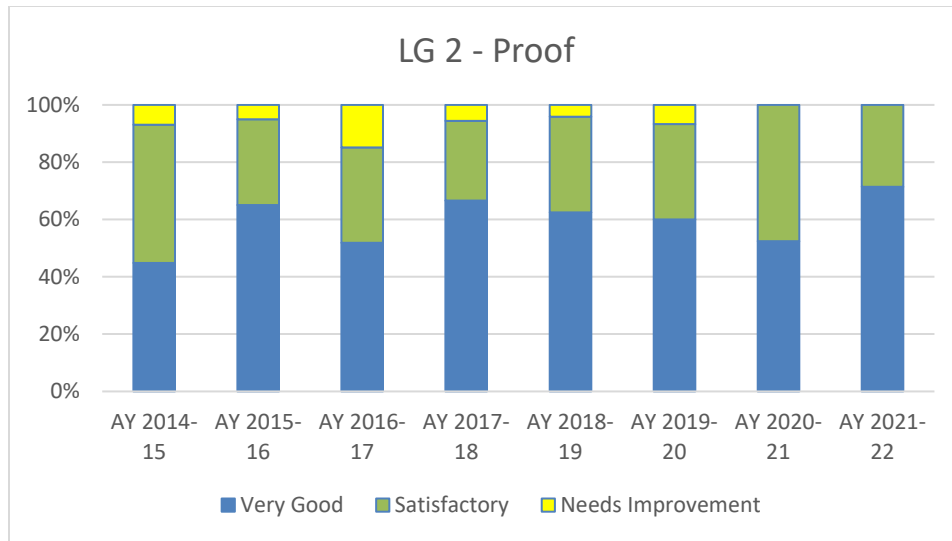
LG 2 - Proof

Learning Outcome 3 – Writing and Communication

Students will develop the ability to clearly communicate mathematics in writing.

| Performance of Graduates	AY 2014-15 (n=29)	AY 2015-16 (n=20)	AY 2016-17 (n=27)	AY 2017-18 (n=18)	AY 2018-19 (n=23)	AY 2019-20 (n=15)	AY 2020-21 (n=21)	AY 2021-22 (n=14)
Very Good (>= 8.0)	66%	70%	48%	72%	61%	73%	67%	79%
Satisfactory (>= 6.0)	34%	25%	44%	28%	39%	20%	33%	21%
Needs Improvement	0%	5%	7%	0%	0%	7%	0%	0%

LG 3 - Writing

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Learning Outcome 4 – Specialized Knowledge at an Advanced Level

Students will learn the standard results of one or more specialized area of mathematics at a level appropriate for advanced undergraduates.

Performance of Graduates	AY 2014-15 (n=29)	AY 2015-16 (n=20)	AY 2016-17 (n=24)	AY 2017-18 (n=18)	AY 2018-19 (n=24)	AY 2019-20 (n=15)	AY 2020-21 (n=18)	AY 2021-22 (n=14)
Very Good (>= 8.0)	52%	70%	54%	72%	67%	53%	56%	86%
Satisfactory (>= 6.0)	45%	25%	38%	28%	29%	40%	39%	7%
Needs Improvement	3%	5%	8%	0%	4%	7%	6%	7%
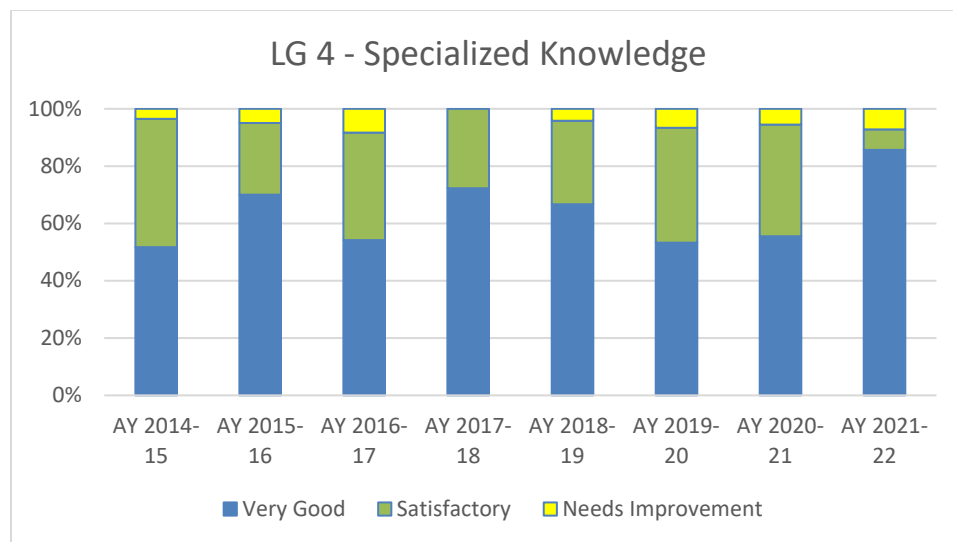
Analysis of Assessment Data

The data show some variation from year to year, which is clearly to be expected given the relatively small number of majors. It would be surprising if the performance were more uniform than it is. In particular, note that small differences in percentages do not seem to be statistically significant.

Overall, the assessment shows a steady, good performance over several years. In particular, for each Student Learning Outcome, the combined categories "Very Good" and "Satisfactory" are usually in the 90% range, while the "Needs Improvement" category usually hovers around 10% or lower (which usually represents 0-2 students and never more than 4 students).

In light of the steady, good performance, at this point the assessment outcomes do not mandate curricular adjustments. The Department of Mathematical Sciences is, however, constantly working to improve its programs, and in the sequel, we list some of the significant curricular changes we implemented during the last few years.

Program Modifications

Modifications to Undergraduate Degree Programs:

1. The Concentration in Statistics (for an undergraduate degree in mathematics) gives students the opportunity to include applied statistics and data science in their course work. To better reflect this, we renamed this concentration for the BA in Mathematics to "Statistics and Data Science".

2. Students completing the BA in Mathematics with the Concentration in Mathematics Education must take 12 credits of science courses (the "Science Requirement"). In order to encourage students to enrich their major by studying another subject in depth, we are now waiving the Science Requirement for students completing a minor in an additional subject.

3. We changed the prerequisite for STAT 301 (Teaching with Technology) to make it easier for mathematics education majors to take this required class earlier in their program.

4. We updated the BA in Mathematics and the combined major in Computer Science and Mathematical Sciences to reflect substantial revisions in the computer science curriculum.

Modifications to Graduate Degree Programs:

5. The graduate program has continued to use targeted recruiting to try to increase the diversity of our graduate student population. This includes advertising at national meetings (Joint Mathematics Meetings, Field of Dreams, and virtual Grad Fairs through the AMS). For over 5 years the grad program was able to use an S-STEM grant from the NSF to fund and recruit select graduate students. This grant ended in June 2022 and consequently we have had to adjust our funding of graduate students and the number of TA positions.

6. For years Lauren Fern ran M 694, the college teaching seminar for first year TA's. After Lauren's departure to Missoula College, Fred Peck and Kelly McKinnie have taken over this seminar.

7. Updates to the graduate guide for our graduate degree programs:
   a. In Fall 2022 the math graduate program submitted a Level II proposal to consolidate two of our MA degrees. Our current MA offerings include "Mathematics MA" and "Mathematics Education MA". These are referred to in our graduate guide as "MA Option 1" and "MA Option 2" respectively. We have proposed to consolidate these two MA programs into one "Mathematics MA" program which allows students to have an emphasis in math education.
   b. We changed our grad guide to reflect a change in policy regarding which preliminary exams PhD students can count toward their degree.
   c. In our last assessment report, it was mentioned that changes were being made to language in our graduate guide from "Comprehensive Exam" for MA students to "Preliminary Exam". This change was completed and can be found in section MA 3 of the graduate guide.

8. The Data Science Master's program is now an approved Western Regional Graduate Program (WRGP). This change occurred in Fall 2021. We have had 2 out of state students enroll in this tuition saving program.

Other Modifications:

9. *Co-requisite Remediation:* The implementation and scaling of co-requisite remediation classes for our introductory mathematical literacy courses continues to thrive and serve our students at UM with noted success (https://www.umt.edu/institutional-research/metrics/student-support/corequesite.php). This model, which mainstreams students deemed academically underprepared into college-level courses with additional learning supports, accelerates mathematics course completion giving students a shorter path to their degree. Sections with co-requisite support are now offered every fall and spring semester for M105, M115, and M121. This program was built by Lauren Fern as a lecturer in the math department. After she joined the Missoula College faculty in 2021, the corequisite support courses are now being offered through Missoula College.

10. *Changes to M 171 Calculus I:* To better serve students, we are changing the way we offer M 171 Calculus I beginning next year. This course is currently offered as one large lecture (meeting MWF) with required small discussion sections (meeting TR). We are changing this to offer the 4-credit course M 171 in smaller sections, capped at 35-40 students, meeting MTWF (and without discussion sections). The new format will make it easier to incorporate active learning into the classroom. Sections will be taught by regular faculty or by experienced TAs under the supervision of a regular faculty member. To minimize scheduling conflicts, we plan to continue offering one online section of M 171 each semester.

11. *Online Courses:* All courses for the MA in Teaching School Mathematics are offered online. With support from UM Online, Adjunct Instructor Rick Darnell is redesigning this academic year the online offering of M 162 Applied Calculus; he is also in the process of updating the online version of M 105 Contemporary

Mathematics. We are in the process of making changes to M 171 Calculus I. Once this has been completed, Professor Kelly McKinnie plans to update the online version of M 171 that she developed in Summer 2020.

12. Many instructors have incorporated *research based instructional practices*, including active and collaborative learning, authentic assessments, and learning assistants. Faculty have also adopted and produced *open educational resources* (OER).

13. *Mathematics Learning Center (MLC)*: During COVID, the MLC went to an exclusive online model using Zoom, which was scaled back to an online-by-appointment model in AY2021-22 and phased out for lack of interest this academic year. One feature implemented early in the pandemic is a "Dear Math Tutor" email service for students to submit questions and request off-hour tutoring. This service is still being offered and is especially utilized at the beginning of the semester.

    Mirroring the overall economy, student employees are offering less availability in their schedules for tutoring, necessitating reducing MLC hours by nearly 25% compared with pre-pandemic levels. The MLC is now open 10-6 M-Th and 10-1 Fri (with no Sunday hours). On the positive side, implementation of the Student Success Fee has stabilized the MLC budget and allowed for increased wages. Although still not on par with off-campus jobs, the rise of starting wages from $9 to $11.50/hour has been helpful in recruiting and retaining tutors, and improved the ability to compete with other locations offering tutoring on campus (TRiO and the Athletics Department). Finally, since AY2019-2020, the MLC has provided tutoring services in PFNAC specifically for Native American students. This year, there are discussions to provide a similar outreach service to TRiO.

14. Although not a curricular issue, we need to mention the renovations made to the classrooms in the Mathematics Building: From new rolling tables and chairs (very useful for group work) to new classroom computers with large monitors, this significantly helps with our instructional mission.

FUTURE PLANS FOR CONTINUED ASSESSMENT

The plans for future continued assessment are outlined in the section "Student Learning Outcomes and Measurement Tools", and are detailed in the departmental policy in the appendix.

In addition, each academic year assessment issues will be discussed at several meetings of the departmental Undergraduate Committee, and at a departmental Faculty Meeting.

APPENDICIES

1. Department of Mathematical Sciences Policy on the Assessment of Program Student Learning Outcomes. (This document includes the rubrics for assessing the learning outcomes.)

2. Mathematics Curriculum Map

Department of Mathematical Sciences
Policy on the Assessment of Program Student Learning Outcomes

Adopted March 3, 2009

Revised: 2/1/2010, 4/25/2015, 10/10/2022

The undergraduate mathematics major is intentionally very flexible, giving students the opportunity to develop, in conjunction with their advisor and their faculty mentor, a program of studies suitable for their particular interests and goals. Because of this, required common capstone courses and exit exams for all math majors would be impractical and even counterproductive. The department offers, however, a significant number of capstone courses at the 400-level, and each major must take at least three of them. In light of this, the department's assessment of the student learning outcomes is based on an individual assessment of all math majors in these advanced courses.

Student Learning Outcomes:

1. **Calculus.** Students will learn the standard results of calculus, and will be able to use them in a variety of applications.
2. **Proof and logical reasoning.** Students will develop clear analytical thinking skills as demonstrated by rigorous reasoning in mathematical arguments.
3. **Writing and communication.** Students will develop the ability to clearly communicate mathematics in writing.
4. **Specialized knowledge at an advanced level.** Students will learn the standard results of one or more specialized areas of mathematics at a level appropriate for advanced undergraduates.

Outline of the Assessment Procedure:

The student learning outcomes for math majors are assessed in each of the 400-level math courses aimed at math majors. More precisely, these are the 400-level courses listed as "Elective Courses" under the "Mathematics Electives Requirement" for the B.A. in Mathematics (without a concentration), according to the current UM Catalog. In addition, these learning outcomes are also assessed in those special topics courses (M/STAT 491) which have been approved by the Undergraduate Committee to count towards the "Mathematics Electives Requirement".

Each math major takes a minimum of three of these courses, and often more. Every faculty member teaching one of these courses selects three of the four learning outcomes, and separately assesses the performance of each individual math major in the course with respect to the selected learning outcomes on a scale from 0-10, using the departmental assessment rubrics developed for each learning outcome (see below), and submits this information to the departmental Undergraduate Committee. The latter compiles these individual assessment reports in two ways: both by individual math majors (using data from several years, where available) and by the individual learning outcomes (only for the academic year for which the individual assessment reports were written). Based on this, the Undergraduate Committee then assesses the student learning outcomes, and determines, where applicable, which corrective actions need to be taken to improve performance.

Assessment Procedure Used in the Individual 400-level Courses:

When an instructor of one of the 400-level mathematics and statistics courses assesses one of the program student learning outcomes, he or she selects a representative sample of relevant assignments. The performance of each math major in the course on each of these assignments is then assessed using the rubrics below. At the end of the semester, the instructor submits a report to the departmental Undergraduate Committee, listing, for each math major, his or her average performance on the selected assignments for each of the assessed program student learning outcomes.

Assessment Rubric for Student Learning Outcomes 1, 2, and 4:

The performance of a student on an individual assignment will be assessed as follows:

10	Exemplary
8-9	Complete; minor details may be missing
6-7	Satisfactory, but with significant, albeit minor flaws
4-5	Major flaws, but significant progress towards the solution
0-3	Inadequate; no significant progress towards the solution

Assessment Rubric for Student Learning Outcome 3 (Writing and Communication):

Depending on the nature of an individual writing assignment (e.g., proof writing, report writing, or expository writing), the criteria used for assessment address some or all of the following areas:

- Clear sequence of arguments
- Clearly stated assumptions and conclusions
- Complete and grammatically correct sentences
- Conciseness
- Correct use of mathematical notation
- Reasoning

The performance of a student on an individual assignment will be assessed as follows:

10	Exemplary
8-9	Minor shortcomings in at most two areas
6-7	Satisfactory, but with significant shortcomings in one area
4-5	Acceptable, but with significant shortcomings in two areas
0-3	Inadequate

UM Curriculum Map
B.A. in Mathematics Degree

9/28/2022

Required Core Courses	Outcome 1: Calculus	Outcome 2: Proof and Logical Reasoning	Outcome 3: Writing and Communication	Outcome 4: Specialized Knowledge at an Advanced Level
M 171 or 181	I		I	
M 172 or 182	D		I	
M 210*	D		I	
M 221		I	I	I
M 273*	D		I	I
M 307		I	D	
6-7 Required Electives, with 3 at the 400-level	Outcome 1: Calculus	Outcome 2: Proof and Logical Reasoning	Outcome 3: Writing and Communication	Outcome 4: Specialized Knowledge at an Advanced Level
M 274	M		D	D
M 301			D	D
M 326		D	D	D
M 361			D	D
M 362			D	D
M 381	M	D	D	D
STAT 341			D	D
M 412	M, A	M, A	M, A	M, A
M 414	M, A	M, A	M	M, A
M 429**	M, A	M, A	M, A	M, A
M 431		M, A	M, A	M, A
M 432		M, A	M, A	M, A
M 439	M	M, A	M, A	M, A
M 440	M, A	M, A	M	M, A
M 445	M, A	M, A	M, A	M, A
M 461	M, A	M, A	M, A	M
M 462	M, A	M, A	M, A	M
M 472	M, A	M, A	M, A	M, A
M 473	M	M, A	M, A	M, A
M 485		M, A	M, A	M, A
STAT 421	M, A	M, A	M	M, A
STAT 422	M, A	M, A	M	M, A
STAT 452		M, A	M, A	M, A

KEY:

* = Not required for students in the Mathematics Education Concentration

** = Most majors take this course (default for the Advanced College Writing Requirement).

I = Introduced

D = Developed/reinforced, with opportunities to practice

M = Mastery

A = Assessment evidence collected

NOTES:

(1) Students typically proceed from the core courses (I and D), over 300-level electives (D and M), to the three required 400-level capstone courses (M).

(2) Instructors of 400-level courses must only assess 3 of the 4 Outcomes. The table reflects which Outcomes were assessed most recently.