I. Profile

Mission Statement of the Mathematics Department at UW-River Falls *

- To provide a complete array of mathematics courses and programs within a comprehensive university benefiting the greater community;
- To dedicate our instruction to developing our students’ mathematical creativity and problem-solving abilities – from quantitative literacy to advanced analytical reasoning;
- To foster an environment in which the free exchange of ideas and the active learning and appreciation of mathematics flourish.


Learning Outcomes

The Mathematics Department has identified the following learning objectives/outcomes for students in its Liberal Arts program:

When students complete the liberal arts mathematics major they will be able to:

LO1. Apply fundamental concepts of algebra, calculus, and discrete mathematics to solve mathematical problems.
LO2. Use mathematics from multiple areas to solve a mathematical problem.
LO3. Read and interpret mathematical essays and valid mathematical proofs.
LO4. Present mathematical ideas clearly both orally and in writing.
LO5. Utilize technology appropriately in solving mathematical problems.
LO6. Demonstrate a depth of knowledge in one area of mathematics.
II. Assessment Review

The following tools are currently used for assessment of the Mathematics—Liberal Arts major.

Mathematics Liberal Arts Program

1. Core course assessment done by eight questions given on exams in MATH 266: Calculus III. (Note that beginning in Fall 2018 these assessment items will be administered in the new 4-credit MATH 268: Calculus III course.)

2. Out-of-classroom learning experiences.
   (Note that beginning in Fall 2018 these assessment items will be administered in the new 4-credit MATH 268: Calculus III course.)
   - Mathematical Modeling Contest
   - Other Undergraduate Research
   - Internships
   - Integration Bee

3. Survey of students in senior capstone.

The core course assessment tool in its current form has been used since fall semester 2004-2005. Prior to this the department used a separately administered exam taken by all mathematics majors who had completed the core courses. The questions on the old assessment exam were extensively modified by a department committee to create our current set of questions. The current tool measures each student’s ability to apply eight fundamental concepts of calculus to solve mathematical problems (LO1) and to present mathematical ideas clearly (LO4) using eight questions given on the exams throughout the semester.

Between the 1990-91 and 2014-15 academic years, the talk and the paper done by students as part of the senior seminar were utilized for assessment. We measured the ability of students to present mathematical ideas clearly both orally and in writing (LO4), to utilize technology appropriately in solving mathematical problems (LO5), and to demonstrate a depth of knowledge in one area of mathematics (LO6.)

Beginning in 2016-17 the senior capstone experience changed so that students had the option of either MATH 385: Mathematical Writing or MATH 495: Undergraduate Research in Mathematics. MATH 385 is a traditional classroom experience which we assess the ability of students to present mathematical ideas clearly (LO4). MATH 495 is similar to our previous seminar experience in which we assess LO4, LO5 and LO6, although students present their work at a venue outside of the department.

With the change in our senior capstone experience, in 2016-17 we began to assess our program through three additional out-of-classroom experiences. For students who participate in the Mathematical Modeling Contest, we use their papers and their posters to assess their ability to apply fundamental mathematics concepts to solve problems (LO1), use mathematics from multiple areas in problem solutions (LO2), present mathematics clearly both orally and in writing (LO4), and utilize technology appropriately (LO5). For students who participate in internships, we use a presentation to the department to assess their ability to apply fundamental mathematics concepts to solve problems (LO1), use mathematics from multiple areas in problem solutions (LO2), present
mathematics clearly both orally and in writing (LO4), and utilize technology appropriately (LO5). For students who participate in the Annual Integration Bee, we use their contest performance to assess their ability to apply fundamental algebra and calculus concepts to solve integrals (LO1) and present mathematics clearly both orally and in writing (LO4).

The survey of students in the senior seminar has been used since fall 1997. The survey is used to assess students’ perceptions of their ability to use mathematics from multiple areas to solve a mathematical problem (LO3), their ability to utilize technology appropriately in solving mathematical problems (LO5) and their depth of knowledge in one area of mathematics (LO6). In Fall 2017, the survey was updated to include questions that directly assess student perceptions about achieving learning outcomes 1-6.
### III. Assessment Results

Summary information from the core course assessment, out-of-classroom experiences, and the survey of mathematics liberal arts students in the senior capstone.

<table>
<thead>
<tr>
<th>Math Program Assessment</th>
<th>Core Course Assessment in Math 266 (Calculus III)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Learning Outcome</td>
</tr>
<tr>
<td>A. Find the equation of a line in 3-dimensional space.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>B. Find the derivative of a vector-valued function with 3 components.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>C. Find the unit tangent vector for a vector-valued function at a specific value of the parameter.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>D. Find the velocity function given the vector-valued acceleration function and an initial condition for velocity.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>E. Find the equation of the tangent plane of a given function of two variables at a given point.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>F. Find the maximum rate of change and the direction in which it occurs for a given function of two variables at a given point.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>G. Change the order of integration in an double iterated integral with varying limits of integration and evaluate the resulting integral.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>H. Evaluate a triple integral over a bounded region in three dimensional space.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
Out-of-Classroom Experiences

Mathematical Modeling Contest
In 2017, two teams of three students competed. One team earned the designation Meritorious (top 8% of 8,843 teams) and the other team earned Honorable Mention (top 48% of 8,843 teams). Faculty evaluated the papers and posters produced for the contest and found that the projects demonstrated excellent student knowledge of discrete mathematics, calculus and statistics. Both teams presented their results at the St. John’s PME Undergraduate Mathematics Conference. This is evidence that the program is successful in achieving LO1, LO2, LO4, LO5 and LO6.

Other Undergraduate Research
In 2017-18, two students completed other undergraduate mathematics research which they presented at the UWRF Fall Gala and the St. Norbert’s PME Undergraduate Mathematics Conference. Faculty evaluated the papers, presentations and posters and found that the projects demonstrated excellent student knowledge of discrete mathematics and calculus. This is evidence that the program is successful in achieving LO1, LO2, LO3, LO4 and LO6.

Internships
In spring 2017, one student participated in a mathematics internship. Faculty evaluated a presentation by the student and found that the internship demonstrated excellent student knowledge of discrete mathematics and statistics. This is evidence that the program is successful in achieving LO1, LO2, LO4, LO5 and LO6.

Integration Bee
In spring 2017, fifteen students competed in the First Annual Integration Bee. Faculty evaluated the student work and found that the event demonstrated good student knowledge of algebra and calculus. This is evidence that the program is successful in achieving LO1 and LO4.
# Mathematics—Liberal Arts Survey Results

<table>
<thead>
<tr>
<th>Quantitative Questions Rated (1 = poor) to (7 = excellent)</th>
<th>Mean Response 1997-2011</th>
<th>Mean Response 2016-17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Mathematics Curriculum</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. How would you rate the flexibility in choosing the elective courses in the major?</td>
<td>5.49</td>
<td>5.17</td>
</tr>
<tr>
<td><strong>II. Teaching</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. How would you rate the effectiveness of the professors in helping you learn mathematics?</td>
<td>5.73</td>
<td>5.77</td>
</tr>
<tr>
<td>2. How would you rate the concern of the math professors for success of the students?</td>
<td>5.79</td>
<td>6.31</td>
</tr>
<tr>
<td>3. How would you rate the grading policies in math courses?</td>
<td>5.68</td>
<td>5.93</td>
</tr>
<tr>
<td>4. Knowledge of the subject matter demonstrated by the instructors in this major is generally?</td>
<td>6.35</td>
<td>6.23</td>
</tr>
<tr>
<td>5. How would you rate the availability of mathematics professors for help outside of class?</td>
<td>5.62</td>
<td>6</td>
</tr>
<tr>
<td><strong>III. Advising</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. How would you rate the academic advising you received when you registered the first time at this university?</td>
<td>4.91</td>
<td>5.92</td>
</tr>
<tr>
<td>2. How would you rate the advising you received from your mathematics advisor for the subsequent semesters?</td>
<td>5.5</td>
<td>6.08</td>
</tr>
<tr>
<td><strong>IV. Extra-curricular</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. The adequacy of the physical facilities (classrooms, labs, etc.) supporting this major is generally:</td>
<td>5.29</td>
<td>4.92</td>
</tr>
<tr>
<td>2. The adequacy of supporting activities (meaning guest speakers, presentations, workshops and clubs) in this major is generally:</td>
<td>5.21</td>
<td>4.77</td>
</tr>
<tr>
<td>3. The adequacy of the library resources related to this major are generally:</td>
<td>5.57</td>
<td>4.92</td>
</tr>
</tbody>
</table>

Summary of responses to qualitative questions. (Complete qualitative responses included as an appendix.)

Items I.1, I.2, I.3, I.4, I.6, and V.2 did not seem to have any repeated themes. Item I.5 demonstrates a concern that the CSIS 161 & 162 option for the required supporting course may not support the mathematics major very well. Item II.6 indicates some concern with the inaugural delivery of the MATH 385: Mathematical Writing course. Item II.6 also indicates that the question does not appropriately gather information about the senior capstone experience. Item III.3 indicates that our advising supports students taking courses in an appropriate order. Item V.1 indicates that students would like more choices in upper division courses. Item V.1 also indicates that we may need to work to create a greater sense of community among our majors. Item V.2 indicates that students are receiving good support from faculty for course and career advising. Item V.3 indicates
that during their years at UWRF students made progress in their approach towards mathematics and mathematics learning.

IV. Assessment Results Analysis and Action Plan

The faculty in the department reviewed the 2016-17 Mathematics—Liberal Arts Survey results in their April 19, 2018 meeting.

Curriculum
The Mathematics Department has made three major program changes in recent years. Each of these changes is in response to assessment of our program and is an effort at continuous improvement. In 2016-17 we changed our senior capstone requirement, as described in section II of this report. The survey indicates that we may need to work to improve MATH 385. External Mathematical Modeling Contest results and internal faculty evaluation indicate that MATH 495 is successful at helping students meet learning outcomes. The department will continue to monitor the new senior capstone structure to assess its efficacy at meeting learning outcomes.

Beginning in Fall 2018, students will be required to take a 4-credit Calculus III (MATH 268) course rather than a 3-credit course. This will allow students to cover multiple variable calculus topics, including vector calculus, in depth. It will also bring our calculus sequence more in line with what other campuses cover in their calculus sequences. The core course assessment in Calculus III indicates that students continue to successfully meet LO1 and L04. The department will monitor the new Calculus III course to assess its efficacy in meeting learning outcomes.

Assuming that it is passed by Faculty Senate and signed by the Chancellor, beginning in Fall 2018 the choices students have for a required supporting course in computing will change. Students will no longer have the option of fulfilling the requirement with CSIS 162. They will have new options of CSIS 239 and GENG 165. The options of MATH 205 and PHYS 211 remain unchanged. This change was made by first creating a careful statement of the purpose of the required supporting course. This change directly aligns with comments made by students in the 2016-17 assessment survey. We expect that this change will help students be better prepared for mathematics related work opportunities. The department will continue to monitor the required supporting course options for their relevance to our majors.

Quantitative item I.7 and qualitative item V.1 of the student survey both reveal that students are somewhat dissatisfied with their options in upper division coursework. Five students, in response to the open-ended question “how could we improve the major?” suggested more availability and wider variety of upper level courses. The Mathematics Department has secured funding to hire a new person in probability and statistics which has the potential for helping us increase our options for upper division coursework.

Advising
In the 2012-13 and 2013-14 assessment cycles, student survey responses indicated that some students majoring in Mathematics—Secondary Education were receiving substandard academic
advising. In Fall 2014, the Department changed the way advisor/advisee assignments were made. Only faculty with specific knowledge and interest in secondary education are now assigned to advise students with a major in Mathematics—Secondary Education. Furthermore, each student who has declared a major in Mathematics—Secondary Education is assigned a second advisor in the College of Education and Professional Studies, specifically to help with advising issues in the Teacher Education part of the curriculum. The average scores in the two quantitative survey questions on advising (III.1 & III.2) have increased from 4.91 to 5.29 and 5.5 to 6.08, indicating that this effort at specialized advising might be working.

A close reading of the 2017-18 student surveys shows one student who rated yearly advising as poor, but everyone else rated advising good to excellent, with a tendency towards excellence. We suspect that this may have been a response from a student who was double majoring and only had an official advisor assigned in his or her other major. To improve advising, the Mathematics Department plans to begin insuring that all of our double majors have an official mathematics faculty advisor.

**Extra-curricular Activities, Facilities**
Survey responses to item IV.2 about adequate offering of supporting activities are low. Some of this may be more related to student perceptions than reality. In Fall 2016 we reinvigorated our Math Club including its spring Integration Bee event. We held Alumni Career events in Fall 2015, Fall 2016 and Spring 2018. We will continue to support and promote these extra-curricular activities.

Survey responses to item IV.2 about our physical facilities are generally low and lower in the 2016-17 cycle than in previous years. In 2015-16, we made a major upgrade to the high use classroom, North Hall 18. In summer 2018, we are scheduled to get much needed air conditioning in our basement classrooms. The Mathematics Department will continue to advocate to administration to improve our facilities.

One survey response to item V.1 suggested putting a microwave/coffee pot in the Math Student Lounge as a way to increase social activity among math students. The Math Department plans to investigate implementing this idea.

**V. Recommendations for Improving Assessment Processes**

1) Analysis of item II.6 in the student survey indicates a need to re-formulate this item so that it accounts for our new senior capstone experience.

2) In order to align with the campus program audit and review metrics, the quantitative items on the student survey need to be changed to a Likert Scale format (strongly agree...strongly disagree, spectrum vs. poor...excellent, spectrum).

3) In order to align with program learning outcomes, the survey should include questions that directly assess student perceptions of having achieved our six learning outcomes.

In September 2017, the student survey was updated to implement all of these recommendations.
VI. Data on Majors and Faculty

Number of Mathematics—Liberal Arts majors: 40

Number of full time tenure-track mathematics faculty: 9
Appendix: Qualitative Survey Responses 2016-17

I. CURRICULUM

1. List any topics or areas of mathematics that you knew well enough from high school and did not need to have repeated in our curriculum.
   - None, I didn’t take much math in high school
   - None, I did not take math in high school
   - None
   - I came at a higher level of math so the topics were very new
   - Calculus 1
   - Calculus 1 and everything below calculus 1
   - None
   - In general I feel that classes could (and should) proceed at a faster place and cover more material. Other than that I felt that everything was covered adequately
   - Most things from algebra 2 basic statistical things like mean median mode etc.
   - Elementary algebra, geometry, calculus I, calculus II
   - High school level algebra, trigonometry, geometry
   - None
   - N/A

2. List topics that were covered only lightly that would be beneficial to study in more depth.
   - Symbolic logic is briefly covered in discrete but would have liked to have more
   - Algebra, trig, and pre-calculus would have been nice to know
   - Statistics- the current class does not go in depth enough with practical application
   - I think expanding on how discrete math came about from number theory
   - Numerical analysis. Real analysis
   - None
   - Discrete mathematics
   - I would have liked to take MATH 336 (combinatorics and graph theory) and MATH 357 (mathematical Statistics), but they unfortunately did not fit into my schedule. Other than that I felt that everything in the classes I did take was covered in adequate depth
   - Conics, topology
   - None
   - There is a good selection of classes
   - Calc, statistics, probability

3. List any mathematics topics that are not now in our curriculum that you would like to study.
   - They’re all there but some aren’t offered while I’m here (I didn’t meet pre-req’s soon enough). Math 306 and math 346 there is a math writing course but a math writing for sophomores might be good to get them ready for higher level math courses
   - Game theory and Chaos
   - None
• Geometry or abstract
• None
• Advance differential equations
• An actuarial mathematics class
• Though MATH 366, 367 and 456 are technically “included” in the curriculum currently, they were not available while I was attending UWRF. I would have like to take them
• Topology, numerical analysis
• None
• None
• Sports statistics

4. List those mathematics courses which provided good background for some of your courses outside mathematics.

• Discrete math: counting/ algorithms/ logic/sets. Linear Algebra: systems of equations. Calc. 2: centroid/ area/ volume Integration and volume by rotation/ calculations
• All the calculus classes along with diff eq. where crucial for physics, linear algebra also
• Linear algebra, statistics, discrete mathematics
• Differential equations
• Probability, applied statistics, discrete math
• Calculus II, Calculus III, differential equations, Complex variables, discrete math, linear algebra
• Discrete and linear algebra
• MATH 326, 327 & 356 provided good background for ECON 426 (though I took it as an independent study – ECON 499)
• Low level programming courses
• Mathematical programming
• Calculus
• Math modeling was useful
• N/A

5. List any ways which the required course in Mathematica (or the programming course you took instead) supported your mathematics major.

• PHYS211, Scientific programming the course teaches how to think logically and systematically
• It was more important in physics but R (stats) was really useful in statistical data analysis
• It allows me to think through real world problems logically and create programmed solutions
• I’d allow myself to apply the equations much faster and return a result that made sense
• I took Java (programing I & II) I was not very appropriate since r of a scripted language r is more useful in math. Java is for system applications not math
• I didn’t take and programming courses in the math department
• It helped me in other classes where I needed to program things on a computer
I took MATH 205 as well as CSIS 161 & 162. I felt that they showed real world example of discrete math concepts such as set theory and recursion.

N/A, but classes involving R code were very helpful.

Helped me learn more about math. Very much supports computer Science major.

I learned a different way to find answers. Not much really.

The intro course to programming is great for getting the coding mindset. Learning Mathematica helped with tedious homework calculations.

I used it to double check homework.

6. List those courses, if any, that have inappropriate prerequisites. Explain.

Math 166 content isn’t used in math 236, math 256, or math 326. Don’t need calculus 1 for discrete, linear algebra or applied stats.

None

None

None

None

None

None

Complex variables, needs more prerequisites because of a lot of proving

None

Can’t think of any

N/A

II. TEACHING

6. Comment on your experience in the mathematics seminar.

My seminar was basically and independent study. I had a good time trying to learn math on my own. Going to math conference was a good experience. I got to practice talking about math in front of a life studio audience and got to hear what other students were doing.

I coupled my physics and math seminar together and I was a lot of fun but a lot of work. I did a project that was related to my job.

I participated in the mathematical modeling contest, created a poster and gave a presentation.

I didn’t like it.

It was good to get a chance to explain and answer questions about the work we did. Answering questions makes you consider your work more carefully.

Took Physics seminar not math

I took the economics senior seminar as I’m a double major and it counted for my math seminar.

I did not take the mathematics seminar. Rather, my economics seminar counted for this requirement.
• Some projects were tedious not sure how much I’ll really gain from latex. Doesn’t feel like I accomplished for completed anything
• N/a
• Good stuff to learn but very tedious and time consuming doing projects
• MATH 495 was a great experience attempting to solve problems that aren’t part of a course is a good skill to have. MATH 395 wasn’t very good in comparison to undergrad research. If I only took 395, I’d be missing out on a great learning opportunity
• N/A

III. ADVISING
3. Were you satisfied with the order in which you took your math courses? If not, explain.
   • Yes
   • Yes
   • Yes
   • Yes, allowed me to understand where the equations came from and maybe take differential equations before
   • Yes
   • Yes
   • Yes
   • Yes
   • Yes
   • Yes
   • Yes
   • Yes
   • Yes
   • I wish I could have taken more stats and probability classes

V. GENERAL
1. In terms of your thoughts, or in conversations with other majors, how could we improve the major?
   • Allow PHYS361 to count as MATH266. Make a math study lounge that acts as a hub for math majors. When I spend time in the physics lounge there are always people in there doing homework and talking about physics or just having a casual conversation. When I go to the math study lounge, I’m usually the only one there. Put a microwave/coffee pot where the magazine rack is and people will spend more time in the lounge. This will lead to more math majors socializing and sharing math ideas or doing math for fun.
   • Offer more elective courses at the upper level
   • I think it would be beneficial to have a 1 credit class which explained career paths for math majors post-graduation especially for non-teachers
   • I think one thing that could be done to improve the course is to create a more consistent teaching for each course. The teachers that are better at that topic teach it
   • R programming would probably be a better substitute than CSIS 161 since R is used in statistics
• More supportive department. I wish I had had an advisor to help with picking classes. Also I am leaving not knowing many of the math professors. Didn’t feel like a community
• I think the availability of certain classes more than once every 2 or 3 semesters would be helpful
• I would suggest that a wider variety of courses be offered at a wider variety of times. There are some classes that I would have liked to take that either didn’t fit in my schedule or weren’t offered at all. Also I wish that someone has suggested that I so undergraduate research. I think it really would have improved my undergraduate experience. But I didn’t think of it (not was it suggested to me) until too late
• Make the seminar a large project that allows students to actively employ whatever math skills the like. Make it feel like a good ending to the major
• Have more classes relate to other classes
• Not sure, its fine the way it is
• More online work, PowerPoints, more test time

2. a) Did you ever ask faculty members about courses, options, post college opportunities or any other concerns?
• No
• No
• Yes
• No I did not
• Yes
• Nope
• Yes
• Yes
• No
• No
• Yes
• Yes
• Yes
• Yes

b) If you did, were you satisfied with the help you received?
• Yes
• Yes
• Yes, I was satisfied and everyone I asked was a good assistance
• Yes
• Yes, depending on person
• Yes
• Yes

3. How would you change your approach to mathematics if you were a freshman starting out and know what you know now?
I’d spend more time trying to actually understand the material instead of memorizing enough to do okay on the next test
- I would have tried harder to set better grades
- I would have joined more math related extra-curricular opportunities right away (seminars, competitions, clubs conferences)
- I would only take one class of math at the beginning and then in my sophomore year take more than one, so things aren’t so rushed at the beginning.
- I would prepare for graduate school sooner and also explore different areas of math and research possibilities to get an idea of what I was interested in.
- I would keep the way I took my courses
- I would have kept it the same I think I was happy with how everything went
- I would have tied to take more math classes. I took what was required, but I wish that I had chosen to take more elective math
- Apply myself more thoroughly in my initial math courses
- I don’t know, seemed straight forward
- When I started I though math was a computation instead of general problem solving. I’d be more interested in math than I was. Doing math for this long has also made me freak out less if I don’t know how to do something. I don’t feel discourages because ill figure it out eventually
- Focus more on the fields I have desire in.