Mathematics MATH

Introduction to the Updated March 2017 version

Changes to the 2014 version are incorporated into each of the sections below.

Introduction

For the purpose of the WNMU Program Prioritization/Enhancement initiative a 'program' was defined in terms of the prefix given to a set of courses. In this section the responses to the Five Core Questions relate to all courses having a MATH prefix, which we then collectively refer to as the 'MATH program'. These courses are listed in Appendix A.

Evaluating Programs: Five Core Questions

1. What was the MATH Program created to do in the first place?

As stated in the most recent WNMU Catalog, "Courses in mathematics are intended for those who are studying the subjects for their own sake, for those who are interested in their applications as a tool in various fields, for those who are interested in teaching, and for those who are interested in graduate study." This statement can be taken to be the raison d'être for the MATH program, although the emphasis given to the various clauses within the statement has varied over the one hundred twenty-four-year history of the University. The place of teaching has always been prominent, but the focus on graduate level preparation was replaced, starting in AY 1997-98, with a focus on the various methods used in the applications of mathematics emphasizing the appropriate use of technology. During AY 1998-99, the Department of Mathematics and Computer Science assumed the responsibility for the DVSM program. In addition, past University initiatives as well as (relatively) recent statewide mandates for general education courses along with the changing needs of client disciplines have helped shape the MATH program. Thus, in its current form the MATH program has been created (and molded) to:

- Provide coordination in curriculum with the MATH remediation sequence;
- Provide curriculum and instruction for courses to satisfy the goals of WNMU's General Education program;
- Provide curriculum and instruction for service courses: math courses required by other departments and majors;
- Provide curriculum and instruction for students in other majors who minor in mathematics; and
- Provide curriculum and instruction for students majoring in mathematics.

The interrelationships among the MATH courses that support the various roles in the last four bullet items above are summarized in tabular form in Appendix A and visually in Appendix B.

2. What is the program doing now?

General Education Courses

General education courses in the MATH program address the goals of the WNMU General Education Program, emphasizing the first and fourth goal, to "Provide each student with opportunities for critical thinking and reasoning, communication of ideas and information to others, numerical analysis, and decision-making …," and to "Instill an appreciation for the variety of perspectives that are used to interpret the world in which we live and [to] provide the foundation for solving the problems that confront society." These goals are accomplished by addressing topics that include: (a) the use of graph theory in networking problems, statistical thinking, and the structure of patterns in artwork (MATH 105/106), (b) the connections among revenue, cost, and profit, decision-making within constraints, and the understanding of compound interest in investing and loans (MATH 121), (c) analyze information presented in tables, line graphs, scatter plots, pictographs, bar graphs, histograms, and pie charts (MATH 107), (d) using relationships between two quantities, both linear and non-linear, to determine trends and to solve problems (MATH 131/132), and (e) using rates of change for linear and non-linear relationships to describe quantities and to solve problems in optimization (MATH 171). The content of these courses is designed to foster analytical thinking and quantitative reasoning as well as the ability to communicate technical information. All courses make use of appropriate technology, including spreadsheets, graphing technology, or a scientific programming environment. Communicating problem solving strategies and results, in which words and mathematical symbols and objects are combined, are integrated into the courses. Efforts are made to ensure that students have the appropriate knowledge and skills to be successful in these courses, which includes the compatibility with the DVSM curriculum (along with the appropriate computer-related and writing skills). All the MATH general education courses are offered in both face-to-face and online formats. MATH general education courses for 2013 (latest data available) make up 7% of all general education courses offered at WNMU.

Service Courses

Disciplines served by these courses include Business, Nursing, Science, and Education along with a variety of other fields that require a course in Statistics. Faculty teaching service courses are in regular communication with client departments to ensure the alignment of curriculum. The department strives to resolve scheduling conflicts with other departments, in particular with the Natural Sciences Department. In doing so, at times, faculty have resolved such conflicts using innovative solutions, such as hybrid course delivery.

Courses for a Mathematics Minor

For students who wish to minor in mathematics, the Department offers a variety of upper division courses intended to suit various needs. Popular courses for these students have been Statistics, Advanced Applied Statistics, Computational Linear Algebra, Differential Equations,

Mathematical Modeling, and a course in MATLAB programming. A growing contingent of students who plan to minor in Mathematics is majoring in Chemistry. In courses, such as Computational Linear Algebra, Differential Equations, and Mathematical Modeling problems are presented that relate to the field of Chemistry, such as balancing chemical equations, modeling rates of reaction, and solving for parameters such as rate constants or activation energies.

Over the past five years a minor in mathematics has been one of the top five choices out of all minors chosen by students, the top five being shown in Table 1:

Table 1
Number of Minors

Minor Discipline\Year	2012	2013	2014	2015	2016 (Fall)
Chemistry	12	13	21	10	16
Coaching	16	17	24	19	10
Criminal Justice	15	12	20	27	21
Mathematics	15	20	19	20	13
Psychology	12	22	42	36	47

The number of student credit hours generated by courses taken by students in general education courses, service courses, and courses for the math minor in the years 2010-11 through Fall 2016 is illustrated in Table 2:

Table 2

Year	2010	2011	2012	2013	2014	2015	2016 (Fall)
SCH in MATH courses, non-majors	3083	3155	3067	3117	2898	2770	1279

Courses for a Mathematics Major

For students who wish to major in mathematics the Department offers three concentrations: Statistics/Actuarial Science, Applied Mathematics, and Teacher Education (Secondary). Regardless of the choice of concentration all students majoring in mathematics must complete a semester-long project tailored to each student's mathematical interest or career path; this is accomplished via the Senior Project and Seminar course (MATH 496).

Students who choose the Statistical/Actuarial Science concentration are exposed to the theoretical/algebraic foundations through courses such as Computational Linear Algebra and

Differential Equations, and they use these foundations to further understand the scopes and limitations of statistical procedures that they study in Probability & Statistics I, and II (MATH 471/472). Students develop further analytical maturity that enables them to solve fuzzy problems and to assess risks. The knowledge acquired has applications in the insurance industry, quality control in manufacturing, and decision trees in production management. In addition, the students develop a better understanding of the foundations of statistical procedures used by scientists.

Students who choose the Applied Mathematics concentration learn ideas and skills similar to the fundamental core curriculum in the Statistical/Actuarial concentration. However, this concentration emphasizes the movement and interplay between the contextual real world of problem-solving situations and the de-contextual math world of structures and techniques. The theoretical and the applied come together within courses in this concentration. The Mathematical Modeling course (MATH 431) offers students opportunities to apply mathematics to learn a variety of problems, including those in Mathematical Biology, Medicine, epidemics, and Chemistry. Students graduating with a degree in Mathematics having an Applied Mathematic concentration have found employment in many sectors of government (e.g., public utilities), industry (e.g., Freeport-McMoRan), and International Business (e.g., Boston Consultancy), while others have successfully pursued advanced degrees.

Students who choose the Teacher Education concentration find the preparation necessary to become a high-school mathematics teacher, as well as gain adequate knowledge to obtain their Teacher Licensure. The demand for high school mathematics teachers in New Mexico continues to exceed the supply. Our graduates have no trouble finding a job, with many remaining in the southwest New Mexico region. The Department has recently hired a new faculty member to work with and advise students who are training to become high school mathematics teachers. Western New Mexico University will likely receive a Noyce Scholarship grant from the National Science Foundation, so that students who are studying to become high-school mathematics teachers will be eligible to receive scholarships. Furthermore, the new faculty member developed a new course (MATH 107) for the specific purpose of aiding education students in passing mathematics-based entrance exams for the School of Education.

The number of mathematics majors along with the student credit hours generated by courses taken by mathematics majors and minors in the years 2010-11 through Fall 2016 is illustrated in Table 3:

Table 3

Year	2010	2011	2012	2013	2014	2015	2016 (Fall)
SCH in MATH courses, majors	273	279	241	375	400	554	240
Number of Majors	20	18	22	21	22	24	25

It should be noted that the 2013 average class size for all lower division MATH courses is 19.5 students, which is 34% higher than the average class size for the College of Arts and Science and 105% higher than the average class size for the University. For upper division MATH courses the average class size is 12.1 students, 175% higher than the average class size for the College of Arts and Science and 188% higher than the average class size for the University.

Finally, department faculty regularly explore innovations in technology and teaching methods to enhance students' skills in applying mathematics to STEM disciplines. Some examples of the student-centered activities employed in various courses are given in Appendix C.

3. Should it be doing what it is doing now?

All four categories of the MATH program are accomplishing aspects of what they should be doing. General education courses support the goals of the University's General Education Program. Service courses, such as the Business sequence, Mathematics for Business Applications I and II (MATH 121/221), support students who need to take courses in Economics or the Mathematics for Health Occupations course (MATH 125) which has served students majoring in Nursing by helping them be successful on proficiency exams that assess mathematical proficiency in areas relevant to their career. Courses for the mathematics minor continue to support a number of students who wish to complement their major with a practical and applied discipline to further their career opportunities, making the mathematics minor one of the most popular minors in the University. Finally, courses for the mathematics major consistently produces graduates that have no issues when looking for a job or pursuing an advanced degree.

Nevertheless, there is always room for improvement. The responses to the next two questions address this.

4. If not, what should it be doing?

General Education Courses

Although the general education courses in the MATH program incorporate critical thinking and communication, there is currently no consistent framework by which this happens. Student experiences in these courses have varied greatly depending on the mode of delivery (face-to-face or online) and on the instructor. This is due, in part, to the fact that a number of these courses are being taught by Adjunct faculty. Consistent guidelines should be developed for instructors who teach these courses. The guidelines should include general principles for all the general education courses as well as principles that guide the connections among sequences of courses, such as MATH 131, 132, and 171 or DVSM 102 and MATH 105/106.

Service Courses

Although communication takes place between faculty teaching MATH service courses and faculty in client disciplines, this is done on an ad hoc basis. There needs to be a structure or process that supports this communication so that service courses can regularly be reviewed and updated (e.g., in the choice of topics, applications, or technological tools and strategies) to meet the needs of the client disciplines, in terms of supporting material for their respective courses as well as in terms of job preparation for their students. A particular example of this is the College Algebra course (MATH 131); after communicating with faculty in both Natural Sciences and Nursing a proposal was made to increase the credits hours from three to four in order to include

material relevant to their disciplines (as well as to Business). The Proposal was approved, and is currently in practice. In addition, faculty in client disciplines need to become knowledgeable about the conceptual understanding along with procedural and technological skills that students in the respective service courses are gaining so that they can better integrate that knowledge into their respective courses. Further, the need for this communication between departments is necessary so as to avoid or minimize conflicts in course scheduling. Mathematics Dept. and the School of Business recently started a collaborative dialog to vertically align Math 321 with a new course in Econometrics that will be offered through the School of Business, cross-listed with MATH 421, Advanced Applied Statistics. The introduction of the said Econometrics course is in its early stages of development.

Courses for a Mathematics Minor

STEM disciplines need people to be able to use the tools of technology to solve applied, real-life problems, as well as know where and how to access information. Computer-based mathematics is becoming the modern focus in STEM disciplines, wherein the emphasis lies in teaching students to reason quantitatively while using technology to make the calculations, as opposed to teaching students *how* to calculate. To be successful in these endeavors, continued efforts need to be made to give students 24/7 access to the software and computer systems used in their courses and to keep up-to-date equipment and software. Further, faculty teaching MATH courses relevant for the mathematics minor need the time (or professional development) to learn and master these ever-changing technologies in order to make appropriate changes to the course materials and delivery methodologies.

Courses for a Mathematics Major

In addition to the items mentioned for the Mathematics Minor some specific tasks apply to the Mathematics Major. First, the Advanced Applied Statistics course (MATH 421) needs to be molded into a service-learning course through partnerships with other campus departments/divisions or community organizations in need of data analysis. Second, a more defined process to assess the suitability of the current mathematics major concentrations is needed. Further, in light of the technological needs of individuals pursuing STEM disciplines, the feasibility of adding a computational science concentration needs to be determined.

5. How should it do what it should be doing?

General Education Courses

To move toward accomplishing a more consistent experience for students in these courses there needs to be a coordinator for MATH general education given the appropriate release time. The coordinator could provide professional development for Adjunct faculty who teach these courses. It will also be imperative that appropriate Adjunct faculty be hired and scheduled for these courses. Not only are these courses important for students obtaining their general education credit, one of these courses (MATH 107) serves pre-service elementary teachers and other courses are ripe with students who would find it helpful to either minor in mathematics or double major in mathematics, but successful experiences and the appropriate advising would be necessary.

Service Courses

To accomplish the communication necessary to keep MATH service courses updated and relevant, the Dean of the College of Arts and Science/Provost can play a key role. Creating a forum for sharing each other's work or allocating resources, such as release time, for faculty to develop materials or projects that could be implemented in both MATH courses and client discipline courses could serve as foundational elements in moving these needs forward. In addition, support by administrators for efforts to modify courses when deemed necessary by discipline faculty, such as the College Algebra proposal mentioned previously, would add value to efforts made by faculty to improve their communication.

Courses for a Mathematics Minor or Major

Administrative support and resources are key ingredients in addressing the needs related to courses for the mathematics minor or major. Computer hardware and software, 24/7 access, qualified faculty positions, and professional development (for keeping up-to-date not only with appropriate technology but also with appropriate teaching methodologies). Further, to accomplish the program goals more follow-up and connection is needed with our program graduates (e.g., surveys or other planned events) to determine aspects of our program that they found most relevant or least relevant to their respective career paths. Here, the Provost or Dean can be a great asset in providing a structure in which the department and the alumni office can work together effectively.

6. Appendices and Other Supporting Information

Appendix A

MATH Course Offerings and Program Categories

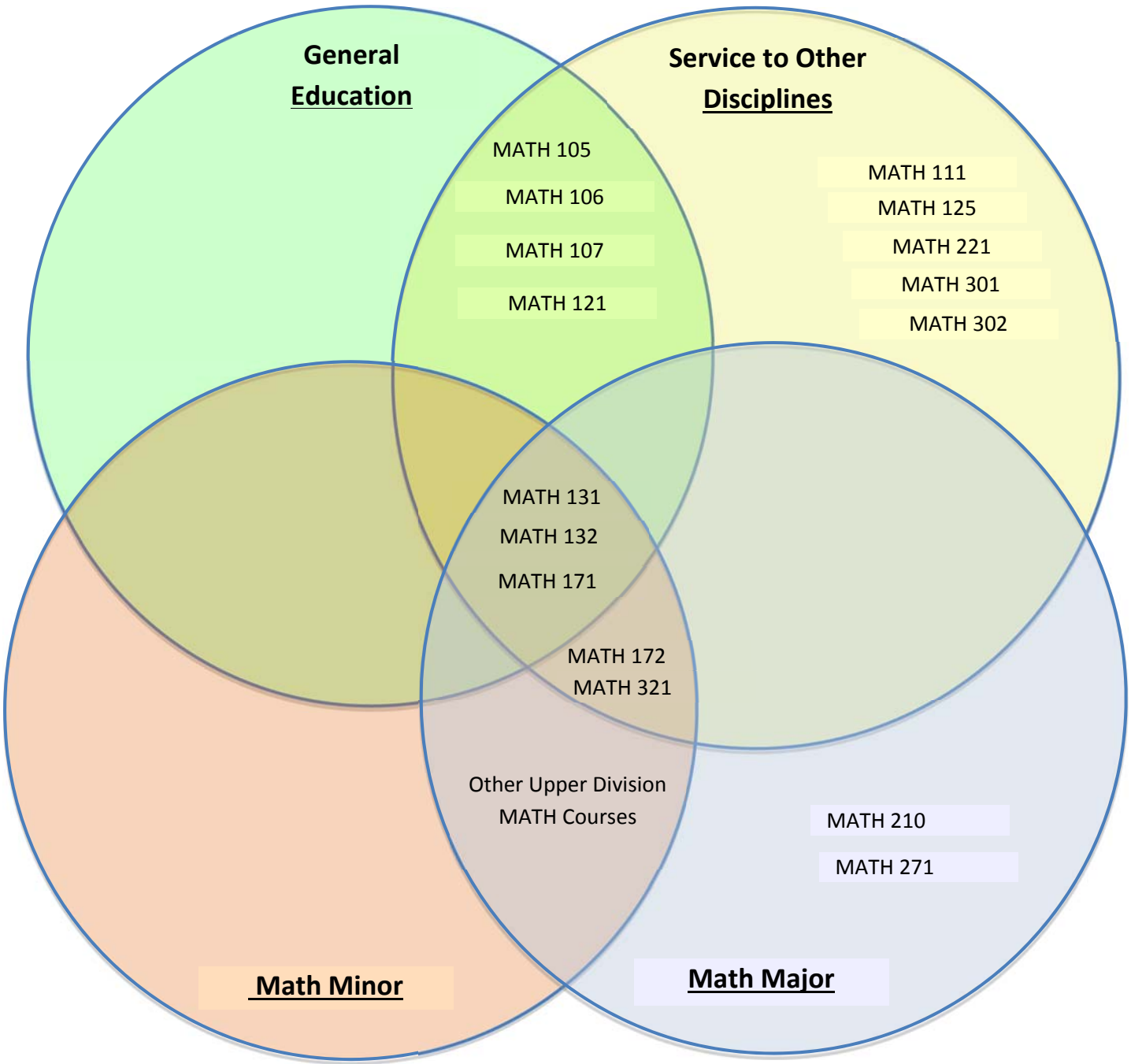
Course	Title	Credit Hours
MATH 105	Mathematics for the Liberal Arts I	3
MATH 106	Mathematics for the Liberal Arts II	3
MATH 107	Mathematics for School Teachers	3
MATH 111	Intermediate Algebra	3
MATH 121	Mathematics for Business Applications I	3
MATH 125	Mathematics for Health Occupations	3
MATH 131	College Algebra	3
MATH 132	Trigonometry	3
MATH 171	Calculus I	5
MATH 172	Calculus II	4
MATH 210	Foundations of Mathematical Thinking	3
MATH 221	Mathematics for Business Applications II	3
MATH 271	Calculus III	4
MATH 301	Understanding Elementary Mathematics I	3
MATH 302	Understanding Elementary Mathematics II	3
MATH 321	Statistics	3
Other Upper Division MATH Courses		3

Course	General Education	Service to other disciplines	Minor	Major
MATH 105	X	X		
MATH 106	X	X		
MATH 107	X	X		
MATH 111		X		
MATH 121	X	X		
MATH 125		X		
MATH 131	X	X	X	X
MATH 132	X	X	X	X
MATH 171	X	X	X	X
MATH 172		X	X	X
MATH 210				X
MATH 221		X		
MATH 271				X
MATH 301		X		
MATH 302		X		

MATH 321		X	X	X
Other Upper Division MATH Courses			X	X

Appendix B

Interrelationships Among MATH Course Offerings



Appendix C

Examples of Student-Centeredness and Other Program Initiatives

Student-Centeredness

The student-centered learning environment in MATH courses involves both curriculum and pedagogy aspects. The curriculum is problem-centered, relevant *and* engaging, relating students' daily experiences and newsworthy events to the mathematical principles being studied. Students complete tasks, either individually or working in small groups, that are part of sense-making activities, activities that require students to solve problems, make conjectures, experiment, explore ideas, and communicate results. Modern technological tools, such as interactive videos or those provided by Mathematica, MatLab and Scientific Notebook, are used to coach students in directed experiments, allowing them to actively participate in the discovery of the conceptual understanding and procedural skills necessary to become proficient with the mathematical material. This, together with employing pedagogical strategies that address various learning styles, supports student engagement and self-directed learning, and creates an environment in which students make their own connections between their major course of study and mathematical concepts. Pedagogical approaches include a hybrid or digital delivery method and interactivity of courses, with the instructor acting as a facilitator and not necessarily the primary knowledge source. In addition, assessment techniques include student participation so as to support a motivated learning process.

The table below summarizes a few concrete examples of topics and innovations used to exemplify the ideas in the previous paragraph.

Concept(s) Being Demonstrated	Innovative Tools and Activities	Related MATH Course(s) and Cross-Disciplinary Connections
Exponential Growth and Decay	Classroom presentation of videos, e.g., the Exponential versus Constant Growth Video, which allows the viewer to act as pilots in spaceships headed to earth travelling first at an exponential rate of growth and then at a constant rate. Also used are Excel diagrams and news stories regarding the national debt (also see U.S. Debt Clock http://www.usdebtclock.org/), cancer tumor growth, 2011 radioactive-isotope poisoning of tuna from the Japanese tsunami and 2014 designer drugs known as *bath salts*. These events are then shown by students to be real-life examples of exponential growth or decay using in-class worksheets with interactive investigations by Mathematica CDFs.	MATH 132, MATH 171, MATH 221, Economics, STEM

Business and Economics topics	Students learn the mathematical interpretation of concepts such as demand, supply, marginal cost (revenue, profit), marginal propensity to consume, and elasticity of demand. In addition, using software such as EXCEL's Solver students learn how to solve complicated problems in Linear Programming, and Optimization in general.	MATH 121, MATH 221, Economics
First Derivative as Slope of Graph; Second Derivative as Concavity Indicator and Slope of the Derivative Graph	Olympic Snowboarding YouTube Video Interactive CDF on Snowboarding over Derivatives: Shows the geometric nature of the first and second derivative using a snowboarder, where you imagine watching a snowboarder using a telescope. The inclination of the snowboard gives a numeric value for the first derivative, as read from the calibrated scale on the edge of the telescope. Here we assume that the snowboarder is not jumping, so that the board is always tangent to the slope. The second derivative is represented geometrically by how the front tip of the snowboard rotates upwards or backwards. You can make flags show in places where the first and second derivatives are zero and you can choose different courses for practice.	MATH 171, All-Encompassing
3-D Vector Algebra of Dot and Cross Products on Parallelepiped	Interactive CDF on Scalar Triple Product: In three dimensions, a parallelepiped is a prism whose faces are all parallelograms. The tool allows the user to input vectors defining a three-dimensional parallelepiped. Then the figure is displayed, and its volume is given by via computing the scalar triple product.	MATH 271, STEM
Numerical Approximation, Vectorizing MatLab Code and Algorithm Timing	Comparison of the approximation of the ellipse's circumference using circumscribing and inscribing techniques in the MATLAB programming environment. Students experiment with approximating an ellipse's circumference with half the class writing a MatLab program to calculate a lower bound and the other half writing a MatLab program to calculate the upper bound. This is followed by a sharing of results, computing their accuracy and comparing the timing on code using vectorization versus non-vectorization. This activity uses peer-to-peer interaction, collaborative thinking and promotes a very active learning environment.	MATH 480, STEM, Business & Industry

Other Program Initiatives

For general education and service courses, the department is continuously evaluating the number of students in need of MATH courses, and providing instructors and sections appropriately. This includes determining the proportion of such courses with regard to student needs in online learning and face-to-face sections. The department is also regularly revising curriculum with regard to standards of the state and other agencies regulating the needs of other departments or programs requiring accreditation. In addition, this includes continuously evaluating the compatibility of lower division math courses with the MATH remediation curriculum.

The department continues to effect communication with the Center for Student Success and with advisors from other departments to ensure proper placement in prerequisite course sequences. Additionally, the department communicates with advisors of STEM students to coordinate and synchronize course rotations.

Further, since Fall 2015 the Math and Computer Science department has assumed the responsibility for continued development and maintenance of the pre-engineering pathway. This entails three components described below.

- Recruitment—In partnership with Admissions, each prospective WNMU student indicating an interest in an engineering field is contacted via email by faculty in the math department. Students are informed of options in mathematics (including BS and AS degrees) that could enhance further study of engineering at other universities.
- Advising—Current WNMU students interested in transferring to engineering programs at other universities are advised by math faculty.
- Partnerships—Math faculty are actively pursuing partnerships with universities to ensure that students transitioning from WNMU to those universities' engineering programs have the best foundation and chance of success possible.

Also, the department has created an associate's degree in mathematics that will take effect starting in AY 2017-18.

Finally, to enhance the math community environment the department: (1) Hosts a Math Club for majors and minors with activities to include lessons, (visiting) lecturers with topics ranging from jobs to research results, competitions, snacks and field trips; and (2) Plans to host math conferences for students and faculty.

Mathematics and Computer Science