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Program Review Self-Study Mathematics 2016

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UNO Department of Mathematics

Spring 2016 Self-Study

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Overview and Objectives of the Department

The Department of Mathematics consists of 26 faculty members (19 professors and 7 lecturers/instructors), 2 staff assistants, and an academic coordinator. The faculty members can be broadly categorized into four groups with respect to research and teaching: *applied mathematics*, *mathematics education*, *pure mathematics*, and *statistics*. Below is a list of faculty members and some general faculty areas of expertise within each category.

Applied Mathematics (John Konvalina, Jack Heidel, Betty Love, Dora Matache, Slava Rykov, Zhenyuan Wang, Jim Rogers, Mahboub Baccouch)

Differential Equations
Discrete Mathematics and Combinatorics
Dynamical Systems and Chaos Theory
Mathematical Biology
Numerical Analysis
Nonlinear Optimization
Operations Research
Scientific Computing

Mathematics Education (Janice Rech, Michael Matthews, Angie Hodge, Judy Downey, Mary Dennison, Kathy Vranicar, Darren Holley, Sam Butler-Hunziker, Michael Pivovar, Jeff Hazuka)

Calculus Education
Math Lab
Math Teacher Education

Pure Mathematics (Griff Elder, Valentin Matache, Andrzej Roslanowski, Robb Todd)

Algebra
Number Theory
Real and Complex Analysis
Complex Functions and Operator Theory
Set Theory
Topology

Statistics (Steve From, Andrew Swift, Mahbubul Majumder, Xiaoyue Cheng)

Computational Statistics
Data Science
Probability and Mathematical Statistics
Statistical Modeling and Inference

The goals of the department encompass six areas which allows the department to provide a full range of educational services and opportunities for our community and region. They are as follows:

General Education Courses

Intermediate Algebra (Math 1310) is a minimal general education requirement for all undergraduate students at UNO. All sections of Pre-Intermediate Algebra (Math 1000), Intermediate Algebra (Math 1310), College Algebra (Math 1320), and Calculus for Managerial, Life and Social Sciences (Math 1930) are taught in the UNO Math Lab.

Undergraduate Service Courses

There are also multi-section service courses in trigonometry, calculus, discrete mathematics, applied linear algebra, differential equations and several different levels of statistics. The department also offers a multi-section course Applied Algebra and Optimization (Math 1370) for business majors. Many other courses, with smaller enrollments, also are taken by majors in other disciplines.

Undergraduate Study in Mathematics

The department offers Bachelor of Arts and Bachelor of Science degrees with a major in Mathematics. A Bachelor of General Studies degree with a concentration in Mathematics is offered through the Division of Continuing Studies. These undergraduate programs have two objectives: to prepare students for productive careers in business and education and to prepare students for graduate study in mathematics and other fields.

Graduate Study in Mathematics

The graduate program is designed to be flexible. Most of our graduate students are either working for business or government in the Omaha area or teaching in a local school system. The department offers a Master of Arts in Mathematics, a Master of Science in Mathematics, and a Master of Arts for Teachers of Mathematics to serve these individuals. A few of our graduates go on to earn a PhD at another university.

Research

Most of the 20 PhDs in the department are active in research in their particular area of expertise. There is a substantial amount of collaborative research effort both within the department as well as with scholars representing other disciplines.

Community Outreach

The department has a very strong and active community engagement program. Examples include: (1) a very successful dual enrollment program with local high schools, (2) professors networking with local math teachers called Omaha Area Math Teachers' Circles, (3) several very popular high school math and problem solving competitions, and (4) forming partnerships with local businesses and institutions to create internships and to engage our students to work on real-world projects while earning their degree.

Overview of the Academic Program

An undergraduate degree in Mathematics consists of 47 hours of required courses in mathematics and computer science. In addition to the traditionally required lower division mathematics courses, math majors have the option to choose the upper division courses in a *concentration* such as pre-actuarial math, statistics, data science, math education, pure research, and operations research. For a BS degree the student takes an additional 18 hours in cognate courses outside of mathematics. For a BA degree the requirement is 16 hours of a foreign language instead of a cognate area. Furthermore there are 50 hours of general education requirements by the College. Thus the typical BS major has a minimum specified credit hour requirement of 115 out of the 125 hours required by the College for graduation.

The MA and MS degree programs have no specific course requirements and allow up to 1/3 of the course work to be outside of mathematics. The typical MS degree requires 36 hours of course work (half of which must be in graduate-only courses) and a written comprehensive examination. The MS degree also has a six hour project option and 30 hours of course work. This option is very attractive to students interested in data science, statistics, and operations research. The MA degree requires 30 total hours, including six hours of credit for a thesis, and at least nine additional hours of graduate-only course work. The MA degree with thesis is frequently pursued by students planning further graduate education, such as a doctorate.

The MAT degree, with 36 required hours, provides an opportunity for mathematics teachers in the Omaha area to pursue a graduate degree that includes a substantial amount of mathematics combined with a few education courses. There is a research component for students who are so inclined which often leads to published results in Mathematics Education journals. MAT graduates are often hired by local community colleges.

Responses to Recommendations of Previous Evaluation Team

We have selected parts of the paragraphs containing recommendations from the 2009 review team and included our responses below in italics:

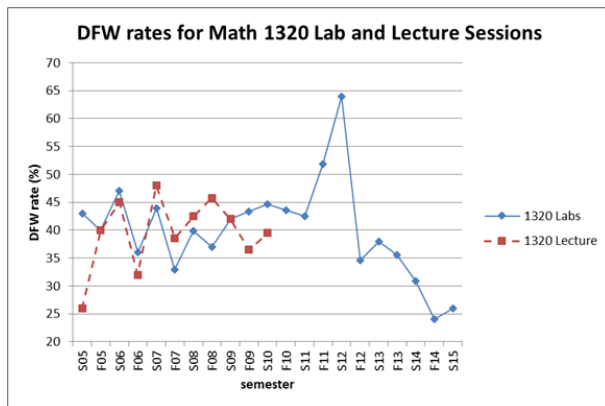
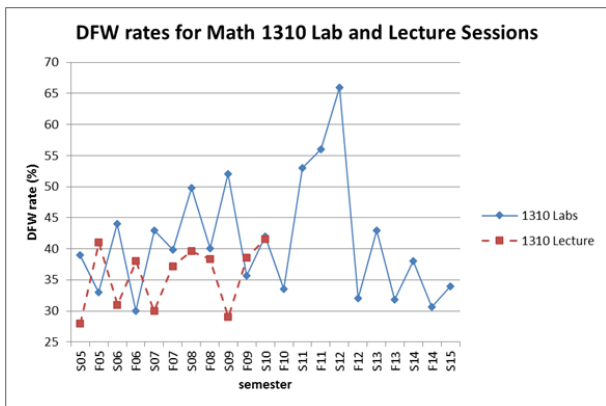
Assessment of the Unit and Its Programs

2009 Review Recommendation: The DFW rate of the lab session of Math 1310 (Intermediate Algebra) is still wandering at unexpectedly higher marks in comparison with the lecture sessions. (...) The committee supports the continuous running of the Math Lab and encourages the department and the Lab Director to focus on the improvement of the learning outcome of the 1310 Math Lab session in the near future.

Response 2015: The decision of the Math department to redesign the UNO Math Lab has had an extremely positive influence on the improvement of the learning outcomes of both 1310 and 1320 Math Lab courses. A new math placement exam was written in spring 2012 by the Math Lab Director to better place our students into Algebra and Calculus. Also, the introduction of Math 1000, Pre-Intermediate Algebra, by the chair of the department has brought students to the Math Lab who are better prepared for Math 1310.

Concrete results from these actions were immediate and dramatic, starting in fall 2012. As can be seen in the 10-year performance graphs below, after the completion of our transition of all course sections moved to the lab, the DFW rates of Math 1310 dropped to 32% and have trended downward every fall semester since and are currently at 30.6%. (Note that the lecture sections, in red dashed lines, were dropped in 2010 for both Math 1310 and Math 1320 in order to maintain uniformity and consistency in algebra education.)

In the spring semesters, the DFW rates of Math 1310 similarly trended downward. The spring rates are a bit higher because many students in the spring are repeating the course because of failures in their first fall semester. They are currently at 34% in spring 2015. Improvement was even more dramatic in Math 1320. In fall 2012, the DFW rates of Math 1320 dropped to 34.6% and have trended downward every fall semester since and are currently at 24% in fall 2014. In the spring semesters, the DFW rates of Math 1320 similarly trended downward, and are currently at 26% in spring 2015. The redesigned Math Lab can be credited for this remarkable turn-around of learning outcomes which currently boasts the amazing withdrawal rate of only 5%.



These results show that the major changes in the Math Lab the last three years have been successful and resulted in much lower DFW rates, minimal student dissatisfaction, and positive student feedback regarding the very helpful and user-friendly Math Lab environment.

2009 Review Recommendation: The department has implemented the Major Field Assessment Test (MFAT), a national examination, to measure undergraduate student

learning outcomes in mathematics. The MFAT score analysis is being expanded immediately by the department to include a question by question breakdown of the performance of the students.

Response 2015: The mathematics majors graduating from UNO during the last few years score at least at the national average on the MFAT, whether one looks at the mean or the median. The performances of UNO mathematics graduates and of mathematics graduates from comparable peer institutions (as categorized by ETS) are not different in terms of statistical significance. We do not have further breakdowns on various areas due to the high cost of the MFAT. We have been in contact with other universities and are reconsidering the suitability of MFAT to assess the student learning outcomes of our own students. In particular, besides the high costs, we consider that the way ETS groups peer institutions may be unsuitable for meaningful comparisons.

Given the disappointment in the effectiveness of the MFAT assessment tool, the department Assessment Committee has developed a comprehensive alternative plan that includes a locally-developed assessment tool in an attempt to generate the results that had been hoped for from the MFAT. The committee has approved a course of action to develop the new test, and this approach has been approved by the full department. The Chair of the Assessment Committee has consulted the Chair of the University Assessment Committee and plans to work with that office going forward as the new testing tools are developed. It is expected that the first (trial) implementation of the tool will occur in the 2016-17 academic year.

Utilization of Resources

2009 Review Recommendation: UNO library may need to obtain electronic access to collections at UNL Library as gaps in UNO Library collections limit faculty research.

Response 2015: This recommendation has been the subject of much activity in the department since it was made. While some members of the Mathematics Faculty have courtesy appointments at UNMC and thereby have electronic access to UNMC library periodicals, others depended on electronic access to UNL library periodicals by developing relationships with UNL Faculty which sometimes led to courtesy appointments at UNL. However, this has proven to be a bit too ad hoc.

Since the last review, another serious library issue has developed; the more and more common imposition of page charges on our faculty members when they have manuscripts accepted for publication. These expenses have become increasingly difficult to bear, requiring action in addition to the ones recommended by the last review committee.

In the face of these issues, the department has taken concrete action. First, in order to reduce expense incurred by the library for subscriptions, our department has gone through a detailed process of updating our own library subscriptions, eliminating a number of journals of little interest and replacing them with new titles that would satisfy a wider population. In addition, we have requested that the library redirect some of the subscription resources to help with page charges.

During the course of these actions on the department's part, there was another positive development; the addition of a new STEM librarian, Heidi Blackburn, to UNO's Criss Library. The department of mathematics has worked in conjunction with Ms. Blackburn and made significant progress on all issues: The UNO library is now offering a convenient inter-library loan service, as well as an online ordering system for interlibrary loan copies of journal articles, and they are also now offering page charge support.

With the department's action and the new personnel and focus at the UNO library, we have largely addressed the committee's recommendation and expect that library issues will be more manageable in the future.

Diversity and Gender Equity

2009 Review Recommendation: ...the department may work on the diversity issue in the future hiring of faculty in terms of hiring qualified female faculty and qualified faculty with color.

Response 2015: Given the importance of addressing issues surrounding lack of representation of women and minorities in the STEM fields, the department takes diversity and gender equity very seriously. As a result, the department has addressed this recommendation through direct action. For all positions, women and minorities are actively encouraged to apply, and the department of mathematics has been very successful at recruiting, retaining, and promoting women and people of color.

As evidence of our action in this area, the trends in faculty hires, promotion, and success in scholarship speak for themselves: Out of the 26 faculty, there are eight female faculty, four of whom are tenured, one on tenure track, and the remaining being masters level lecturers. Also, among our faculty members we have a Tunisian, a Japanese, two Romanians, one Polish, one Russian, one British, one Bangladeshi, and two Chinese. The most recent hire in 2015 was a qualified female assistant professor.

The department is proud of its success in supporting women and minority faculty members, value their unique contributions to our mission, and intend to continue to embrace an attitude of inclusiveness in every activity and at every level.

Assessment of major strengths, challenges, and unit's plans to address

2009 Review Recommendation: ...a strategic approach of maintaining a steady pool of part-time instructors is needed.

Response 2015: The department has, by necessity, developed a highly strategic approach to part-time instructor hiring and retention. Due to ongoing budget cuts, the role of part-time instructors has been

completely re-evaluated by the department.

Following this re-vamping, a reduced, yet substantial, pool of highly qualified part-time instructors has been created. These valued instructors play an important role in our instructional program; all of them have advanced degrees, including several with doctorates. In order to maintain and oversee this pool of instructors, the department has a senior faculty member that maintains a database of qualified applicants and coordinates the evaluation and hiring decisions related to them.

Since the 2009 review, at which time 18 different part-time faculty members taught 25 courses, the new strategic approach developed in response to the committee's recommendation has resulted in 13 part-time faculty teaching 14 classes. Furthermore, the pool of qualified part-time instructors has stabilized, meaning the department has had no difficulty hiring highly qualified instructors as needed.

2009 Review Recommendation: The review team recommends the department give primary emphasis of hiring new faculty in demonstrated areas of student interest and need, in combination with considering some overlapping of faculty research expertise in applied mathematics areas.

Response 2015: The mathematics department has developed a new Strategic Plan consistent with the College that includes plans for appropriate hiring strategies. The new plan can be viewed in Appendix 6, but a brief overview is as follows: The two most recent hires in the last three years were Ph.Ds. in Statistics with overlapping faculty research interests. This has led the department to develop a new and very popular program in Data Science to satisfy the demand by students, businesses, and institutions. The department will also be hiring two new assistant professors in the next three years and will, as recommended, consider areas of expertise that are in demand, as well as common research interests.

2009 Review Recommendation: The department needs a strategic plan to help guide growth and hiring decisions in the future and to help channel the resources it has.

Response 2015: As with the previous recommendation, this one is addressed in the new Strategic Plan that is contained in Appendix 6 (see Section IV). In that section, the human resource needs of the department are laid out in the context of the mission of the department and university. Highlights of that section include the goal of obtaining new faculty members and teaching assistants, and carefully determining how those positions will be specified such that they further the department's mission.

2009 Review Recommendation: There are some challenges presented in the current curriculum of the department. Students mentioned that they need more courses in specific topics. Pure Math majors struggle to get courses they need because they are required to have an area of concentration outside their major. Math requirements of MAT students is “disconnected” with their teaching job as the coursework does not connect math to pedagogy.

Response 2015: *There has been much activity in the department to address this recommendation. In fact, both the undergraduate curriculum and the MAT program have had major overhauls since the 2009 recommendation.*

The undergraduate curriculum for majors is more flexible and includes an option of upper division concentrations such as pre-actuarial math, statistics, data science, math education, pure research, and operations research. A cognate area outside of mathematics is required for the BS degree. The student can opt for a BA degree and avoid the cognate area requirement. In the MAT program new courses have been added and several existing courses updated to connect the mathematics to the pedagogy.

Based on anecdotal student feedback, the department feels that the actions taken so far have, at least in part, addressed this issue. The situation will be monitored going forward and changes made as needed.

2009 Review Recommendation: There was a bit of concern about travel money especially for pre-tenure faculty group. ... Big concern about limitation of their growth as scholars and their research productivity being limited or thwarted by the “budget crunch” casts some challenge on budgeting the department’s faculty development fund.

Response 2015: *As the department has little control over the funds available for any faculty to travel, this is an issue that is difficult to address at the department level. However, the department has done all that's within its power to do to address the recommendation. The travel policy for the last six years has been very consistent and all faculty wanting travel money can receive it. Typically, the dean’s office provides \$1000 and the department \$500, so a total of \$1500 has been available annually to all faculty requesting travel funds. The department acknowledges the importance of travel in junior faculty's academic development and will continue to work to make travel as attainable as possible.*

2009 Review Recommendation: The department currently has no explicit discipline-specific guidelines on promotion and tenure and thus the pre-tenure faculty members are not clear on specifics in order for them to get tenured.

Response 2015: *The department acknowledges that this was a problem in 2009 and has taken action that appears to have addressed the issue successfully. Prior to 2009, each pre-tenured faculty member was assigned to a department faculty mentor for guidance and assistance during the tenure process. It turns out that this was inadequate; mentoring faculty members, while knowledgeable in the technical aspects of a pre-tenure faculty members research, often were not knowledgeable in the area of the administrative aspects of the tenure process. Because college rules, requirements, and styles change considerably over time, tenure candidates in the department often received little or no advice on proper setup and presentation of their credentials.*

In order to address this issue, the department created a new position of “RPT Coordinator.” The person(s) appointed to this position are required to have recently served on the college RPT committee

and, thus, be up to date on all administrative policies and procedures related to the candidate's portfolio. The research mentor is still appointed, but is relieved of the responsibility of advising on technical administrative issues that they would have no way of knowing unless they had recently served on the college committee.

This new arrangement appears to have addressed the problem; all five pre-tenure candidates since 2009 have received tenure.

2009 Review Recommendation: Teaching load combined with supervision of independent studies and student activities seems to be heavy for pre-tenure faculty members.

Response 2015: The department acknowledges that teaching load can be an issue for pre-tenure faculty members but, unfortunately, there is not much action that the department can take unilaterally to address it.

Research release time is available to all pre-tenured faculty to reduce the teaching load. Typically, this reduced load is continually available during the pre-tenure period. All pre-tenure faculty members that were evaluated for tenure since the 2009 report did, in fact, receive tenure. All of these members received acceptable reviews for their research productivity, indicating that they were able to handle the load.

While the choice of offering independent studies is voluntary, work load credit is provided for accumulated independent studies and several faculty members, including pre-tenured faculty, are responding to this incentive. Students greatly appreciate this opportunity to work individually with faculty.

Recommendations for the Future Development of the Unit and Its Program(s)

2009 Review Recommendation: The review team suggests the department to run a series of seminars to share faculty and student research being done in Math Department and to invite UNL math faculty members to give seminars on researches that UNO math faculty is most interested in.

Response 2015: Research meetings and seminars between UNO and UNL faculty, as well as between UNO faculty and students, have been taking place for a long time now (more than seven years). We organize such seminars whenever there is a need for or interest in them. We offer regular colloquia, and interested faculty members drive down to UNL for seminars. Due to the size of our department we do not have a large number of research groups, so much of the research in the department is done in collaboration with other researchers from the US or the international mathematical community.

That said, the department has taken action to address this recommendation. First, we have started a "Cool Math Talk" series targeted to presenting some interesting topics to our lower level

undergraduate students. Second, the Math Club has organized a “Meet your Professor” series where faculty members present not only their research, but also information on their lives and careers. Some of our students are supported to attend and present their work at various mathematics events such as the MAA or AMS Sectional or Regional Meetings.

Based on attendance and informal conversations with students, these talks appear to have been successful and we plan to continue them.

2009 Review Recommendation: Pre-tenure faculty members are “the future” of the department. The department is recommended to make the current mentoring program really work for these pre-tenure faculty members.

Response 2015: The department agrees that proper guidance and mentoring of junior faculty is critical for both the department and the future of academics in general. The department feels that it has fully addressed most of the mentoring issues with the creation of the RPT Coordinator position, as described above. The success in tenure awards supports this conclusion, but the department will continue to monitor this situation to ensure that there is no “advising drift” over time.

2009 Review Recommendation: ...The review team recommends the department to form a budgetary committee in order to establish a transparent policy on spending the departmental F&A funds. One special recommendation is to set aside some money in F&A to support faculty travel to conferences and especially to support at least one trip per fiscal year for junior faculty members who are working for their tenure.

Response 2015: The department has not had a long history of being awarded F&A funds in the past; in fact 2002 was the first year ever that the department has had any F&A funds. Thus, no departmental mechanisms were in place to deal with F&A money. In the past several years, however, the department has had great success in grant awards and dealing with the associated F&A funds has presented some challenges. The amount received fluctuates from year to year and it is thus difficult to spend these funds effectively during the year in which they are received. This makes it difficult for a budgetary committee, as suggested in the recommendation, to establish policies of transparency on spending F&A funds.

In an attempt to move toward a committee system, the first step was that a comprehensive budget report was prepared by the previous chair and made available to the department for review. As a second step, the current chair has set up a mechanism that allows all departmental budget numbers, as provided by the university, to be reviewed by any department faculty member at any time.

As the department has had time to familiarize itself with the budget numbers, the next step in the process will be to actually form the recommended budgetary committee. The committee's mission and reporting activities will be decided by a vote of the full department.

As far as travel money for junior faculty, the response to this is contained in the response to the recommendation regarding pre-tenured faculty concerns above.

2009 Review Recommendation: The department should establish a set of discipline-specific guidelines on promotion and tenure and clearly state the expectations on pre-tenure faculty. These guidelines should emphasize third year review and make the third year review a clear guidance for the pre-tenure to work on in the remaining of their pre-tenure years.

Response 2015: Following this recommendation, the department met to discuss the possibility of creating discipline-specific guidelines on promotion and tenure, and to develop a set of expectations for pre-tenure faculty. However, it was concluded that, as academic excellence is not reducible to a finite set of well-defined activities, it would be impossible for the department to develop specific expectations for the pre-tenure faculty. In fact, it was concluded that it was more advantageous to let these faculty members develop their teaching and research programs in the way they felt was best-- that providing too concrete of guidance might actually have a negative influence of these junior faculty members' development and hurt their chances at tenure.

Thus, rather than taking a risk on creating more confusion than clarity, it was decided to help these faculty members with direct assistance with the technical aspects of their tenure case by the creation the RPT Coordinator position, as was described in previous sections above.

The evidence suggests that these decisions and changes were successful-- all five pre-tenure faculty have, in fact, received tenure over the previous period.

2009 Review Recommendation: Structure of Department Committee for the Masters of Arts for Teachers of Mathematics (MAT) should be examined with a view to improving “connectedness” or relevance of the Math courses required for the MAT students with pedagogy, particularly at the secondary level. Add to the MAT curriculum an integrative assignment at the “front end” to integrate learning near the beginning of the program as the “capstone” integrates learning at the end. Address the lack of connection among MAT students by providing structural support to facilitate collaboration: may form a Preservice Teachers of Mathematics NCTM affiliate and may develop “Models of Teaching” classes within Mathematics to provide opportunities for undergraduates to engage in Mathematics from a teaching perspective.

Response 2015: It appears that this feedback is most relevant to the pre-service secondary education majors. For example, the capstone course is not part of the MAT degree but is a capstone of the pre-service secondary education program, although since the course is cross-listed as a graduate course, some MAT students take it as an elective but not as a true capstone of the MAT degree. The structural support discussed above is in fact intended for pre-service secondary education majors, not for the MAT student directly. For the undergraduates, the pre-service secondary education majors, this lack of connectedness among each other is a huge problem. However, we have seen little evidence of the same issue among the MAT students.

We agree that the connectedness of the math courses to pedagogy can and should be reviewed for

both the MAT program and the pre-service secondary education program. We have already taken steps to update the MAT program by revising existing core courses to make them pedagogically relevant. Also, we believe that providing the structural support to facilitate collaboration is a necessary step for the pre-service secondary education majors.

2009 Review Recommendation: The review team recommends the departmental curriculum committee considering the designation of “core courses” in its Master’s programs so that students get necessary trainings in fundamental mathematics courses that are viewed as standard courses in other universities. By doing so, the department can also streamline each faculty member’s teaching concentration on several courses so that each faculty member gets more time on their research agendas.

Response 2015: This recommendation has been difficult to address as we have a diverse graduate program with mostly part-time students. However, in an attempt to address it, we have introduced graduate concentrations in data science, statistics, and operations research. We are and will continue to monitor the effects of this action over time, and modify as necessary.

As these concentrations evolve, they will provide the preliminary information necessary to aid in the creation of the recommended core courses.

2009 Review Recommendation: The review committee recommends the department to actively engage in a strategic planning process to identify short and long-range goals of the department. ... A strategic planning process would be useful not only to plan how to respond to the recommendations of the current review, but to address the areas where the review identified a need for improved communication, e.g., with Math students, MAT students, pre-tenure faculty, and the department’s diverse researchers.

Response 2015: The previous Strategic Plan for the department was 15 years old. The current revised plan can be seen in Appendix 6. In consultation with the departmental Advisory Committee, the department will continue to develop the Strategic Plan, as well as keeping it up to date and consistent with our College policies.

Recognizing the need for ongoing strategic planning, the department will be instituting (through the Assessment Committee) yearly analysis of both the Strategic Plan and the department’s progress in addressing the current committee’s recommendations.

With the revision of the Strategic Plan and the periodic review by the Assessment and Advisory Committees, the department is committed to making the Strategic Plan a “living document” fostering future growth and development.

2009 Review Recommendation: The review committee recommends the university to secure funds for the department so that students are better served by a full-time academic coordinator. This investment is necessary for recruiting and retention of

students for the department.

Response 2015: The Department's enormous (and constantly growing) student credit hour production creates much traffic for the staff to handle. The technical nature of mathematics means that advisors from all over campus constantly have questions regarding course prerequisites, evaluation of transcripts, allowable authorizations, etc.

The department has addressed this recommendation by securing funds from the College to fund a full-time academic coordinator for the past several years. Our current academic coordinator has done an excellent job going above and beyond advising our majors, as well as helping in the recruitment and retention of students for our department.

2009 Review Recommendation: ...the review team recommends the department to work with the college to obtain funds for adjustment of wages of the student workers to a competitive level.

Response 2015: The department has been working with the college and the wages of the two dozen student workers employed by the Math Lab have increased from \$7.25 per hour in 2008 to \$8.50 in 2010 to a current rate of \$10 per hour in 2015. This represents a 20% increase over inflation for student workers.

2009 Review Recommendation: ...the review team recommends increasing office space available for part-time instructors as the current space for them is inadequate.

Response 2015: Due to the enrollment growth in the Math Lab the last few years and the hiring of several instructors and assistant professors, lack of office space has become an issue. The current office space for part-time instructors is minimally adequate. Our conference room DSC 208 has been used as a backup for the part-time instructors and their student, but space is an ongoing issue over which the department has little control.

2009 Review Recommendation: The review team recommends creating a lounge area for faculty and students to improve more student-faculty, student-student, and faculty-faculty connections.

Response 2015: As described in the previous response, we are currently facing a space shortage that we can do little on our own to address. However, we have attempted to address this recommendation to the degree possible; we have transformed our conference room (DSC 208) to be used also as a lounge, with chairs and tables to promote student-faculty or faculty-faculty interactions.

2009 Review Recommendation: The review team recommends the department faculty to study the possibility of establishing a Ph.D. program in mathematics in the future due to students demand and the community needs.

Response 2015: This issue has been discussed by the Department as a part of our strategic planning. There are a number of obstacles to the creation of a Ph.D. program-- the most significant being the restriction that UNO cannot offer Ph.D. programs that UNL already offers. The department feels that it could successfully maintain a Ph.D. program; there are about a dozen former departmental students currently enrolled in doctoral programs nationwide.

While a difficult proposition, the department continues to work in this direction. Potential areas for doctoral programs in our department that would not conflict with UNL or UNMC include operations research, financial mathematics, and, possibly, the emerging data science program. Evaluation of these possibilities is ongoing.

Self-Assessment

A. Program Quality

1. Undergraduate

The General Education Requirement and Pre-Calculus Courses

Intermediate Algebra (Math 1310), or a Math ACT score of at least 23, is required of all undergraduate students at UNO, and thus approximately one-half of entering freshmen take Intermediate Algebra. This course and its follow-up, College Algebra (Math 1320) are taught in the Mathematics Laboratory. The Math Lab went through “course redesign” in Fall 2011. All sections of Math 1310 & 1320 are now taught in the Math Lab. Additionally, a technology-based beginning algebra course, Math 1000, is now taught through the Math Lab to prepare students to be successful in Intermediate Algebra. Through these efforts, student success has greatly improved for students needing to satisfy their general education mathematics requirement.

Coordination with other groups on campus occurs to enhance the likelihood of success for all students. The Thompson Learning Community (TLC) and the Goodrich Scholarship program are scholarship programs established for students with identified financial need. Math Lab personnel work closely with personnel in these programs to deliver instruction in algebra to those students.

Additionally, an algebra class for students enrolled in the College of Business has been introduced. Applied Algebra & Optimization, Math 1370, has been offered since Fall 2014. The focus of problems in this course is business applications, and the course is taught in Mammel Hall, the College of Business building. Mathematics faculty worked with faculty from the College of Business to ensure that the course was appropriate and challenging for students pursuing degrees from their college.

Traditional lecture sections are available each semester for students enrolled in Trigonometry (1330) and Precalculus, Math 1340. These courses are designed to prepare students to be successful in Calculus and to meet enrollment prerequisites. Close attention is given to topics covered in these courses, so students will transition readily into the Calculus sequence.

The Mathematics Laboratory

Supporting information can be found in the attachments included in Appendix 1.

The UNO Math Lab has always been innovative in its approach to student learning, originally providing small 24 student interactive classrooms with unlimited tutoring available, and beginning in 2006, supplemented with computer testing programs. The addition of a small 21 seat computer testing lab led to remarkable improvement of previous success rates and higher student learning and satisfaction. In 2011, using the emporium model as designed by LSU and recommended by the National Center for Academic Transformation, the Department of Mathematics proposed a redesign of the UNO Math Lab to make the teaching of Math 1310 (Intermediate Algebra), and Math 1320 (College Algebra), more student-centered, requiring our students to spend more time doing mathematics rather than watching mathematics as in a traditional classroom. The use of interactive e-books and computer testing software has proven to decrease drop rates, increase final exam scores and increase the percentage of ABC rates in the beginning mathematics courses. This computer-based system requires more from the student while offering extensive support in a laboratory setting and allows for a course coordinator to create all homework, quizzes, and tests on-line and thereby ensure quality control and timely student participation. The students' focus on learning is amplified and distractions are minimized in this computer lab setting. This change has resulted in more students passing on the first attempt of the course, improving student time management skills, and speeding up the time until graduation. Passing entry level mathematics courses has become not so much dependent on ACT scores, but on the amount of time spent in the lab. (Appendix 1, attachments 1- 4)

Perhaps the biggest change in this redesign model was the inclusion of all Intermediate Algebra and College Algebra classes in the UNO Math Lab. LSU had found that as long as traditional lecture sections were available, the students would choose the traditional because they were not required to work as hard as they were in the LSU Math Lab, where the students are required to complete at least 85% of their homework correctly in order to open a quiz on-line. As soon as all the algebra sections were changed to the LSU Math Lab, success rates increased dramatically and have continued to be about 75% in the Fall semesters. LSU has now added their entire Trigonometry (our Math 1330) and Pre-calculus (our Math 1340) sections to their Math Lab with a total of 3,500 students in the Fall and 1800 students in the Spring. Their overall success rates in the Spring semesters, usually containing weaker or repeat students, are about 55%. Change was difficult for our beginning math students at UNO, and the transition required additional adjustments to better "fit" our diverse campus and urban student population. These adjustments consisted of improving computer syntax in homework, quizzes and tests, extending lecture times from 50 minutes to 75 minutes, offering optional lectures, offering lab exemptions if students achieved 100% on their weekly quizzes, and extending Math Lab hours to include evening hours. Fall of 2012 saw our first completely redesigned semester where our Intermediate Algebra students achieved ABC rates of 68%, up from an average of 63%, and College Algebra students had ABC rates of 66%, up from an average of about 57%. Algebra students are now

fully engaged in their own learning and are taking advantage of the learning aids offered in the software as well as the personal assistance of the tutors in the Math Lab.

Under this new redesign the UNO Math Lab has experienced huge growth. Our biggest addition since the start of the redesign is Math 1000, Pre-Intermediate Algebra, with 640 students in the Fall semester and about 400 in the Spring semester. University statistics currently show that, on average, 34% of new students arrive at UNO with an ACT Math sub-score below the 19 required for placement into Math 1310, and that this average is increasing. (Appendix 1, attachment 5) In their February 2012 report, President Obama's Council of Advisors on Science and Technology also observed this current national trend. They encourage all 2- to 4-year institutions to action, saying, "Reducing or eliminating the mathematics-preparation gap is one of the most urgent challenges – and promising opportunities – in preparing the workforce of the 21st century." These students with an ACT Math subscore below 19 are advised to take the newly created course, Math 1000, Pre-Intermediate Algebra, a two credit hour "stepping stone" course to Math 1310. This course is presented in the same manner as the UNO Math Lab, regarding student homework, quizzes, tests, final exam, and grading. It uses the identical course software as the UNO Math Lab, and upon successful completion, (achieving a 70% or higher), the student has the needed pre-requisite to enroll the very next semester in Math 1310 in the UNO Math Lab. The biggest benefit of this new course is that our students no longer are "waiting" to complete their General Education required course, Math 1310. If they cannot initially meet the prerequisite for Math 1310 because of poor mathematics preparation, they are able to enroll in Math 1000. This student success has been made possible largely because of the redesign of the UNO Math Lab. By helping our students succeed within these critical first two years of college, our university will enjoy increased student recruitment and retention. (Appendix 1, attachment 6)

Our students have appreciated the up-scaled and attractive Math Lab with large, comfortable work spaces. The facility appears high tech and includes 121 computers, tables and chairs, one large desk for student check-in, and one smaller high tech classroom to be used for overflow at peak use times, staff training, and also for use by advanced math classes at non-peak times. The tables provide adequate work space for the students and the tutors assisting them, and the chairs are of high quality to provide comfort as well as to hold up under constant daily use. To accommodate our new Math 1000 students a new 40 student computer lab in DSC 023 is used as a classroom for lectures, a testing center, and, because of its close proximity to the Math Lab, for over-flow for the UNO Math Lab during testing or at peak use times. Students in Math 1000 are required to attend class once a week for two hours and fifteen minutes, with half the time spent in instruction and half the time spent taking quizzes or tests on-line. Both labs make use of virtual desktops (thin clients) as opposed to traditional PC's. In doing so, it allows for better client management and application support as well as power savings. Traditional PC's consume around 250 watts while virtual desktops consume 15 watts. Savings will also be realized by not having to upgrade PC's on a three or four year cycle, as thin clients can be used anywhere from seven to ten years. (Appendix 1, attachments 7-8)

Administrative staff in the UNO Math Lab consists of a director, course coordinators for each class taught in the lab, and an administrative assistant. The 45(each Fall) lecture sections are taught by six GTA's, and there are 25 undergraduate tutors working part-time shifts as tutors in the Math Lab. In addition to Math 1000, the UNO Math Lab has added Calculus for Managerial, Life and Social Sciences, (Math 1930), in the Fall 2014 semester, which currently has an annual enrollment of about 300 students. This course is projected to increase with the College of Business Administration requiring this course for some of its business majors starting this academic year. Also, the redesigned

UNO Math Lab adopted all Summer courses taught in the Math Lab during the regular semesters, approximately 250 students each Summer. In addition, the UNO Math Lab administrative staff has been instrumental in creating and teaching the on-line sections of all the courses taught in the Math Lab each year. Currently for Spring 2016, we are planning to teach three on-line sections for Math 1000, two on-line sections for Math 1310 and one each for Math 1320 and Math 1930. We need to stress that both Math Labs are designed specifically for Pre-Intermediate, Intermediate, College Algebra and Business Calculus students and are not to be confused with the Math Science Learning Center. Talking with the MSLC director and our students we have found that upper level math students take advantage of the MSLC tutors whereas students in the Algebra and Business Calculus classes make use of our tutors who are specialized in tutoring these classes.

The greatest impact of the UNO Math Lab redesign to all students will be their increased learning of mathematics that will naturally lead to an increase of possible majors and career choices. Student success and satisfaction are paramount in the UNO Math Lab. (Appendix 1, attachments 9-10)

Calculus and other multi-section service courses

The Mathematics Department offers many courses that serve as required courses for students outside of the mathematics department. This includes students enrolled in programs in the Engineering College and the College of Information Science & Technology. In fact, most Calculus I students are students enrolled in these two colleges. The addition of online courses has provided opportunities for more students to enroll in these required courses. A new prefix for courses, "MTCH" was developed in 2013. This prefix was adopted for courses developed for College of Education students. The mathematical content of these courses, specifically geared toward K-12 math instruction, provides a solid foundation in relevant mathematics for future teachers. With the large number of sections of these courses, it is necessary to hire part-time instructors to teach several of these courses. In all cases, part-time faculty have graduate degrees in mathematics and are provided guidance and oversight by the coordinator of part-time instructors. A summary of all multi-section courses follows:

Course	Course #	Credit Hours	# of sections
Calculus I	Math 1950	5 credit hours	18/yr (2 online)
Calculus II	Math 1960	5 credit hours	10 per year
Calculus III	Math 1970	4 credit hours	6 per year
Discrete Mathematics	Math 2030	3 credit hours	6/yr (3 online)
Applied Linear Algebra	Math 2050	3 credit hours	7/yr (1 online)
Differential Equations	Math 2350	3 credit hours	7/yr (1 online)
Applied Statistics	Math 1530	3 credit hours	3 per year

	Stat 3000/8005 Stat 3800/8805	3 credit hours 3 credit hours	6 per year 4 per year
Math for Elementary Teachers I/II	MTCH 2000 MCH 2010	3 credit hours 3 credit hours	6 per year 6 per year

Changes in Calculus Instruction

Beginning in Fall 2013, two sections of Calculus I, followed by two sections of Calculus II have been offered using “Inquiry-Based Learning.” Funding was acquired to change the physical layout of one of the classrooms to accommodate this mode of instruction. In these classes, students are provided guided instruction and then given worksheets and activities to complete at their tables. Students sit at tables of four, and work cooperatively to develop ideas and concepts in calculus. The results have been encouraging. The success of students in these sections has been as high as 80%, compared to a success rate (earning an A, B, or C) of 60% in traditional sections. Grant funding has been acquired to provide for the integration of undergraduate learning assistants in these classrooms. Students also work with the assistants and the instructors in “homework room”, held daily for an hour prior to class.

In the fall 2015, a new calculus text was adopted by the Department. An online homework component is now a part of some calculus classes. With the utilization of “webassign”, students are able to get immediate feedback on assignments and get guided assistance.

Upper-level coursework

In 2013/2014, the department approved the following requirements for our major:

Required Foundation Courses in Mathematics (26 credit hours)

Math 1950 Calculus I (5 credit hrs)

Math 1960 Calculus II (5)

Math 1970 Calculus III (4)

Math 2050 Applied Linear Algebra (3)

Math 2230 Introduction to Abstract Mathematics (3)

Math 2350 Differential Equations (3)

Math 3230/8235 Introduction to Analysis (3)

Required Upper Division Courses in Mathematics (15-18 credit hours)

Option 1: *Concentration* of upper division courses in one of the following areas: *Data Science, Math Education, Pre-Actuarial, Research, or Statistics.*

Option 2: 15 credit hours of approved upper-level Math/Stat courses, with 3 courses at the 4000 level.

Other Requirements for the Major

Computer Science Requirement (6 credit hours)

The department also has a computer requirement: Two courses from the following:

CIST 1400 Introduction to Computer Programming (3)

CSCI 1620 Introduction to Computer Science II (3)

Math 2200 Mathematical Computing I (3)

Math 3200 Mathematical Computing II (3)

Note: This means that a math major can require a minimum of 47 credit hours of mathematics courses (depending upon where the student takes their computer requirement). This is one of the larger required loads in the College of Arts & Sciences.

Cognate Area (15-18 hours)

For the BS degree in mathematics an approved cognate area of a minimum of 15 credit hours outside of mathematics is required.

Finally, to earn a BA at UNO, a student must have 16 hours of a foreign language instead of a cognate area.

The Concentration Option and Requirements

The department currently has about 140 declared majors. Since the concentration option was added two years ago, 92 students have chosen a concentration. Below is the breakdown of the number of students in each concentration.

Data Science: 55

Education: 20

Pre-Actuarial: 6

Research: 6

Statistics: 5

The current Concentrations along with their requirements follow.

B.S. in Mathematics with a Concentration in Education

This concentration is recommended for students interested in pursuing a career in Secondary Education.

In addition to Math, 3230 *Introduction to Analysis*, the 18 hours of upper-level courses must include

MATH 3100 *Combinatorics*

MATH 3640 *Modern Geometry*

MATH 3850 *History of Mathematics*

MATH 4030 *Applied Modern Algebra*

MATH 4740 *Introduction to Probability and Statistics I*

This concentration must also include MATH 4800, *Math Education Capstone*, which is counted as the second computing course.

Cognate Area: Students must include a Secondary Education Cognate involving the following 24 hours: EDUC 2020, EDUC 2030, EDUC 2010, EDUC 2510, EDUC 2520, EDUC 2524, TED 3550, TED 3690, TED 4000.

Additionally, for those who want a Nebraska Teaching Certificate:

The Nebraska Teaching Certificate requires a semester of Student Teaching (12 hours), TED 4600, TED 4604.

B.S. in Mathematics with a concentration in Data Science

This concentration is recommended for students interested in a career as a data science professional or to pursue graduate study in disciplines with a strong data analysis component.

In addition to MATH 3230 *Introduction to Analysis*, the 18 hours of upper-level courses must include

STAT 4410 *Introduction to Data Science*

STAT 4420 *Data Visualization and Exploration*

MATH 4740 *Intro to Probability and Statistics I*

MATH 4750 *Introduction to Probability and Statistics II*

Along with one 3 hour elective from the following:

STAT 4430 *Linear Models*

STAT 4440 *Time Series Analysis*

MATH 4300 *Deterministic Operations Research Models*

MATH 4310 *Probabilistic Operations Research Models*

Cognate Area: One approved statistics course from outside the department, along with one of the following three options:

1. Minor in Business Administration
2. Minor in Management Information Systems
3. 15 hours of an approved cognate area outside the department.

B.S. in Mathematics with a concentration in Research Experience

This concentration is recommended for students interested in independent work and for students planning to pursue graduate work in mathematics.

In addition to Math 3230 *Introduction to Analysis*, the 18 hours of upper-level courses must include the following 3 courses, not more than 3 hours of independent study credit, and an approved research experience.

Math 4050 *Linear Algebra*

Math 4110 *Abstract Algebra I*

Math 4230 *Mathematical Analysis I*

An approved research experience. A variety of options exist for meeting this requirement. They include 1) Research experiences such as an REU or FUSE that lead to a project paper, or 2) senior honors theses leading to graduation with distinction. To satisfy this concentration, students must complete a Research Experience contract that is approved by the Curriculum Committee and submit the thesis or research paper required by the contract. Visit with the Chair of the Department for more information.

Cognate Area: The cognate area must be a minor in another department or program (any department/program), or be a cognate area designed for the research experience with the Research Mentor and then approved by the Curriculum Committee.

B.S. in Mathematics with a Concentration in Statistics

This concentration is recommended for students interested in the theoretical and practical aspects of statistics, particularly those students who are interested in pursuing graduate study in statistics or biostatistics.

In addition to Math 3230 *Introduction to Analysis*, the 18 hours of upper-level courses must include

MATH 4740 *Intro to Probability and Statistics I*

MATH 4750 *Introduction to Probability and Statistics II*

The remaining 3 courses can be chosen from the following list of 7, with at least 2 from group A.

Group A:

STAT 4420 *Data Visualization*

STAT 4430 *Linear Models*

STAT 4440 *Time Series Analysis*

Group B:

MATH 3100 *Applied Combinatorics*

MATH 4310 *Probabilistic Operations Research Models*

MATH 4900 *Independent Study on Statistical Topic*

STAT 4410 *Introduction to Data Science*

Cognate Area: 15 hours of courses outside the department that contain statistical components, as discussed with advisor and approved by curriculum committee.

B.S. in Mathematics with a Concentration in Pre-Actuarial Math

This concentration is recommended for students interested in a career as an actuary and who plan on taking the actuarial exams

In addition to Math 3230 *Introduction to Analysis*, the 18 hours of upper-level courses must include

MATH 3400 Theory of Interest

MATH 4740 *Intro to Probability and Statistics I*

MATH 4750 *Introduction to Probability and Statistics II*

STAT 4440 *Time Series Analysis*

Cognate Area: Pre-actuarial cognate area already exists.

Data Science

Data Science concentration

Due to the demand by local industry and students, we started a data science concentration in the UNO mathematics department in 2014 for both undergraduate and graduate students. This led to the hiring of two statisticians both with doctorates from Iowa State. In addition, several new courses were created as part of a data science program. The core courses in the program include Introduction to Data Science (Stat 4410/8416), Exploratory Data Visualization and Quantification (Stat 4420/8426), Deterministic Operations Research Models (Math 4300/8306), Time Series Analysis (Stat 4440/8446) and Linear Models (Stat4430/ 8436). Our experience suggests there is great demand for data science skills. When we started our first course in data science (Stat 4410/8416) in 2014 we were expecting a dozen or so students. Surprisingly, 30 students enrolled for the class. This semester the enrolment is over 40 students with diverse backgrounds.

Interestingly, data science skills are not only useful for data analysis applied to real-world problems; but very beneficial in academic research as well. This explains why some Ph.D. students from UNMC, IS&T and the engineering college are taking data science courses from our department.

Since launching in 2014, more than 10 undergraduate and 2 graduate students have completed their degree with a data science concentration. Currently, it is the most popular concentration in the department.

Data Science lab

A computing facility with the necessary data science tools is an essential infrastructure, if we want our data science students to succeed. Consequently, the department has created a data science lab with available resources. Currently, the lab has 10 computers, but we are planning to extend the facility due to the growing demand. All the learning software are typically open source, so that those tools are available for the students even after they graduate. This was carefully designed based on feedback from local industry. Many companies prefer to hire students having a broader and deeper understanding of software.

A parallel computing infrastructure is set up for data science students in the high performance computing facilities at PKI. Students can get access to that facility from the lab if they need high performance computing resources. The design of the lab machines are kept similar to those at high performance facilities, so students can use them utilizing their lab experience.

Data Science Partnerships

Our initiative is bolstered by the feedback we received from local industries that deal with data and use data in their decision making processes. The skills, which are unique to data science, are commonly learned through practical work experience. However, many businesses, institutions and organizations are turning to colleges and universities for trained students with data science skills. Our department has formed partnerships with many local companies including

1. Union Pacific
2. Election Systems & Software
3. OPPD
4. TDAmeritrade
5. Catch Intelligence
6. Haygoods Inc.
7. Physicians Mutual
8. ConAgra

Since the launching of the concentration 2 years ago, over a dozen students have completed their degree. Two graduate students completed their MS degree data project in collaborations with Union Pacific and OPPD. Currently, five more graduate students are working in collaborations with Haygoods Inc., Physicians Mutual, Catch Intelligence and the Office of Latino/Latin American Studies (OLLAS). Students are usually financed through internship and are given access to the data to gain practical experience of real data. The companies benefit from students' research with their data, which is powered by the input of the faculty members who guide the students. Due to the mutual benefit, the overall acceptance of data science concentration among students and the companies has been extremely positive.

We are also working to establish long term data science partnerships. With the support of the Dean of our college and with the assistance of our University of Nebraska Foundation representative, we are making major progress in this direction. Not only do these long-term partnerships promote our data science program, but also create a sense of sustainability.

Summary of Undergraduate Mathematics Courses

Upper-division course offerings include: Applied Combinatorics, Numerical Methods, Number Theory & Cryptography, Applied Modern Algebra, Linear Algebra and a two-course sequence in Abstract Algebra. Introduction to Analysis, Complex Variables, and a two-course sequence in Analysis. We have a two-course sequence in Operations Research, as well as another in Probability and Statistics. These are complemented by courses in Partial Differential Equations, Differential Geometry, Elementary Topology and Transform Methods. And more recently, supplemented by courses in Data Science. Because this department once included Computer Science, there are a number of courses that are cross-listed with that department, and some, such as Graph Theory and its Applications which are taught by that department.

Academic Coordinator and Advisor

The department has a full-time academic coordinator who is also the academic advisor. The advising duties are divided into different categories; Math majors pursuing a BA or BS; students with Math as a second degree or second major; current UNO students interested in changing their major to Math; current UNO non-degree seeking students taking courses for specific reasons such as preparing for the first three Actuarial Exams, Teacher Academy Program Math course deficiencies, or Math course deficiencies to apply to the Math Graduate Program; non-UNO students working towards applying while taking preliminary courses elsewhere. Occasionally, the academic coordinator also meets with high school students, sometimes including their parents, who are considering attending UNO.

Each fall and spring semester Math majors are required to have an advising appointment to plan courses for the following term, with additional appointments as needed. Students whose second major is Math are not required to have an advising appointment, but are highly encouraged to do so. Assistance is provided regarding course selection, proper course sequencing, choosing a Concentration or the No Concentration option, developing a Cognate Area, and adding a minor, second major, or second degree. Individual academic plans are created and revised as needed. Detailed written and electronic records are kept for each student to insure timely graduation.

Duties not required, but performed are advising the College of Arts & Sciences B.S. Chemistry and Physics students pursuing a Concentration in Education to earn grades 7-12 teacher certification. Information is provided on how students may also earn a B.S. in Secondary Education from the College of Education. These students are also required to have fall and spring advising appointments. Individual academic plans are utilized as well as the same detailed records used for Math majors.

The feedback from the students has been extremely positive regarding the job performance of the current academic coordinator, Deb Challman. Her professional and personalized approach to advising is especially noteworthy, as well as the impact of encouraging students to succeed.

Honors in Mathematics

Students at UNO can take any course at the level of calculus or above for honors credit. The purpose of offering classes for honors credit is to provide an additional learning experience for students beyond what is offered in the regular class by acquainting students with challenging and interesting problems and topics that are beyond what may be encountered in the normal curriculum. By providing students with this opportunity, additional benefits may include the fostering of an increased love of mathematics in students and a resulting increase in math majors and minors. Special emphasis has been placed on offering Calculus I, Calculus II, and Calculus III for honors credit by the appointment by of an honors calculus coordinator by the department chair. The numbers of students completing the requirements and receiving honors credit are shown below.

Semester	Calculus I	Calculus II	Calculus III	Total
Spring 2015	3	8	2	13
Fall 2014	21	8	1	30
Spring 2014	1	3	3	7
Fall 2013	17	5	3	25
Spring 2013	3	5	4	12
Fall 2012	1	2	0	3
Spring 2012	0	4	4	8
Fall 2011	1	0	0	1
Spring 2011	0	8	4	12
Fall 2010	16	9	2	27
Spring 2010	0	1	1	2

Last year the University Honors Program hired a new director and the focus is now on quality student projects rather than quantity of honors credits. A student meets with a faculty member and contracts to do a project for honors credit. Ultimately, the goals of our honors program in mathematics are (1) to increase the number of our majors that graduate with honors and (2) use Honors Calculus to recruit more math majors, especially double majors. Note that on average one mathematics student each year (so far only double majors) chooses to graduate with Honors. The department will revisit this issue and discuss effective methods to increase the number of Mathematics Honors students.

Technology in the curriculum

About 25 years ago the Mathematics and Physics Departments decided to introduce the Computer Algebra System *Maple* into the curriculum and UNO cooperated by acquiring a campus wide site license. Since 2013, other computer algebra programs have become more available to students (including Mathematica, MatLab, and others). As such, the Department now requires the use of a computer algebra system In Calculus II and III as well as Applied Linear Algebra. Technology, in the form of computer algebra systems, graphing calculators, and

apps available to be downloaded to other devices are used extensively in many other upper level courses as well.

The current textbook being used in the Calculus courses has several interactive applets, demos, and lectures available for student use and within the classroom. The online homework component also provides feedback and valuable instruction to students. These technologies are generally available on handheld devices, making them extremely accessible to students. The precalculus class, for example, uses online homework on a daily basis, to assess the progress of students and provide immediate feedback. The Math Lab operates completely through “course redesign” with computer interface for homework, instruction, quizzes and tests. Through the variety of these experiences, students are afforded several opportunities to increase their understandings through the appropriate use of technology and engagement with those resources.

2. Graduate Program

The Mathematics Department offers a graduate program with three degrees: an **MA**, an **MS** and an **MAT**. The available courses include combinatorics, mathematical analysis, complex variables, numerical methods, geometry, abstract and linear algebra, graph theory, operations research, partial differential equations, number theory and cryptography, topology, probability, stochastic processes, mathematical statistics, applied statistics, data science, fuzzy set theory, and dynamical systems.

The variety of programs offered, along with the flexibility of the program requirements, allows for students to tailor their program to suit their individual needs. However, those students who are considering entering a Ph.D. program in the future are usually advised to pursue the MA program, and complete the required thesis. Since 2009, there have been 20 students who took mathematics courses in our department and were accepted into a doctoral program. A dozen of these students are currently enrolled in Ph.D. programs nationwide.

The graduate program has been enriched with several new graduate courses since 2008. These courses are: MATH 8016, Introduction to the Theory of Recursive Functions; MATH 8250, Partial Differential Equations; STAT 8416, Introduction the Data Science; STAT 8426, Exploratory Data Visualization and Quantification; STAT 8436 Linear Models; STAT 8446 Time Series Analysis; STAT 8700 Bayesian Statistics.

Although we specifically define our program requirements to be flexible in order to accommodate the differing needs of each student, we have recently started introducing concentrations within the MS program for those students who want to study a particular branch of Mathematics. The Data Science concentration was introduced in 2014, and there are plans to introduce concentrations in Operations Research and Statistics in 2016.

In conjunction with the MS Data Science concentration, we have also introduced a thesis-equivalent project as an alternative to the Comprehensive Exam. Students work with a faculty advisor and an external advisor (usually someone from a local company) to work on a 'real-world' problem. As of Fall 2015, 2 projects have been complete, with several more currently in progress.

The MAT (Master of Arts for Teachers of Mathematics) degree is ideal for those who are planning on teaching advanced secondary mathematics such as Dual Enrollment calculus or freshman/sophomore level mathematics courses at local universities. Additionally, the program provides a solid masters-level foundation for those who are pursuing a Ph.D. in Education with an emphasis in mathematics.

3. Interdisciplinary collaborations

The department is very active in interdisciplinary collaborations, especially within the NU system (UNO, UNMC, and UNL). Below are some examples.

Operations Research

The department offers operations research (OR) courses at the graduate and undergraduate level. These courses have proved to be popular as many students enjoy the "real world" problem-solving aspect. The students are primarily in a math degree program, but the courses also attract students from computer science, engineering, economics, and other programs. OR students are in demand locally as well as across the country. One graduate student presented a poster describing her solution to a "real world" production planning problem at a recent INFORMS conference and was offered a job at GM on the spot. Other companies were also interested in pursuing her. Companies in Cape Canaveral, Austin, and Chicago flew in another of our graduate students for interviews. Opportunities abound and students are taking advantage.

Chaos Theory and Dynamical Systems

The department has strong interdisciplinary collaborations with Dr. Nick Stergiou and the Biomechanics Laboratory in the School of Health, Physical Education, and Recreation. Several faculty members in our department, including Dr. John Konvalina, Dr. Dora Matache, have provided their expertise in chaos theory and dynamical systems to biomechanical problems involving the neuromuscular control mechanism of human movement. A number of students from the Biomechanics Laboratory are required to take our course in Dynamical Systems and Chaos which is offered every fall semester. Dr. Matache has worked on several research projects with Dr. Stergiou and his students. This has been one of her reasons to develop a new course in dynamics of Boolean networks that attracts students from the Biomechanics Laboratory, as well as mathematics, computer science, economics, physics, or biology.

Dr. Matache has also worked on a joint project with Dr. Prithviraj Dasgupta of the Department of Computer Science at UNO, on applications of chaos theory to the modeling of prediction markets. They have applied for several national and local grants.

Drs. Dora Matache and Jim Rogers have collaborated with Dr. Tom Helikar who is now in the Biochemistry Department at the University of Nebraska at Lincoln, on several joint projects with applications of elements of chaos theory to the modeling of signal transduction networks in cells. They have applied for several national or local grants.

Mathematical Biology

Since the last review, the Mathematical Biology Research Group has grown significantly. The group has published 11 primary research papers in collaboration with other researchers at UNO, UNL, and UNMC. Details are given later in the research section.

Mathematics for Elementary Education

The department of Mathematics and Teacher Education have explored the possibility of creating a master's degree for elementary teachers in the department of mathematics. The degree was conceptualized and even a few course syllabi were approved. However, after working with OPS and UNL and UNO, there are several major roadblocks that have impeded the progression of work on the program. Major roadblocks are resources (time of faculty) and funding for scholarships to make the program affordable for teachers who are frequently unable to pay for graduate degree programs. This is an ongoing collaboration and many of these issues still need to be resolved.

Applied Statistics

The department has four statisticians involved with interdisciplinary collaborations: Dr. Xiaoyue Cheng, Dr. Dr. Steven From, Dr. Mahbubul Majumder, and Dr. Andrew Swift. Dr. From has recently consulted with various colleagues at UNMC about statistical modeling questions. In the past, he has published in various interdisciplinary journals, including medicine, engineering and computer science. Dr. Cheng is currently collaborating with the Office of Latino/Latin American Studies (OLLAS) on a research project to visualize and analyze local Latino data. Dr. Majumder teaches the data science courses and, consequently, has numerous collaborations across several colleges, universities and local industry. Dr. Swift has several collaborations with the College of Education. Currently, he is collaborating with Biology as a co-PI on a FIRE grant, as well as working on two research papers. In addition, he has organized an interdisciplinary group of colleagues from three colleges (Arts & Sciences, Business, and IS&T) to explore offering a multi-college graduate degree in data science and analytics.

4. Outcomes_Assessment

Supporting materials are found in Appendix 2 containing the extended departmental assessment plan.

Undergraduate

I. Program Goals

The department has the same three Program Goals for the BA/BS/BGS degrees in mathematics:

1. Demonstrate basic understanding of core areas of mathematics; specifically Calculus, Differential Equations, Linear Algebra, Analysis, and Probability and Statistics.
2. Demonstrate ability to use a Computer Algebra System (CAS) to solve problems.
3. Be prepared for graduate school.

II. Methods of Assessment/Results from the latest assessment report

In order to assess progress toward achieving the above goals, the department uses the following methods of assessment:

1. Major Field Assessment Test (MFAT). This is a nationally administered test of mathematics competency.

Results: National Averages are not available on a year-by-year basis, however, for all the students who took the test between February 2004 and February 2010, the mean score was 156.0 with a standard deviation 18.0. The median score over the same period was 155. Compared to UNO's peer institutions, UNO students have scored right in the middle of the scores distribution whether one looks at mean or median score and also when one looks at individual student/individual institution score distributions. This is true despite the fact that the exams contain several abstract algebra questions and the fact that our students are not required to take abstract algebra. We have found, however, that sometimes students don't take this exam seriously and have seen instances where a student just randomly answers questions and walks out after 15 minutes or so. For these reasons and others, we are currently considering alternative means to test their mathematical knowledge.

2. Short survey after MFAT. Graduating seniors are asked their level of agreement to the statement "I have been well-prepared in the area of mathematics by my education."

Results: Generally speaking, the students have felt that this was the case, although the percentage of favorable/very favorable responses is a bit less than on our other surveys for similar types of questions. The positive response rate (i.e., Strongly Agree + Agree) since 2009 was 64.4%.

3. Undergrad exit interviews. The department interview graduating seniors, and the main question is: "How would you describe your overall student experience while at UNO?"

Results: These surveys have found mostly favorable opinions on all sorts of questions. The positive response rate on the question above (i.e., Strongly Agree + Agree) since 2009 was 88.3%.

4. Alumni surveys. Graduates are surveyed every two years as to how they are using mathematics in their careers, and how well their education at UNO prepared them.

Results: From 70 to 90 % of the students on these surveys had a favorable or very favorable impression of the UNO mathematics program depending on the survey year and survey question. For instance, the positive response rate (i.e., Strongly Agree + Agree) since 2009 was 91.6% in 2012.

5. CAS training. Use of the CAS Maple is a required component of three classes (Calculus II and III, Linear Algebra), and the competency of Maple usage is certified by the instructors in Linear Algebra.

Results: On the exit interview for graduating seniors there are two questions related to technology: "Should there be more or less use of technology? Or is the use about right?", and "Please comment on the following, saying whatever comes to your mind: Use of Maple in your courses." Over the last two years, there were only 5 comments; too small a sample to make any inference. On exit interviews some students indicated they would like to see more usage of technology in class. We currently do not have a unified assessment of the Maple assignments across courses and instructors that would represent a direct measure. If students pass Math 2050-Applied Linear Algebra they are certified by the instructor to be competent in Maple. One area of concern is that students have an unfavorable opinion of the computer software package MAPLE, that it is not 'real-world' enough, especially since they prefer various on-line software like Wolfram Alpha, etc. (This package is required in several courses, including Math 2050-Applied Linear Algebra. The instructors in these courses require competency in this software package as part of the grade.) We will address this in the future.

6. CS requirement for math major. Majors are required to select at least two Computer Science courses (from a list of four) developed by the department. Passing these courses is assumed to provide a good background in mathematical computing/computer science.

Results: We do not have any specific results regarding this measure.

In summary, the various assessment tools used thus far indicate that the UNO Department of Mathematics is preparing students fairly well for graduate school or the work force. We will work on improving our assessment procedures in the future. We are currently starting to do this by considering an alternative test to the MFAT exam, at least for calculus in the near future.

Graduate

I. Program Goals

The department has the same three Program Goals for the MA/MS/MAT degrees in mathematics:

1. Demonstrate depth of understanding of more advanced topics in analysis, algebra, number theory, geometry, topology, operations research, probability, statistics, probability models, programming, numerical methods, differential equations, dynamical systems etc.
2. Be well prepared for employment in their field.
3. Be well prepared for further graduate study, if this is desired by the student.

II. Methods of Assessment/Results from the latest assessment report

In order to assess progress toward achieving the above goals, the department uses the following methods of assessment:

1. Alumni surveys every two years. Every other summer, surveys are mailed to of graduates over the previous two years, and asked their level of agreement to the statement "I was well prepared for graduate study in an area related to mathematics." Another question is "Overall, how do you feel about the mathematical training you received at UNO?"

Results: The positive response rate (i.e., Strongly Agree + Agree) since 2009 to the question "I was well prepared for graduate study in an area related to mathematics." was 78.6% in the 2014. The positive response rate to the question "Overall, how do you feel about the mathematical training you received at UNO?" was 94.0%.

2. Master's comprehensive exams. All MS/MAT students are required to take and pass this exam in order to graduate. The pass/retake/fail rates are easily obtainable.

Results: During the past few years, no student has failed the comprehensive exam. Several, however, were allowed to retake the exam, after failing one part of it. During the last 13 years, no more than one or two students have failed this exam.

3. Employment in a mathematics-related area. This is determined from the answers to specific questions in the alumni survey (discussed above).

Results: We are currently looking at this item separately and will include the statistics in the future. In the past up to 80% of responses was YES.

4. Acceptance into a Ph.D. program. This is determined from the answers to specific questions in the alumni survey (discussed above).

Results: Most of the students applying for Ph.D. programs are accepted somewhere. Currently we do not have significant statistical information. Some faculty members hear from former students who have been accepted into Ph.D. programs. However, we do not have yet a mechanism for collecting this data in an organized fashion. We realize that more details like this would clarify and could be valuable in indicating the quality of student preparedness. It would be useful to tabulate the schools; to find how many students are accepted into their first choice of school; to track completion rates for those accepted into Ph.D. programs. That would also be useful in assessing their preparedness, even though there would be some distortion due to other variables. In a recent informal faculty survey, 20 students were identified as being accepted into a Ph.D. since the last self-study in 2009. At least a dozen of these student are currently active in doctoral programs throughout the nation including UNL, UNMC, Cornell, Michigan State, Tulane, University of Florida, University of Missouri, and University of Texas-Austin.

5. MA/MS student exit interviews. This was begun in 2011, and the main question is: "Overall, how would you describe your overall student experience while a graduate student in mathematics at UNO?"

Results: The positive response rate (i.e., Very Positive + Positive) since was 100% in the 2014.

5. Indicators of Student Accomplishments and Achievements

Student Activities

Some supporting materials are found in Appendix 3.

- The **UNO Math Club** represents a partnership between several STEM disciplines with a focus on mathematics. It serves as a great recruiting tool for students with interests in math/math education. To recruit students into mathematics fields, we host several events during the year (social events, informational meetings, Meet your Professor Talks - UNO faculty members give talks selling their research/courses and also discuss their math journeys.) A list of recent Math Club activities and Meet your Professor talks can be found in Appendix 3.
- **Cool Math Talks** - UNO hosts a Cool Math Talk series for undergraduates on a regular basis. These talks are accessible to a wide audience with the hopes that they will spark student interest in mathematics. Some of the talks educate students on issues of the teaching and learning of mathematics, while others present a mathematical problem that students can engage with during the talk. A list of recent Cool Math talks can be found in Appendix 3.

- **Putnam Study Group.** UNO offered the Putnam Mathematical Competition for the first time in December of 1999. In a typical year, the Putnam Study Group meets every Friday during the Fall Semester for about an hour and a half to socialize and prepare for the competition. Over the course of the Fall semester, students come and go, as they determine whether this is really something that they enjoy doing, and participation varies from 3 to 12 per week. The study group is kept purposely low-key for that reason. Participation in the competition averages around 7-8 students per year. Nonetheless, UNO competes well. During 4 of the 6 years from 2009 through 2014, we have had at least one student earn 20 points (scoring in the roughly top 20%). In 2013, two students scored above 20 points, and as a result, UNO's Putnam Team placed in the top 10% of the participating universities in the US and Canada.
- We had an annual **Mathematics Awareness Month Symposium** each April with student speakers in the Kerrigan Research Minigrant Program. This activity was cancelled in 2014 due to a change in direction of the program, namely, focusing more on the quality of the student research.
- The UNO math department hosts an **annual problem solving contest**. This contest has several goals: First, we wish to promote the pleasure and joy that can be found in mathematics. Second, we want to show high school students and teachers the types of problem solving skills on which they should be working to be successful as these students transition to the college level. Thirdly, it provides a contact between the staff of the university and the staff of the high schools. Lastly, we wish to promote the university by getting the students on campus to see the campus and facilities and make the students aware of the opportunities, particularly in the mathematics department, available here at UNO. The contest has grown. Our UNO contest began in 2002 as a half-day event for largely 12-15 Omaha Metro High Schools in conjunction with the April Math Awareness Month (MAM) activities. We later changed to a fall date to accommodate more students. In 2013, there were 125 contestants from 13 schools; in 2014, 163 students from 16 schools; and in 2015, there were 328 contestants from 36 schools including Omaha Metro schools, outstate Nebraska schools, and some out-of-state schools. The 2015 contest was an all-day event consisting of multiple competitions ranging from written problem solving to fast answer clicker questions. In addition, a team problem solving competition was included.
- The UNO Math Department and Dual Enrollment program held the 3rd annual **Calculus Bee/Calculus the Musical** Event on UNO Campus on Friday, April 10th, 2015. Over 900 students attended the events with 650 students taking the qualifying exam. To qualify for the Bee, tests were sent to local high schools and the top scorers from each school earned a spot in the clicker round held in person at UNO. The clicker round consisted of 30 multiple choice questions and students used clicker technology to send in their answers. The top 8 scorers continued on to the double elimination buzzer round where students went head-to-head to prove that they were the Grand Deriver. Due to the high

attendance of the event (over 650 students came to UNO to compete and/or cheer on their classmates), there were two Bees held simultaneously - one in CPACS and the other in the Community Engagement Center. Winners were declared in each room with the top 3 being awarded gift certificates to the UNO Bookstore. The event could not have happened without the extraordinary support of the UNO Math Department faculty and students. Approximately a dozen faculty members assisted with the planning and implementation of the event with the faculty members acting as MCs, flippers, and judges. There were also roughly 30 student helpers that volunteered their time to help serve pizza, sign-in the schools, pass out t-shirts, set-up for the event and clean up after. The Food Services department at UNO also played a huge role in making sure there was enough pizza to feed all of the high school students. The success of the Calculus Bee is directly related to the collaboration and communication between the departments and between the faculty and students.

- **MA Theses** have been written by 18 graduate students in the past eight years. The complete list since 2009 can be found in Appendix 3 together with subsequent publications.
- **Kerrigan Research Minigrants Program:** Many faculty members advise students (graduate and undergraduate) enrolled in the Kerrigan Research Minigrant Program. Between 2009 –2014, \$300 minigrants were offered to students working on mathematics research with faculty mentors. The students were asked to submit a research report at the end of their program, and present their work on the occasion of the Mathematics Awareness Month symposium which was held every April in that period of time. Since its beginning in 2005, an average of 9 projects per year were funded, until 2012, when student participation started to drop. In an attempt to help that, the value of the student work per project was updated from \$ 300 to \$ 500 last academic year. Some of these research reports have evolved into joint publications with the project advisers. The list of publications stemming from the KRMP can be found in Appendix 3 together with subsequent publications.
- Students attend various conferences and presented their research as **talks or posters**. A recent list of events can be found in Appendix 3.
- Several undergraduate students and graduate students have been awarded **research grants**. A list can be found in Appendix 3.

6. Summary of Faculty Research

In February 2002, *Mathematics Program Review Team* praised the quality of research in the Department of Mathematics in these words:

The department deserves high marks for scholarship. (...) In view of the high teaching loads and the absence of significant financial incentives for research, the overall level of scholarship is impressive. Several faculty members have research records that one would expect from departments with doctoral programs.

In May, 2010 the most recent *Mathematics Program Review Team* included the following statement regarding departmental research in their final report:

The Faculty has done impressive research in mathematics in the past seven years and is encouraged to continue their research agendas and efforts.

The research programs and scholarly activities in the Department today are even stronger and more ambitious and impressive. Almost all of the PhD faculty in the Department are engaged in research of high quality, many of them have obtained internationally recognized results. They regularly publish in major national and international journals and successfully compete for outside funding. Our faculty is serving on editorial boards of five international mathematical journals.

- Zhenyuan Wang is a member of the editorial boards of *Fuzzy Sets and Systems* and *The International Journal of Fuzzy Mathematics*. He is also an Associate Editor of the *Journal of Intelligent & Fuzzy Systems*.
- Slava Rykov is an Associate Editor for *Discrete Mathematics, Algorithms and Applications (DMAA)*
- Andrzej Roslanowski was a member of the editorial board of *MLQ – Mathematical Logic Quarterly* from January 2007 to December 2013.

Almost all of the mathematicians in our Department are regularly asked to serve as referee for professional journals, some refereed grant proposals for national and foreign funding agencies. All this proves recognition of the quality of our scholarship among other professional mathematicians.

Summary of productivity

In the discussed period (2009-present) the faculty of our department authored and/or co-authored the total of 113 published in or accepted to refereed professional journals (previously 106):

- 69 of them are in the various areas of Applied Mathematical Sciences (by 11 faculty); (previously it was 61 by 10 faculty).
- 15 articles may be classified as research in Math Education (authored/coauthored by 5 faculty); (previously was 15 by 3 faculty).

- 29 papers presented results in Pure (Theoretical) Mathematics (authored/coauthored by 5 faculty); (previously was 30 by 4 faculty).

This gives the Departmental average of about 1 research article per PhD faculty per year (weighing into this count that some members of the Department have been at UNO for a portion of the discussed period only). Many of these articles are of the highest internationally recognized quality and they are published in leading journals in the respective areas of mathematics and/or top general scientific journals. One may argue that this quality and quantity of research is rather unusually high among departments comparable with UNO Department of Mathematics.

Below we present the highlights of the research activities in the Department since Spring 2009. Detailed lists of publications can be found in the attached vitae (Appendix 9).

Mathematical Biology

Since the last review, the Mathematical Biology Research Group headed by *Dr. Jim Rogers* has grown significantly. The group has published 11 primary research papers in collaboration with other researchers at UNO, UNL, and UNMC. In addition, two papers in the area of education have been published.

The research papers involve the large scale modeling of several biological systems; influenza virus, HIV, breast cancer, and immune cells. The groups has collaborated with several investigators at UNMC to introduce the quantitative methods developed at UNO into the laboratory work performed at UNMC. In addition to collaborating with laboratory investigators, the group has also published in the area of development of new mathematical methods for analyzing these large scale models for emergent behaviors that are not observable in the lab (see Chaos theory section). As a result of these activities, members of the Mathematical Biology Research Group have received since 2008 external funding of \$391,000 and more than \$100,000 in internal funding.

The research by the group in education involves ongoing work in creating and implementing the computer tools we have developed for research as new tools that can be used in the classroom. Because of their highly complex nature, biochemical networks are not only difficult to do research on, they are becoming difficult for students to learn. Thus the very tool the group has developed to perform research on these complex networks are being converted into education tools that can be used by students to create models of already described networks as a way for them to learn about them. So far the group has published two papers regarding the use of these tools.

The Mathematical Biology research group has also been active in training students at both UNO and UNMC. At UNO, we have had 13 undergraduate students actively participate in research. 11 of these students have appeared on subsequent publications and six students received FUSE grants totaling \$18,000. In graduate education, one student did their Ph.D. at UNMC working

within our group. That student also completed a postdoctoral fellowship with the group and is now a faculty member in mathematical biology (Department of Biochemistry) at UNL.

Other Areas of Applied Mathematics

Dr. Zhenyuan Wang is an internationally recognized expert in the area of Fuzzy Measure Theory and Data Mining. He is a very prolific researcher who is regularly publishing on non-additive measures and nonlinear integration, nonlinear optimization and their applications in information fusion and data mining. In the discussed period he published 10 refereed journal papers, and he co-authored a book *Nonlinear Integrals and Their Applications in Data Mining* (with Rong Yang, and Kwong-Sak Leung), World Scientific, Singapore, 2010. Wang also authored 16 refereed conference papers, and delivered about 20 invited lectures.

Dr. Dora Matache is interested in Boolean Networks, Dynamical Systems and Chaos, and applications in biology, physics, prediction markets, social networks etc. Since 2009 she has published 8 research articles in the following journals: Phys. Rev. E, BMC Systems Biology, Complex Systems, Eur. Phys. J. B, Biosystems, J. Math. Phys., Appl. Math. Comput., Proc. IEEE/WIC/ACM Intl. Conf. Web Intelligence. Three of them were written with colleagues or peers from other institutions, and five were written either with students, or with colleagues and students.

She mentored several students under the KRMP (list found in Appendix 3) and also students who received student grants from UNO:

- 2012-2013 UNO FIRE grant for students Amanda Ludes, Celeste Mott, Naomi Kochi, New mathematical analysis and systems biology to understand complex biological systems.
- Summer 2013 GRACA grant for student Amanda Ludes, Boolean network modeling of edge-of-chaos in certain biochemical networks.
- 2013-2014 NASA Space Grant Fellowship for student Amanda Ludes, Boolean network modeling of edge-of-chaos for multi-body systems.

She has been the co-organizer of the following events:

- Co-organizer (with J. Rogers UNO, A. Veliz-Cuba UNL), special session on Discrete methods and models in biomathematics, Fall 2011 AMS sectional meeting (central), UNL.
- Co-organizer (with S. Wilson ISU), special session on Discrete Methods and Models in Mathematical Biology, Spring 2013 AMS sectional meeting (central), ISU.

Numerical Analysis and Scientific Computing

Dr. Mahboub Baccouch's research interest is in numerical analysis and computational methods in science and engineering. He is conducting top quality research by addressing pressing issues in finite element methods and computational science. Currently, Mahboub is working in the

general area of Computational Mathematics and, more specifically, on numerical methods for PDEs. Most of his work is on the so-called discontinuous Galerkin (DG) and local DG (LDG) methods. These numerical methods are very popular since they provide high-order accurate approximations on arbitrary meshes for a wide variety of PDEs. He is working on the development of a posteriori error estimates, which are of great practical applications as they allow us to know how close we are from the exact solution without actually knowing it. He is also conducting top quality research by addressing pressing issues in the finite element method and computational science. His traditional area of expertise is related to robust numerical methods for solving a wide range of problems in engineering described by differential equations. This is a vast and well-developed discipline with applied mathematics. His research involves performing rigorous mathematical analysis and developing of algorithms and computer programs. Recently, he began investigating a new research area related to numerical methods for the solution of stochastic differential equations.

Mahboub has been a highly productive member of the department with 24 research publications (15 single-authored papers and 21 papers since 2009) in top ranked journals with more under review and more in preparations, one book chapter, and one Encyclopedia article. He currently has an additional 7 articles under review and 10 additional articles in progress that are planned for submission within the next year.

Statistics

The department has four statisticians: Dr. Xiaoyue Cheng, Dr. Steven From, Dr. Mahbubul Majumder, and Dr. Andrew Swift.

Dr. Xiaoyue Cheng joined the department in Fall 2015. She is currently collaborating with the Office of Latino/Latin American Studies (OLLAS) on a research project to visualize and analyze Latino political participation in Nebraska. She is a recent hire of the department.

Dr. Mahbubul Majumder joined the department in Fall 2013. He is currently involved with several interdisciplinary research projects in data science and data visualization. He has published several papers on visual inference, including a high impact feature article in the *Journal of the American Statistical Association*. His research activity covers a broad spectrum of areas including environmental monitoring, proteomics, computational statistics, bioengineering, institutional research, and cellular & integrative physiology.

Dr. Andrew Swift's research interests include Stochastic Modeling, Statistical Forecasting, Bayesian Inference, Paired Comparison Studies, Data Analysis, and Statistics and Sports. He was awarded a UNO FIRE grant and a grant from the Simons foundation. In addition, Dr. Swift has become well-known nationally and locally for his various TV appearances on ESPN and locally concerning predicting the outcomes of various sporting events such as the NCAA basketball tournament.

Dr. Steve From has been a faculty member for nearly three decades. He publishes in a variety of areas in statistics and mathematics including reliability theory, probability inequalities, statistical inference from branching processes, and differential equations. In the past five years has published eleven papers in refereed journals. Recent examples follow.

Mathematics Education

Dr. Angie Hodge is a new addition to the department since the last review. She is a national leader in mathematics education and holds the Dr. George Haddix Community Chair of Mathematics. She is a [Project NExT](#) fellow and a Special Projects Coordinator for the [Academy of Inquiry-Based Learning](#) (AIBL). She has published over 30 papers, given over 50 international/national conference presentations, lead and organized over 20 conference sessions and workshops, and given over 30 invited talks/presentations. She recently co-authored the chapter on preparing future high school teachers in the Mathematical Association of America's 2015 Committee on the Undergraduate Program in Mathematics Curriculum Guide. She is interested in teaching using inquiry-based learning, organizing Mathematics Teaching Circles, and inspiring interest in mathematics.

http://www.maa.org/sites/default/files/pdf/CUPM/pdf/CUPMguide_print.pdf (CUPM guide link)

Dr. Janice Rech and *Dr. Michael Matthews* along with co-authors have contributed heavily in the field of research on effective teaching of mathematics to preservice elementary teachers and other fields in mathematics education.

Pure Mathematics

Currently, there are four faculty members engaged in research in the areas of Pure (Theoretical) Mathematics: Griff Elder, Valentin Matache, Andrzej Roslanowski and Robert Todd. The latter is a low dimensional topologist who joined our Department in Fall 2007

Dr. Griff Elder works in Algebraic Number Theory, mostly in Ramification and Extension Theory. He has published 5 research articles. The papers appeared in the following reputed research journals: [Proc. Amer. Math. Soc.](#), [J. Number Theory](#), [Arch. Math. \(Basel\)](#). All journals are covered by Math. Sci., the electronic version of mathematical Reviews.

The research of *Dr. Valentin Matache* lies in the areas of Operator Theory and Complex Functions of One or Several Complex Variables. He has published 8 research articles in the following journals: [Oper. Matrices](#), [J. Operator Theory](#), [New York J. Math.](#), [Complex Anal. Oper. Theory](#), [Rocky Mountain J. Math.](#), [Houston J. Math.](#), [Appl. Math. Comput.](#), [J. Math. Phys.](#). All journals are covered by Math. Sci.

Dr. Andrzej Roslanowski's research interests are in Set Theory. Most of his work concerns the theory and applications of Forcing and large portion of this work is carried out in cooperation

with professor Saharon Shelah of the Hebrew University of Jerusalem, Israel. They solved a couple of well known problems and their joint projects has been supported by outside funding:

- Andrzej Roslanowski (co-PI) and professor Saharon Shelah (PI) were awarded a grant by the US-Israel Binational Science Foundation for the project “Problems in the Theory of Forcing”, 2007-2011.
- Andrzej Roslanowski currently has the grant: Research Grant of the US-Israel Binational Science Foundation for the project "Creature Forcing" (joint with Professor S. Shelah), 2012-2015.

During the discussed period, Andrzej Roslanowski authored (or co-authored) 8 research articles. They appeared in the following journals, all covered by Math. Sci.: Real Anal. Exchange, Period. Math. Hungar., Colloq. Math., Arch. Math. Logic , Ann. Comb., Bull. Lond. Math. Soc., Notre Dame J. Form. Log.

Dr. Robert Todd authored/co-authored 5 papers. All appeared in the following Math. Sci. covered journals: Topology Appl., J. Knot Theory Ramifications, Geom. Dedicata, Adv. Appl. Math. Sci., J. Knot Theory Ramifications. His field of expertise and that of his papers is topology.

The group of pure mathematics has a good citation record. Currently Math. Sci. reports a combined number of 395 citations for a total of 98 papers authored or co-authored by the members of that group. The number of authors making those citations is 195 and they are mathematicians working at universities all over the world.

Some of the members of the pure mathematics group have been invited/principal speakers at international conferences, in the period 2009-2016 (see vitae Appendix 9).

A list of recently funded projects is included in Appendix 4.

Research Involving NU Students

The Mathematical Biology and Applied Mathematics groups systematically get NU students involved in their research. Several articles published by some of the faculty members were co-authored by NU students. Mathematics Education also has a few publications with students during the last six years. A list of recent publications with students is included in Appendix 4.

B. Need and Demand for Program

- Math 1310, Intermediate Algebra, is a general education requirement for all UNO students. One-half of all entering freshmen are required to take Math 1310 because their Math ACT score is < 23. The follow-up course, Math 1320, College Algebra, is required for some business majors many biological sciences majors, as well as for many social science majors Engineering majors take 23 hours of mathematics, including all three levels of calculus. Many Engineering majors obtain a minor in Mathematics which

only requires 26 hours. Computer Science majors take 16 hours of mathematics including two semesters of calculus. Several departments in Arts and Sciences, such as Chemistry, Geography/Geology and Physics require their majors to go well beyond the general education requirement in mathematics. Other majors, such as economics, exercise science, and the social sciences recommend advanced mathematics to their majors.

- Quantitative knowledge is becoming increasingly important in higher education, perhaps because it is a foundation for technology. This is reflected in the growth of student credit hour production in Mathematics at UNO (see Appendix 6). In 2014-2015 the math department accounted for 15.4% of the total SCH production in the college. The department experienced declines in SCH in 2011 and 2012, but during the past two years we have experienced significant growth in SCH. For example, last year we had a 13% increase in our total SCH from the previous year. This increase was due primarily to the introduction of the Math 1000 into the curriculum. In fact, the enrollments in the Math Lab last year increased 50% from the previous year because of the demand for the Math 1000 course. During the past two years the lower division courses experienced a 20% increase (total for the two years) in SCH. Certainly the Math 1000 course contributed significantly to this increase. After declining for several years the upper division SCH showed an increase last year due in part due to the expansion of our statistics program and the introduction of the data science curriculum. Due to the expected demand for this program, we expect this trend of increasing upper division SCH to continue for at least several more years. The graduate SCH experienced a decline for several years, but last year we experienced a 16% increase due in part to the introduction of new graduate courses in statistics and data science. The same patterns of declines a few years ago and increases the last two years can be found in the number of majors/minors and graduates.
- This trend towards increasing interest in mathematics is also reflected in the increasing numbers of students earning degrees in our program. These numbers include double majors by students whose primary major is (often) Computer Science or Physics. In the past few years we have seen a substantial number of Engineering majors also obtaining a double major in Mathematics (Engineering/Mathematics double majors are not listed in audit indicators because they are UNL graduates). The table below shows the recent increase in graduate degrees and an expected increasing trend in the undergraduate degrees based on our recent initiatives in data science and recruitment of more math majors.

	Year	Bachelors	Masters
Mathematics Degrees	2014-2015	24	16
	2013-2014	23	9
	2012-2013	27	13
	2011-2012	29	11

2010-2011	31	15
2009-2010	25	15
2008-2009	20	10

The table below shows the number of undergraduate majors/minors in math and the number of graduate majors since the last review. Observe the significant increasing trend in the number of undergraduate majors. In fact, in 2015 we have over 140 undergraduate majors.

Year	Undergrad	Grad	Undergrad
	Majors	Majors	Minors
2014 MATHEMATICS	130	45	56
2013 MATHEMATICS	121	43	54
2012 MATHEMATICS	105	39	52
2011 MATHEMATICS	109	42	38
2010 MATHEMATICS	115	50	42
2009 MATHEMATICS	107	49	40
2008 MATHEMATICS	97	42	37

We are expecting enrollment growth and increase in graduates from our department based on the following initiatives: 1) expanding the data science program with the addition of new courses in data mining and computational statistics, 2) implementing an interdisciplinary data science degree program with the Colleges of Business and IS&T, 3) through the NOYCE program we are expecting more math graduates to become certified teachers, and 4) encourage and recruit more computer science and engineering students to double major in mathematics with a data science concentration.

We expect these increases to continue, especially in the Data Science program, and, consequently, more resources will be needed.

Here is a summary of the minimal requirements:

- 1) Two additional GTAs for the Math Lab.
- 2) Two GAs for the Data Science program.
- 3) Permanent funding for the two Math Lab coordinators.
- 4) One additional faculty member for the expansion of the Data Science program.

C. Utilization of Resources

- The Mathematics Department has a dedicated and hardworking faculty of 26 full time members. In addition, every semester there are about 15 part-time faculty members teaching lower division courses. The faculty are assisted by a full-time Academic

Coordinator, who provides campus-wide mathematics advising services, and two Staff Assistants, one of whom is assigned to the Mathematical Departmental Office and the other to the Math Lab Office. In addition there are six GTA's assigned to the Math Lab as well as a variable number of joint UNO/MCC GTA's who perform teaching duties on the MCC (Metropolitan Community College) campus (five in 2014-15). Finally, a large number of students, both graduate and undergraduate, are hired hourly to work in the Math Lab as facilitators and tutors (about 24 in 2015), and also to serve as paper graders for faculty. An additional dozen or so math undergraduate students work as tutors in the Math-Science Learning Center each semester.

- The Mathematics Department operates very efficiently. In 2014-2015 the SCH/FTE ratio was 780, among the highest ratios on campus. There are several reasons for such a high rate of efficiency. One reason is the large number of classes approaching a size of 50, which is the typical room capacity in the Durham Science Center. This class size holds all the way up to the level of Math 2030, Discrete Mathematics, Math 2050, Applied Linear Algebra, and Math 2350, Differential Equations. Many of these large enrollment 1000 and 2000 level classes are taught by Instructors, full and part time, who have higher teaching loads than the PhD faculty. For faculty with very large classes, paper graders are provided upon request. Another reason for our high rate of efficiency is the Mathematics Laboratory which teaches the three high enrollment courses, Math 1000, Pre-Intermediate Algebra, Math 1310, Intermediate Algebra and Math 1320, College Algebra.
- Due to the growth of the department in the past several years, shortage of space has become an issue. For example, classroom space in Durham is becoming tighter and tighter. More classroom space is needed to allow for flexible classroom instruction. More space is needed in the Math Lab for testing. Teaching space for a computer lab and an expanded data science lab is crucial in delivering a quality and relevant education to our students. The University is currently exploring renovating and expanding Durham. However, this could take up to five years to realize.
- The Mathematics Department makes heavy use of computer resources for both teaching and research. Many classrooms in Durham are now high-tech and more are converted each year. Information Services maintains a User Room in Durham with about 75 PCs. The Mathematics Curriculum also makes heavy use of the Computer Algebra System Maple, beginning in Calculus and Applied Linear Algebra and then continuing on in higher level courses. The campus has a universal site license for Maple.
- UNO Library facilities are adequate. Monographs are ordered upon faculty request. Journal cancellations due to rapidly escalating costs are mitigated by a very quick and efficient Inter-Library Loan service, paid for by the University. Our department has gone through a detailed process of updating our own library subscriptions, eliminating a number of journals of little interest and replacing them with new titles that would satisfy a wider population.
- Another resource being actively developed is alumni support. The department has produced an annual fall newsletter since 1999 (copies are included in Appendix 8), which are sent to the approximately 1100 UNO math alumni of record. It is possible

that having a newsletter is related to the generous financial support from math alumni in recent years. In 2002 an anonymous donor contributed \$125,000 to endow the James Earl Scholarship Fund named after a former longtime department chair. Since 2004, Mr. Patrick Kerrigan (BA, Math and Physics, 1973) has given the Department \$8000 annually to support both the annual Kerrigan Award for Excellence in the Teaching of Mathematics and the Kerrigan Research Minigrants Program for students.

D. University and/or College Initiatives

1. Diversity and Gender Equity

Gender equity does not appear to be an issue in the Mathematics Department. Currently, about 30% of the faculty are women, 36% of undergraduate math majors and 50% of our graduate majors are women. Also, in the past several years we are averaging about 36% women earning degrees in mathematics.

2. Student Recruitment and Retention

UNO is in the fortunate position of having constantly growing enrollments. Likewise enrollments in mathematics courses and numbers of declared math majors are also growing as are graduation rates for math majors. An excellent source of new majors in mathematics is to encourage science and technology majors to pick up a double major and we are successfully implementing this strategy. The department is making a conscious effort to increase student success rates at all levels of instruction. The Math Lab has been especially effective in doing this by using supplemental internet testing.

The following is a list of initiatives currently in place to recruit math majors and help retention:

- 1) New data science program has attracted majors from outside our department.
- 2) Annual high school math competitions are used to recruit students.
- 3) Dual enrollment program with local high schools used to recruit students.
- 4) Creating of internships with local business is effective in recruiting students.
- 5) Student activities such as Math Club and Kerrigan minigrants are effective in retention.
- 6) Honors Calculus program has great potential to attract math majors.

3. Community Engagement

Dual Enrollment

UNO’s Dual Enrollment program was developed to allow academically talented students to earn college credit while still in high school. Only “Advanced Placement” calculus courses are considered for dual enrollment. AP Calculus AB is dual-enrolled as Math 1950 and AP Calculus BC as Math 1950 and 1960. In three high schools, dual enrollment instruction is also provided for Differential Equations (Math 2350) and Calculus III (Math 1970).

High school mathematics teachers with a M.A./M.S. in Mathematics are considered by status as a dual enrollment calculus instructor. They are required to submit an application that includes a vita and transcripts. Once approved, faculty are required to submit copies of tests to the Dual Enrollment Coordinator. Instructors may also apply to teach Math 1970 and Math 2350. Prior to being certified to teach these courses, the high school faculty must first serve as a part-time instructor and teach the respective course on the Dodge Street campus. These faculty are provided guidance and resources from full-time faculty teaching those courses. After successful completion of the on-campus instruction, high school teachers are considered as Dual Enrollment Calculus III and/or Differential Equations instructors. Currently, four high school teachers serve in this capacity.

During the past seven years, 21 different schools have participated in the Dual Enrollment program with the mathematics department. Within the metropolitan Omaha area, 13 large public high schools and 5 private high schools are involved, as well as 3 smaller rural districts outside of the Metro area. The program began in 2003, and experienced continued growth during the initial 7 years of the program. Since that time, the participation by students has stabilized. The following tables summarizes the engagement of students in this program:

Academic Year	Total # Students Enrolled
2009-10	404
2010-11	403
2011-12	418
2012-13	411
2013-14	413
2014-15	446

The overwhelming majority of students that participate in Dual Enrollment are enrolled in Calculus I (Math 1950). The following table summarizes the numbers of students enrolled in each course during the past six academic years.

Course	Total # Students Enrolled
Math 1950	1748
Math 1960	514
Math 1970	126
Math 2350	107

Revenue generated by the Dual Enrollment program has been utilized to enhance the calculus instruction with the Omaha area. Guest speakers have been invited to campus to present “Calculus Teachers Circles” for all area calculus teachers. They have been held each semester during the past three years. At these events, activities and information relevant to calculus teachers is provided. Additionally, a grant program has been developed for Dual Enrollment faculty. They may apply for grant funding annually to support travel, equipment, technology, or other resources to enhance their classroom instruction. Grants awarded have been used for additional technology resources in the classroom, for travel to relevant conferences, and for classroom materials. Additionally, funds are provided for a departmental “Math Teachers’ Scholarship.” Area teachers that are not currently qualified to be a “Dual Enrollment Calculus Instructor” may apply to receive tuition assistance to pursue a graduate degree in mathematics that will lead to their qualification as a DE Calculus instructor.

Funds from the Dual Enrollment Calculus program are also used to support the annual “Calculus Bee” for all calculus classes in the greater metropolitan area. The Calculus Bee for high school students has taken place in conjunction with a performance of “Calculus the Musical” for the past three years. The event has grown each year, and in the Spring 2015 semester, approximately 650 students were on the UNO campus competing/observing at the Calculus Bee. Two competitions were held simultaneously, with approximately 325 students in each campus location. The first portion of the competition involved a “clicker round”, where 95 students competed for a position in the head-to-head competition. In that portion of the competition, a double-elimination tournament among the 8 finalists took place. Top three winners were awarded prizes in each of the competition rooms. The “Calculus Bee” has become a major annual event to attract students to campus and engage them actively with the mathematics department.

High School Problem Solving Contest

The UNO math department hosts an annual problem solving contest. This contest has several goals: First, we wish to promote the pleasure and joy that can be found in mathematics. Second, we want to show high school students and teachers the types of problem solving skills on which they should be working to be successful as these students transition to the college level. Thirdly, it provides a contact between the staff of the university and the staff of the high schools. Lastly, we wish to promote the university by getting the students on campus to see the

campus and facilities and make the students aware of the opportunities, particularly in the mathematics department, available here at UNO. The contest has grown. In 2014 there were 163 students from 16 schools, while in 2015 there were 328 students from 36 schools.

Omaha Area Math Teachers' Circles (2011-present)

The Omaha Area Math Teachers' Circles meet approximately once a month. These are events where area mathematics teachers and mathematics professors (from UNO and from other universities) lead sessions on inquiry-based mathematics. These teachers and professors are also part of a national Math Teachers' Circle group as state on the MTC website. "The Math Teachers' Circle Network brings together Math Teachers' Circles throughout the United States. Our mission is to establish the foundation for a culture of problem solving by fostering the enjoyment of mathematics among middle school math teachers." A list of the meetings can be found in Appendix 5.

Noyce Teacher Scholarship Program

The University of Nebraska at Omaha (UNO) will soon contribute more STEM educators to the work force after receiving a \$1.2 million grant to provide scholarship funding and internship programs for future teachers.

UNO was announced as the recipient of a highly competitive grant from the Robert Noyce Teacher Scholarship Program, which is run out of the National Science Foundation (NSF).

The NSF funding will be spreads out over a five year period (2015-2020) and will provide stronger guidance for high school-level math teachers who enroll in UNO's Bachelor of Science in Math with Teaching Certification.

During the timeframe of this grant, we fully expect to produce at least 27 high school mathematics teachers who are prepared and committed to teach in high need schools. All of the teachers supported by the Noyce program will leave UNO with a BS in mathematics and will have focused training to prepare them for teaching careers, including extensive fieldwork in area schools.

The grant will be used in three key areas:

- Providing structured internships for first-and-second-year undergraduates, referred to as "Noyce Interns."
- Establishing financial, academic and professional development for third-and-fourth-year undergraduates, referred to as "Noyce Scholars."
- Continue professional development in support of former Noyce Scholars that have gone on to become Noyce Teachers."

The Omaha/Noyce partnership is really going to help us here at UNO strengthen our mathematics teacher prep program, creating a foundation that will continue beyond the timeline set by the grant. We really want to be the model program for the education of

culturally response mathematics teachers who can succeed in the schools that need STEM education the most.

The Noyce Teacher Scholarship Program was launched in 2002 and reauthorized in 2007 in order to respond to the critical need for K-12 teachers of science, technology, engineering and mathematics (STEM) by encouraging talented STEM students and professionals to pursue teaching careers in elementary and secondary schools.

Similar programs have been established at universities such as Xavier, University of New Hampshire, University of Louisville and Virginia Tech.

Mathematics Teaching Assistantship Program (MTA) (August 2009 – June 2012)

- Established by Jack Heidel, UNO Mathematics Department and Rachael Wise, Building Bright Futures with the collaboration of Brian Lisko, 8th grade mathematics teacher at King Science Magnet School in Omaha. Funded by Building Bright Futures. Supervised by Michael Mathews, UNO Mathematics Department.
- UNO undergraduate mathematics and mathematics education majors were sent to 10 different middle schools in metro Omaha to work as teaching assistants in 8th grade mathematics classes.
- Over the four year period of operation, 10,000 eighth grade pre-algebra students were served by about 120 MTAs.
- The best quantitative measure is that the MTA program helped raise the percentage of OPS students passing the NeSA-M exam from 33% to 37%.
- The participating teachers almost always felt that the MTAs were making a big difference with their students.
- The MTA program also had an impact on the MTAs themselves. Several MTAs decided on a teaching career because of the program. Several others, who were previously considering teaching as a career, decided not to become a teacher because of the program. Both of these outcomes are considered favorable.
- The program was discontinued in 2012 because Building Bright Futures made a major change in its organizational structure at this time.

NSF STEP Grant: “UNO and MCC STEPping Together”, May 2004 – August 2009

- Awarded to UNO and MCC in August 2003
- PI: Jack Heidel, UNO Mathematics Department and co-PI: Dana Richter-Egger, UNO Chemistry Department
- Successes:

- **Collaboration between Institutions:** MCC Bridge Scholarships. UNO Bridge Scholarships. Increase in the number of MCC students transferring into STEM majors at UNO. Establishment of “Joint UNO/MCC GTA program” whereby UNO graduate students in Mathematics are awarded GTA positions with the teaching duties performed at MCC. The GTA positions are still continuing today with approximately 4 such positions each year.
- **Walk-in Tutoring and the Math-Science Learning Center at UNO.** Math/Physics walk-in tutoring in Fall 2003 led, in 2006, to NU Foundation funding for a permanent Math-Science Learning Center located on the first floor of the Durham Science Building. MSLC use has now stabilized at around 1500 visits per week.
- **Early Undergraduate Research.** One of the major STEP activities was to fund summer research for both UNO and MCC undergraduate students. In fact over 6 summers, 194 students participated in 40 different projects lead by a total of 19 different faculty members of both institutions.
- **Scholarships.** In addition to the bridge scholarships discussed above, an Adult Learner Access Scholarship program operated from Spring 2006 – Summer 2009, whereby adult learners, age 24 or over, were awarded tuition waivers for a e credit hour course needed to complete a STEM major. In Fall 2010, 118 ALAS recipients had either graduated with a STEM major or were still pursuing a STEM degree, out of 126 ALAS awards granted.
- **Evaluation.** A thorough evaluation of the STEP grant was performed by UNO.

E. Strengths, Limitations, Opportunities and Challenges Analysis

1. Major Strengths:

- The department has an excellent faculty in which pure mathematics, applied mathematics, statistics and mathematics education are all well represented. There is enough overlap in expertise between faculty that it is seldom a problem to schedule necessary courses regardless of who is on leave in a particular semester. Most of the 20 PhD faculty are very active in research and have extensive publication records. Having 6 masters level instructors is also beneficial in providing continuity of instruction in both pre-calculus and calculus courses. The PhD and Masters level faculty interact well together in conducting departmental business. On the whole departmental life is harmonious with a minimum of interpersonal friction.
- Mathematics is one of the largest (in student credit hour production) and fastest growing academic unit at a thriving university in a growing and dynamic city, with all of its many attractions. The engineering and technology programs at the Peter Kiewit

Institute on UNO's south campus, with huge support from the Omaha business community, are attracting many more students with mathematical ability and interests. The University of Nebraska Medical Center, just two miles away, is especially supportive of advanced programs in applied mathematics and statistics. The newly formed data science program is attracting students from a variety of disciplines including doctoral students from UNMC and the College of Engineering. Our Mathematics Education program is very strong not only at the local level but nationally as well.

- The large, growing and diverse clientele of the mathematics program is accommodated with great flexibility in course offerings, degree requirements and class scheduling. For example, most upper level courses are taught in the evening to best appeal to the typical part time student with a full time job and family.

2. Major Areas of Concern and Plans to Address Them:

- **Growing pains.** Because of the rapid rate of growth of student credit hours in mathematics and of the number of degrees granted each year, the department is perennially understaffed in spite of the several new positions added in recent years. Classroom space is tight in the Durham Science Center and during the prime times of morning and early evening, some mathematics classes have to be scheduled into other campus building. The College and the University are attempting to address these issues.
- **Faculty growth.** It is likely that mathematics enrollments will continue to grow at the same rapid rate as at present and therefore the faculty will presumably continue to grow in size. There is disagreement within the department about hiring strategy. One approach is to identify those areas in which the department will maintain or establish research strengths. Then the department should work to maintain at least two people in each area of strength. Another approach is to give primary emphasis to hiring new faculty in demonstrated areas of student interest and need.
- **Curriculum.** The mathematics department should consider clearly defining goal-based tracks in its curriculum. This may be done by following the University of Nebraska – Lincoln, and would address the following problem. There are cases where good students, intent on graduate school, graduate without the Algebra or the Analysis sequence, and without a course in Topology. Additionally, it may be worthwhile to reorganize our major in other ways along lines similar to those at UNL. For example, a choice between Intro to Analysis and Applied Modern Algebra might make the Mathematics major more attractive.
- **Honors.** There are two goals for our Honors Program. In Calculus, the goal is to develop a pipeline ushering capable students into our upper-level courses. The goal in our upper-level courses is student achievement as measured in Honors Theses, Kerrigan Mini-grants, REU participation, and Putnam Performance as well as successful transitions to the work-place and to PhD programs. The program is still in its infancy. What hopefully will become a steady, though small, stream of capable students is still an intermittent trickle.

- **Budgeting F&A funds.** In several of the past seven years the department was unable to spend its F&A funds effectively and efficiently during the year in which they were allocated. The Chair has requested that a mechanism be created for budgeting these funds more evenly and over a longer period of time but has not yet been able to get this accomplished.
- **Research evaluation for promotion and tenure.** There is much disagreement in the department as to the best way to measure research quality. Currently, citation rates are not used. Outside of mathematics education (for which a separate system is used), whether a journal is judged to be of the highest quality depends entirely upon whether the journal is listed in Thompson Scientific (ISI) Journal Citation Reports. The Thompson Scientific Impact Factor is not considered. The College of Arts & Science *Instructions for Preparing RPT Form and Portfolio (Fall 2007)* encourage the use of citation rates in the evaluation of research. It may be that for mathematical research, MathSciNet's MCQ (Mathematical Citation Quotient) provides a better indicator of the quality of a journal.
- **Multi-section classes.** The department needs to have more active course coordination for our multi-section courses such calculus, differential equations, and statistics. This issue will be brought to the attention of the departmental curriculum committees.

3. Plans for Future Development:

I. Academic Programs

(A) Programs for undergraduate and graduate majors and minors

- i. The department will continually review its undergraduate and graduate curricula to evaluate whether they conform to the recommendations of disciplinary organizations such as the Mathematical Association of America. The information which is obtained through the departmental assessment procedures will periodically be reviewed to see whether that information indicates that any particular areas of the curricula should be addressed.
- ii. The department will ensure that graduates of our programs receive a sound mathematical education which will prepare them for more advanced work in mathematics or for a successful entry into the many employment opportunities available to them.
- iii. The department will provide students with the opportunities to learn about the career options that are available to those who complete a major or minor in mathematics. Increased effort will be made to provide internships in local industries for interested and qualified students taking concentrations such as data science, statistics, or operations research. Increased effort will be made to work with the local actuarial societies to provide students interested in that field with appropriate course work and with internships and other employment possibilities.
- iv. The department will develop strategies to recruit students into its degree and minor programs. Efforts will include the encouragement of undergraduate students to have

double majors such as mathematics/computer science; mathematics/physics; or mathematics/philosophy. Recruitment efforts for the graduate program will be intensified, building on the efforts which have already begun through the College of Arts and Sciences.

- v. The department will sponsor activities and inform students of opportunities which will enrich the educational experiences of our majors and of other students interested in mathematics. Such activities and opportunities will include, but will not be limited to, a Math Club, opportunities for undergraduate research, and problem-solving groups.
- vi. The department will explore the development of a Ph.D. program in areas such as operations research, financial mathematics and data science.

B) Service courses

- i. The department will continue to monitor the content of the service courses it offers for the general student body and for specific units, such as the College of Information Science and Technology, College of Business Administration, and the College of Engineering, in order to provide the best mathematical foundations for their students.
- ii. Whenever resources permit, the department will respond to requests from other units within the University to develop or revise service courses in mathematics to support their programs.
- iii. In its strategic plan, the College of Arts and Sciences promises to provide the resources needed by all departments to maintain an appropriate mix of full-time and part-time faculty; to reduce the size of sections whose size precludes effective learning; and to meet enrollment increases in service courses. The Department of Mathematics will make similar provision.

C) Technology

- i. The department already makes extensive use of technology with the computer algebra system MAPLE required in MATH 1960, 1970, and 2050. Many instructors use MAPLE and more specialized software in upper level courses. Keeping up with advances in computer technology will be one of the most important issues for the department during the next five years. The department will evaluate the results of research studies on these issues; seek the advice of local business and industry with respect to what is expected of employees; survey past and present students; and maintain a close liaison with the secondary schools in order to help the faculty to determine the best way to use technology in the classrooms.
- ii. The department will continue to find support to expand the data science lab (DSC room 243), as well as find space for a teaching computer lab for advanced courses in applied mathematics. A careful study will be made as to how the lab should be configured and what computer resources can be supported there.

II. Faculty and Staff

The goals listed in this section are the most important for the successful implementation of all sections of this strategic plan. The department faces a severe shortage of faculty and staff which will make it impossible to meet the goals of other sections in this plan - unless resources are made available to alleviate the shortage.

Just as important as the addition of new faculty positions is the ability to provide the resources needed for current faculty and staff development.

A) New Faculty and Staff

- i. The department will make the strongest possible case that without an increase of at least three full-time faculty members it will be impossible for the department to satisfy the growing demand for mathematics courses to meet general education requirements and to provide the more advanced quantitative skills required by students in the social, natural, and physical sciences; engineering; computer science; education; and business.
- ii. Whenever a position is to be filled, the department will carefully determine how the position should be filled in order to fulfill our mission. This includes determining the level of the position and disciplinary specialties. In the latter case, consideration will be given to selecting new faculty members who can meet the department's diverse needs for instruction and research.
- iii. The addition of at least two graduate teaching assistants in the Math Lab would ease the current teaching overload problem. The addition of two graduate research associates in Data Science would ease the heavy workload in the classroom and the data science lab for the instructor. The department needs at least one more faculty member for the fast growing data science program.

B) Faculty and Staff Development

- i. Recognizing the essential role played by faculty research in the quality of both undergraduate and graduate programs, the department will support in every way possible the productive involvement of the faculty in both mathematical and pedagogical research.
- ii. In order to meet the objective of (i) above, faculty will be encouraged to seek funding for research projects from sources outside the department. Ways and means of providing this encouragement will be thoroughly explored.
- iii. By using the approaches given above, the department will develop a plan to support domestic travel to professional conferences for all those who are presenting papers or recruiting. Other faculty will be encouraged to submit proposals for professionally related travel. Funds for international travel for similar purposes will be sought from the Dean and the Vice Chancellor for Academic Affairs.

- iv. The department will encourage and support the involvement of faculty members in workshops and conferences which will widen their contacts and enhance their skills in teaching, research, and service roles. Such support will include assistance in applying for funds from sources external to the department.

III. Budgetary Resources

There are several sources of funds to support the instructional, research, and service activities of the faculty. The departmental operating budget should be adequate to meet reasonable ongoing or recurring needs. These include supplies; communications; duplication of instructional and research materials in reasonable quantities; minor equipment purchases and office furnishings; and departmental-related travel. Departmental operating budget surpluses can be used to purchase electronic equipment and to supplement the Dean's travel budget.

Other sources of funds for departmental activities include the Dean's travel budget, the equipment budget, and the technology fee account. The department should plan its use of funds so as to meet as many of its goals as possible. This includes the submission of proposals to UCRC, UCAT, the technology fee account, etc.

By using the approaches given above, the department will develop a plan to ensure that all faculty, staff, and graduate assistants are provided with computers and software which are adequate for their needs and preferences. In order to achieve this goal, different approaches to hardware and software may be required for different individuals. This plan will include the preparation of proposals to sources outside the department, when that is appropriate.

IV. Space and Facilities

Due to enrollment growth, space and facilities have for some time been a serious concern for the department. The need and demand for lab space is threefold: 1) enlarge the data science lab, 2) expand the Math Lab to include a testing center, and 3) find space for a teaching computer lab.

In addition to the reassignment of space to the department, there are other space and facility concerns in the Durham Science Center. For example, there must be an enlargement of the existing classroom space in the building for alternative forms of instruction and the construction of a computer classroom large enough to accommodate 40-50 students.

V. Outreach

- i. The department will encourage and support the involvement of faculty members and students in outreach activities. Examples of such activities include local educational efforts, high school math and problem solving competitions, expand dual enrollment with local high schools, and the creation of internship opportunities.
- ii. The department will support efforts within the University and from the community to strengthen mathematical education at all levels.

Summary/Conclusion

In summary, the UNO Mathematics Department is an active and growing department, moving forward with new faculty, courses, and programs over the previous seven years. The department's development is in line with the university's overall mission of "...providing appropriate educational opportunities, discovering and disseminating knowledge through research and teaching, and offering public service to the citizens of the State, particularly the residents of the Omaha metropolitan area..."

One of the most important lessons learned in the creation of the current Self-Study is the importance of continual assessment and evaluation of the departmental mission, long-term goals, and objectives. Thus, the department is committed to transforming the Self Study process from a once in seven year exercise to an active, year-to-year part of the department's process for development that is transparent and is open to input from all faculty members. It is hoped that the result of this change is an improvement not only in the assessment product the department supplies every seven years, but also a real road map to guide and organize departmental growth and development over the next review period.