

# **External Review**

**Mathematics Programs  
Department of Mathematics and Computer Science  
College of Arts and Sciences  
Western Carolina University**

**February 17, 2009**

## **Reviewers**

**Tim Howard  
Department of Mathematics  
Columbus State University**

**Lou Ann Lovin  
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## **I. Introduction**

### **a. Visit by the Review Team**

The external members of the review team arrived late Sunday afternoon, February 15, and departed at noon on Tuesday, February 17.

### **b. Meetings Conducted by the Review Team**

Sunday evening:

- Dinner with three members of the mathematics faculty

Monday:

- Breakfast with Mark Holliday, Ben Kearns, and Jeff Lawson
- Meeting with Scott Higgins, Dean of Graduate School
- Meeting with Mathematics Department head, associate heads, and curriculum committee chairpersons
- Meeting with mathematics curriculum committee
- Tour of department facilities conducted by Kathy Jaqua
- Lunch with three mathematics students – one graduate student, one applied math student, and one secondary math education student
- Meeting with graduate mathematics committee
- Meeting with department members minus department head
- Paperwork with Pam Buchanan
- Working session for review team members
- Meeting with Wendy Ford, Dean of Arts and Sciences College; Dave Butcher, Associate Dean; and Niall Michelson, Associate Dean
- Dinner with three members of the mathematics faculty

Tuesday:

- Breakfast with two junior faculty members – Risto Atanasov and Axelle Faughn
- Work meeting for review team
- Meeting with Beth Tyson Lofquist, Associate Provost
- Meeting with department faculty

## **II. Analysis of Program**

### **a. Undergraduate Program.**

As mathematics departments across the country have seen a decline in mathematics majors as well as students who continue into graduate work in mathematics, many universities are experimenting with different approaches to attract and mentor majors and to help students transition to graduate work. One approach has been to create a more flexible major by offering different areas of concentration. The mathematics department at WCU has created four options for the major (a Traditional option, an Actuarial Science option, an Applied option, and Mathematics Education option) which broadens the opportunities for students to pursue the study of mathematics and offers an interdisciplinary approach through the Actuarial Science and

Applied options. The program's requirement that students obtain a minor or a second major clearly strengthens students' backgrounds and makes them more competitive for post-baccalaureate careers; however, it might be a hurdle that will discourage some students from choosing the major. Another strength related to attracting more students to mathematics is the 5-year program which mentors talented students to complete a bachelors and masters degree in 5 years.

The core requirements and prerequisites for all three options are typical and provide a solid foundation for further study in each of the options. As noted above, we see the different options as a positive effort in attracting more majors to mathematics by offering alternatives to the traditional approach. However, in the interest of cost effectiveness, the faculty might wish to consider the number of elective choices offered to students. For example, in the traditional program there are three choices for the analysis requirement, three choices for the computing and modeling requirement, and three choices for the algebra/discrete requirement which results in nine courses to fill three requirements. These are low enrollment classes in most cases. We suggest that the department consider whether the program outcomes can be achieved while streamlining these options.

Class sizes for lower level courses are typically in the range of the high teens to low thirties. As would be expected, enrollment in the higher level courses is smaller. Although upper level electives are not offered every semester, students are able to graduate in a timely manner. The advising templates provided to students and faculty offer detailed information about the major that no doubt contributes to students being clearly informed about major requirements. Most of the students who graduate from the department successfully enroll in graduate school or obtain employment in the field.

The number of graduates in the BS Mathematics Program in the last five years has ranged from 5 to 11 with a mean of 8 graduates per year. Since the BSED students were essentially taking the courses in the BS Mathematics program, the Department has proposed that these students will also earn the BS in Mathematics (Dual Degree Proposal). Including those numbers, the number of graduates in the program in the last five years ranged from 8 to 12 with a mean of 10.4 graduates per year. The number of BS/BSED math degrees conferred in relation to the number of all degrees conferred at WCU since 2002 are 0.5%, 0.9%, 1.3%, 1.1%, and 0.7%, which are consistent with national trends<sup>1</sup>. An interesting trend since 2006 is that the number of females majoring in mathematics is greater than the number of males majoring in mathematics, which defies national trends.

The mathematics programs benefit from a complementary relationship with the computer science program. A number of students either double major in mathematics and computer science or major in one and minor in the other; hence, course enrollment in shared courses is enhanced and supported by both programs. This dual subscription in common courses should be acknowledged when contemplating the cost of the mathematics programs. Having the two programs in the same department also allows faculty to teach courses in the other program as their area of expertise allows.

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<sup>1</sup> In 2004 the NSF determined that 0.7% of all degrees conferred in the U.S. were in mathematical sciences.

The mathematics program's major asset is the exceptionally dedicated teacher/scholars who constitute the mathematics faculty. They are committed to engagement with their students as evidenced in particular by the amount of student-dedicated space included in the recent renovations. Both students and faculty remarked how the student work space in close proximity to classrooms, labs, and faculty offices enabled faculty to provide ready assistance to students and increased interaction among students and faculty. Students identified faculty accessibility and knowledge of the discipline as key assets of the program. The number of student awards and recognitions is also evidence of the dedication of the faculty to support and encourage students in the program. The department also fosters a nurturing atmosphere for students pursuing the major by engaging students in research and professional organizations as undergraduates as well as recognizing outstanding students through awards and scholarships. Among the many initiatives that help introduce students into the professional community of mathematicians, a few are standouts: the department sponsorship of and engagement in the Smoky Mountain Undergraduate Research Conference on the History of Mathematics; the encouragement for students to present at the annual conference of the Mathematical Association of America; and the support provided to students to participate in the COMAP modeling contests and the Putnam Math Competition.

The program provided information in the self-study report about how they document student learning. While the goals are appropriate, some of the learning outcomes are not listed as measurable outcomes so it may be difficult for the program to document student learning (e.g., what would "demonstrate an understanding of the axiomatic development of geometric systems" look like? Are different faculty looking for and evaluating similar ideas and how do you know?). It is recommended that the learning outcomes for the program and for individual courses be revisited to ensure that the outcomes are clear and measurable.

## **b. Graduate Programs.**

### **M.S. in Applied Mathematics**

The courses and requirements of the M.S. in Applied Mathematics program are appropriate. Class sizes in this graduate program are small, but students commented that they appreciate the small classes and the individual attention they receive from the faculty which fosters a supportive learning environment. One student remarked that it was the supportive and non-competitive environment in this graduate program that attracted him and others to it. Most of the students who graduate from this graduate program successfully obtain employment in a related field or enroll in a Ph.D. program. In particular, this program has been a consistent source of instructors for the mathematics department at WCU. This graduate program was also mentioned as a draw for faculty applying for positions at WCU because it provides opportunities to work with graduate students and aids in continuing research because of the required masters thesis or project and because of the focus and level of coursework. This attraction for faculty is an extremely important consideration given the rural location of the university if the university values attracting and retaining quality mathematics faculty.

One of the recommendations made by the UNC Tomorrow Commission was that UNC should increase access to higher education for all North Carolinians, particularly for underserved regions. Offering the M.S. in Applied Mathematics at WCU seems to be consistent with this

recommendation by providing access to a graduate degree in mathematics to the people in the western region of NC. Otherwise, people living in this region would have to travel to or relocate to the Charlotte area to enroll in the graduate programs in mathematics offered at UNC-C.

In an effort to increase enrollment, the department has implemented the 4+1 program in which talented undergraduates are able to complete the bachelors and masters degree in 5 years. This approach is a positive effort to attract capable individuals into the program. More competitive scholarships and tuition waivers may also be helpful in attracting more students to this program. A two-prong approach may be beneficial to increasing enrollment numbers: increased support from the Graduate School and funding from external funding sources, such as NSF's S-STEM Scholarship program described later in Section V (Summary).

As with the undergraduate program, is also recommended that the M.S. in Applied Mathematics program identify clear and measurable learning objectives. It is unclear what is being assessed when the intended outcome is "Students will demonstrate an understanding of the following fundamental concepts."

In our discussions with various university representatives, it became clear that the M.A.Ed. program will continue, albeit consolidated into one degree program with multiple concentrations. This program will require graduate-level mathematics courses, many of which are included in the M.S. in Applied Mathematics program. In light of this, the incremental cost of maintaining the M.S. in Applied Mathematics program would seem relatively small especially when one considers the benefits of the program attracting quality faculty and meeting the UNC Commission's recommendations for serving the WCU region with opportunities for graduate education.

### **M.A.Ed. – Two-Year College Teaching with Mathematics Concentration**

As noted in the recommendations by the UNC Tomorrow Commission, UNC should prepare for wide-scale faculty retirement and increase efforts to recruit and retain high-quality faculty at all levels, including community college settings. The M.A.Ed. program serves to prepare high-quality faculty for two-year colleges. Considering the guidelines for the academic preparation of mathematics faculty at two-year colleges (<http://www.amatyc.org/documents/Guidelines-Position/GuidelinesforAcademic.htm>), a program which prepares these faculty members needs to ensure graduates "know a great deal of mathematics and understand the interconnections among its various branches as well as applications to other disciplines." Furthermore, the program needs to prepare faculty members who are knowledgeable about pedagogical issues such as collaborative learning, effective classroom teaching, assessment strategies, and the use of technology in the collegiate classroom. The content coursework in the current M.A.Ed. program overlaps extensively with the coursework in the M.S. in Applied Mathematics program and prepares people with strong content knowledge and an understanding of applications to other disciplines. One difference is that students in the M.A.Ed. program are not required to complete a master's thesis or project, which could be considered a weakness of a graduate program. The M.A.Ed. program also includes appropriate coursework which addresses the pedagogical requirements for teaching at the community college level; however, it is not clear where assessment strategies are addressed. It could be assumed that assessment is addressed in EDHE

610, but the course description does not explicitly indicate that assessment strategies are included.

As the M.A.Ed. program is consolidated into one degree program with multiple concentrations, it is imperative that the guidelines provided by AMATYC be seriously considered. Attention given to both content and pedagogy will ensure the program has the potential to produce strong candidates for teaching mathematics in a two-year college setting.

### **III. Analysis of Faculty**

#### **a. Qualifications**

Among the members of the Western Carolina University mathematics faculty, we find appropriate degrees and credentials but we have concerns about a heavy reliance on non-tenure track faculty members. The mathematics faculty is diverse with regard to specialty areas and doctoral institutions. They have established a strong presence in the professional community. This standing may be jeopardized by a heavy reliance on graduate assistants and fixed term instructors.

The mathematics faculty includes nine full-time tenured or tenure track faculty members, two of whom are teaching reduced loads, one phased retirement faculty member who is teaching a reduced load, and eight non-tenure track faculty members. Ten faculty members are far too few to run a master's degree program and sustain the present level of engagement with the undergraduates in the mathematics programs. This places undue strain on the tenure track faculty, erodes the long term viability of the junior faculty, and might hamper recruitment into the major. We note that the two newest tenure track faculty members report no peer reviewed scholarship since beginning at WCU, and that the department's tenure criteria require such an achievement.

#### **b. Resources and Support**

The Department of Mathematics and Computer Science has published a lucid and reasonable policy on faculty evaluations, reappointment, tenure, promotions, and post-tenure reviews. The reviewers salute the department for its clarity and inclusiveness. Junior faculty members indicated their satisfaction with what is expected of them and the clarity with which it has been communicated. We also commend the faculty for its commitment to high standards. During the review team's on-site visit, it was noted that students' evaluations of instruction come in the form of free-response statements that get read and evaluated by every member of the Annual Faculty Evaluation committee. A review of this nature is time consuming but valuable. The practice reveals a strong faculty commitment to quality teaching.

Physical and electronic resources appear to be adequate for the needs of the program. The department occupies an extraordinary facility designed to lure students and engage them. The hallways feature numerous displays of student and faculty awards, as well as copies of faculty publications; students have the chance to view the field of mathematics as alive and thriving. An abundance of study space entices students to remain in the department while conducting their studies.

### **c. Teaching, Research/Creative Activity, and Service**

The mathematics faculty does an excellent job engaging its students while maintaining respectable levels of participation in research and creative activities and service. It probably could achieve more if the service load were more broadly distributed. As it stands now, a set of nine tenured and tenure track mathematics faculty members along with three computer science faculty members seem to carry almost all of the departmental service responsibilities while a corps of eight fixed term instructors and several graduate student instructors teaches a majority of the lower division course sections.

The faculty does a fabulous job of engaging students majoring in mathematics. All students in the program complete a capstone project and many participate in professional meetings. The program is known throughout the southeastern United States for its engagement of its students. The master's degree program in applied mathematics helps fuel this experience for undergraduates by challenging the faculty to keep current in their fields.

The high proportion of non-tenure track mathematics instructors might pose a challenge for recruiting new students majoring in mathematics. In spring 2008, for example, non-tenure track faculty accounted for 51% of the total SCH production in mathematics. The gateway to the mathematics major is through core mathematics courses; students need to interact with tenure track faculty members who are engaged in research and capable of conveying a sense of excitement about the frontier of mathematics.

The faculty raised a concern about a lack of work load credit for the supervision of independent study courses and undergraduate research projects. It seems that, in order to complete program requirements in a timely manner, many students must take independent study course work. The faculty members who direct these courses and/or research projects get no recognition for the time devoted to them. This is a reasonable concern and the department might want to consider making adjustments to give work load credit or to reduce the necessity of independent study courses.

The mathematics faculty has maintained a respectable level of research and creative activity. Seven out of the nine current tenure track faculty members have published at least one paper in the last five years; over this period of time the average tenure track faculty member has published almost two publications. The faculty also boasts numerous conference presentations during this time period.

The mathematics faculty is active in service at all institutional levels and highly active within the profession. Four faculty members have held an office of prominence within the profession at the state, regional, or national level in the past five years.

## **IV. Analysis of Operational Facilities and Budget**

### **a. Does the program have adequate facilities to meet their educational mission?**

The program has impressive facilities that foster and enhance student learning. We were impressed by the physical layout of the Mathematics and Computer Science space on the fourth floor of the Stillwell Science Building. It is clear that much thought and planning went into the

design of the classrooms, tutoring center, computer clusters, and computer lab. Other spaces that are available for students to use include common areas with study carrels, blackboards, an ActiveBoard portal, comfortable seating, and food preparation areas. With faculty offices surrounding these areas, students are in constant contact with their teachers and are frequently able to access help, seek advice, or visit. There is clearly a great sense of community. We agree with the department's statement that use of classrooms nearest to the department would be of the greatest value to the students in enhancing student-student and student-instructor interactions. Classrooms nearest the department are outfitted with much requisite software and technology necessary for teaching modern mathematics. Important resources that the department supports include their own server, Polaris, with many programs available through it and such software as Maple, Geometers Sketchpad, and TI-SmartView (for scientific calculating). MATLAB and Mathematica are other key programs and require greater updating needs (see below).

Library resources for the program seem adequate with online and print journals available in Hunter Library or easily obtained via cooperation with UNC-Asheville, Appalachian State University, or Interlibrary Loan. Monograph holdings are reasonable and the department receives \$4,000 per year to update the collection (each new faculty member is able to use \$500 to increase holdings in their particular discipline).

**b. Does the program have adequate budget to meet their educational mission?**

The department makes the most of the budget that they have and have used their modest funds wisely, especially in the context of faculty and student development. Nearly one half of the budget in 2007-2008 went toward faculty and student travel to professional conferences. This is invaluable assistance for maintaining highly engaged instructors and research faculty as well as in training undergraduate and graduate students. The largest issue in funding for the program relates to resources for the M.S. in Applied Math. Recruitment of students into the program is hampered by a meager stipend (\$9,000) and low number of tuition waivers (both in and out of state waivers). Recruitment is also impaired by the shortage of tenured and tenure track faculty mentors to take on larger numbers of graduate students.

2007-2008	WCU	JMU	CSU
Size	9.5 faculty* 8 fixed term faculty	40 faculty* 4 instructors 1 math lab director 2 part-time adjuncts	11.3 faculty* 2.5 FT lecturers 1.75 PT adjunct(FTE)
Operational	\$8,890	\$138,489	\$11,500
Faculty Travel	\$13,860	\$41,777	\$5,500
Job Searches	\$4,622	Allocated as needed	\$2,000/position
Equipment/Furniture	\$1,980	\$5,000	Allocated as needed
Educational Technology	\$3,443	Allocated as needed	Allocated separately as needed
Total	\$32,795	\$185,266	\$17,000

\* tenured, tenure-track, or phased retirement

As mentioned above, the resources available for library improvements in mathematics holdings are important and help in faculty and student research and educational endeavors. Service contracts for maintaining software (e.g., Mathematica, MATLAB) are crucial and should be kept up to date.

## **V. Summary of Program Strengths and Areas for Improvement**

### **a. What is your general impression of the program?**

Very positive. While the program is in critical need of more tenure track faculty, the department is performing admirably. The success of the program over the last few years is unsustainable with fixed term faculty and the reviewers were pleased to learn that as many as six searches, including one for a permanent Department Head, are underway or planned. A relatively few faculty have to take on much of the service and research burden of the department in the current environment. Great strides will be made when this burden is lessened by new faculty joining the department. There were some concerns expressed about faculty turnover in recent years. Our sense is that the turnover is not extreme, especially considering that the turnover has involved statisticians who are in high demand and can leave virtually at will.

The students that we met with had many good things to say about the department and its faculty. They expressed contentment with the course offerings, faculty accessibility and professionalism, and opportunities for conducting research and for getting help in their studies. We were impressed with the number of student awards given each year and with the fact that the department's annual student banquet is funded entirely by the faculty.

### **b. Areas of Strength**

- The four options for majors (Traditional, Applied, Actuarial, Mathematics Education) create broader plans of study which has potential to attract more majors.
- The 4 + 1 program which identifies talented students to complete a bachelors and masters degree in 5 years has potential to attract more majors.
- The M.S. program is an area of strength to the department for a number of reasons. First, it provides access to a graduate education in the WCU service area as endorsed in the UNC Tomorrow Commission Report. Secondly, it prepares quality instructors for the department and area community colleges. Finally, the graduate program is an incentive that attracts faculty to the department.
- The M.A.Ed program is another area of strength in that it is a joint program with the College of Education that prepares community college instructors with a strong content background and a focus on pedagogical issues.
- Tenure/tenure track faculty can opt for a 3/3 teaching load so that they can also focus on research and service
- Mentoring of students is a high priority

- Mentoring of and support for new faculty is a high priority (e.g., no advisees the first year)
- Have a very focused mission of training high quality educators (B.S. Ed., M.S., and M.A. Ed.) and there is great communication and cooperation between the programs and M.S. Ed.
- Envious physical layout of the department
- The sense of community between faculty and students
- Very organized departmental structure with well defined and operating committees
- Numerous displays honoring students and faculty and promoting mathematics
- Website is replete with useful information and links
- Smoky Mountain Undergraduate Research Conference on the History of Mathematics (SMURCHOM) is run by the department with external funding

### **c. Suggestions for Improvements**

- Better publicize the department's very positive roles in undergraduate research and education; representation on the Research Council or Committee to Institutionalize Undergraduate Research and Creative Scholarship would be welcomed
- Advertise the M.S. program more broadly and creatively (on and off campus). In particular, the university web site might be utilized to draw more attention to the graduate program.
- Increase the number of faculty in tenure track positions
  - This would mean more contact with tenured/tenure track faculty during the freshman/sophomore years and would help recruit/encourage majors
  - This would also mean better recruitment of more M.S. students into program
- Having a vibrant M.S. program will lead to recruitment and retention of high quality faculty.
- Include a requirement for a master's thesis/project in the M.A.Ed. program.
- Revise learning outcomes for the program and for individual courses to ensure outcomes are clear and measurable to enable the program to better document student learning and inform program/course changes.
- Reduce the number of upper level electives in the options for majors.

- Look for more opportunities to recruit for the undergraduate program
  - become more visible at New Student Orientations by offering short interactive talks about the mathematics major and the interesting career options for mathematics majors;
  - offer an Academic Open House each semester for high school juniors and seniors as well as for freshmen where students can engage in interactive sessions with faculty and current students engaged in interesting mathematical tasks and projects;
  - identify current mathematics majors who could serve as “ambassadors” for the mathematics program for admissions tours, visiting students, and recruiting in area middle and high schools.
  
- Increase funding to support Graduate Students
  - Increase funding for Graduate Student stipends and out-of-state tuition waivers
  - Apply for scholarship funding through the external funding sources (A revision of the current Indirect Cost Structure used by the university may also provide additional incentives for faculty to pursue external grants.)
    - o National Science Foundation S-STEM Scholarship program ([http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5257](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5257)). This NSF program offers grants to Institutes of Higher Education to fund scholarships for academically talented and financially needy students enrolled in an associate, baccalaureate, or graduate level degree program in a STEM discipline. Abstracts for recent awards made through this program indicate that a range of institutions, from research to teaching institutions, received funding through this program.
  - Investigate external sources of funding that might provide direct or indirect funds that can boost the stipends available to graduate students.
  
- Faculty need to receive work load credit for supervision of independent study courses and undergraduate research projects.
  
- Survey the regional employment market and target new areas for growth in the graduate program.

## **VI. Summary of Recommendations**

Although we listed numerous items the faculty could undertake in order to make an already strong program even stronger, we feel that the following recommendations should be given priority:

- (1) Increase the number of faculty in tenure track positions.
- (2) Revise the system so that faculty receive work load credit for supervision of independent study courses and undergraduate research projects.

- (3) Advertise the undergraduate and M.S. programs more broadly and creatively (on and off campus), emphasizing the unique activities and opportunities offered through the programs.
- (4) Increase funding to support the graduate programs, from the administration as well as tapping external funding sources.
- (5) Survey the regional employment market and target new areas for growth in the graduate program.