

**Report of External Reviewer for the Program Review of the Fitchburg  
State University Department of Mathematics**

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## Summary

The Department of Mathematics at Fitchburg State University appears to be a well-functioning university department. Its members and leadership are aware of the importance of ongoing self-analysis, and they work on keeping up with changing issues in curriculum, student needs, and the like. The Department offers a variety of majors and minors, and it teaches many service courses, providing excellent breadth of service to the University. Members of the Department are involved in scholarship, professional development, and University service, all in addition to their substantial teaching loads. The site visit of April 25, 2012 revealed no obvious contradictions with the self-study document of February 25, 2012 (in the sequel, "the Self-Study Report") and no glaring omissions or inconsistencies were observed. The Self-Study Report was candid and well-written and suggests that the department takes its mission and its improvement seriously.

Here is a brief summary of the observations made by this reviewer. More details will be found in following sections.

### 1. Previous Recommendations and the Department's Follow-Up

As a consequence of a 2006 program review, the department had in hand a series of recommendations. Those recommendations have been taken seriously and significant action has been taken on all of them.

In the Self-Study Report, the Department also outlined the "Best Practices" for undergraduate mathematics departments and programs as defined by the Mathematical Association of America, and thorough descriptions of their efforts to follow those guidelines were included. No inconsistencies or major recommendations related to those practices were observed, and the reader is referred to the Self-Study Report for more detail regarding this topic.

### 2. Assessment

The Department is active in assessment and is comfortable with its importance. The Department is pursuing assessment through a variety of avenues. The details of the work are still evolving, of course, and what is being done is very good.

### 3. Staffing

The Department would like to have another tenure-track or full-time position. They recognize that the University administration faces tight constraints on funding for such a change, but it certainly appears that further communication between the Department and the University administration regarding this issue is in order.

### 4. Recommendations

This report will include certain recommendations, to be mentioned below.

## 1. Previous Recommendations and Follow-Up

Recommendation 1 (numbered 2.1 in the Self-Study Report): Establish a chapter of the Pi Mu Epsilon Mathematics Honor Society at Fitchburg State.

The recommendation has been implemented. The chapter was established in 2007 and six to seven new members are being inducted annually.

Recommendation 2 (numbered 2.2 in the Self-Study Report): Establish additional mathematics courses for pre-service majors in early childhood/elementary/middle school, continue collaboration with the Education Department, and encourage faculty to attend PMET Conferences (“Preparing Mathematicians to Educate Teachers”)

The most important parts of the recommendation have been implemented, and done so in exemplary fashion. The Department’s three-course required sequence for all Early Childhood, Elementary, and Special Education majors provides a very strong foundation in mathematics for these students. The required background in mathematics for Early Childhood and Special Education majors should now be better at Fitchburg State than at most comparable institutions. It is worth noting that to receive departmental endorsement to teach middle school mathematics, a student must complete the same mathematics major as those who are headed for secondary education. This requirement is commendable; many middle schools have their mathematics departments staffed by teachers without this depth of background. In addition, the Department has developed a Minor in Mathematics for Early Childhood, Elementary, and Special Education majors, helping to fill a dire need in the K–12 education system. The Department is already working on collecting data to assess the effectiveness of its new programs in this area.

Recommendation 3 (numbered 2.3 in the Self-Study Report): Consider changing the sequencing of the upper level calculus courses to make calculus a smaller fraction of the required major coursework, but keep the labs for Calculus I and II.

The Department has addressed this recommendation in the following manner: software labs were kept in Calculus I and II, and the topics in Calculus III and IV have been arranged so that the courses can be taken in either order, helping individual students with their schedules and helping the Department with enrollment. Topics in calculus classes are also chosen to align with courses in the new Applied Mathematics track so that prerequisite requirements allow for the most possible flexibility.

This report will contain further recommendations below on the subject of the calculus sequence and the sequencing of other courses within the major.

Recommendation 4 (numbered 2.4 in the Self-Study Report): Consider the use of Maple and Geometer’s Sketchpad for appropriate courses.

The first part of this recommendation has been implemented, in very thorough fashion. The Maple package is an integral part of the calculus sequence and can then be used as needed in all upper-level courses. At this time, the Geometer's Sketchpad is not in routine use.

Recommendation 5 (numbered 2.5 in the Self-Study Report): Delete course listings from the catalog for courses not regularly offered.

This recommendation has been implemented.

Recommendation 6 (numbered 2.6 in the Self-Study Report): Develop other upper-level mathematics courses.

This recommendation has been implemented. The new Applied Mathematics concentration has been installed, involving three new courses, including MATH 3500 and MATH 4600 as well as the freshman seminar MATH 1850. In addition, an upper-level graph theory course has been offered, and both Linear Algebra II and Abstract Algebra II have been offered as independent study courses. These steps represent a significant amount of new upper-level curriculum in a short time.

Recommendation 7 (numbered 2.7 in the Self-Study Report): Include Geometry in the mathematics minor for Education students.

This recommendation has been implemented and even more has been done along these lines. The group of three new courses required for all Early Childhood, Elementary, and Special Education majors includes MATH 2000 (Informal Geometry) as one of its courses, and the new Mathematics Minor includes MATH 3000, an upper-level geometry course, among its electives.

Recommendation 8 (numbered 2.8 in the Self-Study Report): Implement the Outcomes Assessment Plan.

This recommendation is being implemented. The process is always ongoing and in a state of change, so it is not possible to say it has been "done". There is serious effort going on within the Department to implement assessment of even proof-writing and proof-reading, among the most important topics within mathematics and almost certainly the most elusive when it comes to measurement. This is impressive work. Moreover, the assessment process and feedback from it is already resulting in faculty members improving the way they present assignments and material. That last observation is one of the key components of successful assessment endeavors. More detail on assessment efforts follows in the next section.

Recommendation 9 (numbered 2.9 in the Self-Study Report): Increase library acquisitions in mathematics-related materials.

While this recommendation is in the process of being addressed – the Library has somewhat better funding than it had had in the past and the Department is making requests – it is more appropriate in this day to modify the recommendation somewhat. It is no longer quite so important, particularly in mathematics, for a university library to have a vast collection of texts on hand. Rather, it is most important that the Library and Department have good lines of communication regarding inter-library loans, access to electronic journals, and access to the burgeoning collection of materials available in various digital formats. The Library has expressed in strong fashion its willingness to help the Department in any way possible and the Department is aware that this support is available.

Recommendation 10 (numbered 2.10 in the Self-Study Report): Increase collaboration with the Director of the Placement Testing Center and Math Center.

This recommendation is being implemented. There has been considerable collaboration between the Department and this Director, including ensuring the availability of review test preparation materials for help with placement tests, arranging for tutoring for students in the mathematics classes required for education majors, and the early stages of work to make more online mathematics remediation and preparation available to students. The Department Chair has met with the Math Center Coordinator at least once a year to discuss Math Center data, and the Chair indicates that meetings are to be scheduled much more frequently. There is also collaboration occurring regarding placement testing to allow qualified students to bypass Precalculus and enroll directly in Calculus I.

This report will contain further recommendations below on the subject of collaboration between the Department and the Director of the Placement Testing Center and Math Center.

## 2. Assessment

The Department is working actively to implement the Outcomes Assessment Plan adopted in Fall 2005. The goals described in this plan are appropriate, and the objectives which lead to those goals are well-conceived. The reader is referred to the Self-Study Report for details of this plan and its implementation. Some particularly noteworthy facts are described here.

1. The Department is constantly reviewing and updating its assessment instruments and data collection. They are not just “going through the motions”; they have made the assessment process part of the way they do business. They note that faculty have already used information from assessment activities to help them clarify objectives for specific assignments.
2. The Department is tackling the toughest questions of assessment within college mathematics. Specifically, they are writing rubrics for assessment of written proofs and of lab/technology work. These are “third rail” topics in assessment; many schools have found it extremely difficult to articulate objectives and measurement for these topics, and very little is in place at some comparable institutions.
3. An exit interview for students is in development. This will be a valuable instrument indeed and such interviews are not commonly in place at comparable institutions.
4. The Department makes a practice of staying in touch with alumni, and alumni surveys have been conducted. Soon, the Department of Education will connect information about the results of certain teacher evaluations to the colleges/universities the teachers attended. The importance of work in the direction of post-graduate assessment data cannot be overstated. In some sense, information about how graduates do in the workplace is the Grail of assessment. Which is more important – data on how students do on assessment instruments completed while they’re in college, or data on how they do after they graduate? Certainly the latter is dramatically more meaningful if we are trying to assess the overall effectiveness of a program. At many colleges and universities, the logistical difficulties of obtaining data in this category has caused faculty and administrators to throw up their hands and give up on trying to get it. The fact that this Department is actively pursuing assessment based on post-graduation information is a feather in their cap.

### 3. Staffing

The Department has expressed its desire to have one or more additional full-time members. Naturally, most departments at most universities would like the same thing, and the extreme challenges of the current era of budget constraints make such a goal difficult. That said, there is room for further discussion of this topic between the Department and the University.

By contract, no more than 15% of college courses can be taught by adjunct faculty members. However, developmental mathematics courses are not considered college courses, essentially all of them are taught by adjuncts, and some other courses are also taught by adjuncts. The result is that the Department feels that dependence on adjuncts is too high. Moreover, there is some disconnect between the Department and the University in their view of other situations. The University indicates that circumstances like sabbaticals and leaves should naturally result in the use of adjunct faculty members to fill gaps rather than the creation of a full-time position, and their view is certainly understandable. At the same time, the Department suggests that things like sabbaticals and leaves are almost always going on, so that circumstances that might be called special are actually routine. Their feeling is that with an additional full-time position, the issues resulting from such circumstances will dissolve.

The point here is that the Department and the University need to communicate closely on this issue. It appears that the two entities may not fully appreciate one another's position or situation, and it may be possible to remedy that disconnect.

When it does come time to hire a tenure-track faculty member, whether to fill a current position that becomes open or as a result of the creation of a new position, the Department and University should consider seeking someone with expertise in mathematics education. A significant amount of the Department's work and courses relate to teacher preparation, and having a new faculty member with specific knowledge in this field will be of great help. Naturally, it is quite difficult to hire from the tiny pool of candidates who have doctorates in mathematics education, and that ideal situation may not be achieved. If not, it may well be possible to hire someone with other experience and background in the field.

## 4. Recommendations

1. The Department should review the calculus sequence in the major and determine whether they think it is feasible to change to a three-course sequence instead of a four-course sequence. (Note that the recommendation does not say that they must change the sequence, merely that they give the question careful consideration and decide if a change is possible given their goals and objectives.)

At many institutions, the required calculus sequence is three semesters of four-credit courses. While most report that it can be a tight squeeze to get all the way to the topics of line and surface integrals by the end of three semesters, many do manage to get it done, and there is then room for another course in the major. At each department's discretion, this may be an elective or a new required course, either way providing an opportunity for more breadth.

How might the condensation be done? All topics in the syllabi are good, and it is unnatural to recommend that topics be deleted; nonetheless, perhaps some can be skimmed or deleted. The Department's commitment to lab time for familiarizing students with the use of mathematical software is commendable and need not be truncated. Indeed, it may facilitate some streamlining of topics; subjects like trigonometric substitutions, partial fractions, direction fields, polar coordinates, conic sections, certain applications, and many others can be covered especially rapidly when a computer algebra system is in use.

2. The Department should review what mathematics courses are taken by each of its majors over a period of time and determine whether it might be appropriate to list more courses as required in the major. (As above, this is not to say that a change must be made, just that the Department should review the potential possibility of delineating it more clearly.)

As it now stands, on paper the major looks like calculus, algebra, and "everything else". If the Department finds that almost all of its majors take certain other courses, or determines that they want all majors to take certain other courses, then they may consider clearly requiring those courses. This topic is linked to course sequencing and enrollments. Some courses often taken by majors are now offered in alternate years. If one or more of those courses were required in the "core" of the major, there is some possibility that such a course could eventually be offered every year and bring more stability to the program.

3. The Department should continue to expand its cooperation with the Placement Testing Center and Math Center.

The more closely these entities can work together, the better. There should be nonstop communication. As the Department communicates its needs and observations, the Center can adapt its



practices. As the Center communicates its data and observations, the Department can adapt its objectives if necessary.

4. The Department and the University should strive to reach common ground on staffing issues and to strengthen the Department in the field of mathematics education.

This recommendation is discussed in a preceding section and the reader is referred there for more detail.

5. The Department should continue its development and implementation of the Outcomes Assessment Plan.

Good work is being done and the Department should continue its work in this direction. There appears to be no reason to doubt that this will occur.