Annual Assessment and Program Review Report

Mathematics Program

September 15, 2009

I. Mission Statement, Student Learning Goals and Student Learning Outcomes

1. Mission Statement

Our mission is to provide a program of study in mathematics and to assist students in their general intellectual, moral, and spiritual growth as Christian thinkers. We want students to:

- acquire mathematical knowledge and analytical ways of thinking,
- develop the ability to communicate mathematical ideas,
- mature as creative mathematicians and problem solvers, and
- ponder the connections between faith and mathematics.

Ultimately, we seek to serve others and glorify Jesus Christ by preparing scientists, teachers, scholars, and other professionals to use their mathematical gifts with competence and charity.

2. Student Learning Outcomes

1. **Core Knowledge.** Demonstrate knowledge of the main concepts, skills, and facts of the discipline.
2. **Communication.** Be able to communicate ideas from the discipline following the standard conventions of writing or speaking in the discipline.

3. **Creativity.** Demonstrate ability to formulate and attack a novel problem.
4. **Christian Connection.** Know how to incorporate their discipline-specific skills and knowledge into their thinking about their vocations as followers of Christ.

These learning outcomes have been in place since September, 2007.

II. Data and Interpretation

1. Assessment of the Learning Outcomes

Core Knowledge

The department administered the ETS's Major Field Test in mathematics (external link) to all graduating seniors. The results for 2009 are as follows:

Student ID	Date Taken	Score	%ile
X	4/27/2009	161	≥ 60
Y	5/6/2009	166	≥ 65
Z	5/7/2009	143	≥ 20

Table 1: ETS Major Field Test in Mathematics results, 2009.

These data are available on the ETS website (password required), along with data from previous years.

The department met on 6/11/2009 to discuss these results. The Educational Testing Service will calculate subscore data for a cohort of size five or greater. However, we have decided to wait until next year to request this data in order to provide a more representative sample. Subscore data will tell us more than raw score data, because it will indicate areas in which students are doing well and areas which need improvement.

In addition to the MFT, some of our students take the CSET exam. The following table shows the mathematics subject scores for the past five years (maximum score = 4).

CSET Subject Scores					
	04–05	05–06	06–07	07–08	08–09
Mathematics	4.0	3.875	4.0	4.0	4.0

Table 2: CSET Subject Scores: Mathematics, 2004–2009.

Communication

Writing samples were collected in MA-108 (Spring 2009), an upper-division writing-intensive course within the major. Two sets of problems—one from early in the semester and one from late in the term—were graded using the department's rubric. The department met together in June 2009 to collectively grade the papers, discuss the rubric, and interpret the results. Results are summarized in Figure 1; data and rubrics are available from the department's program review web page.

	1A	1B	1C	1D	1E	1F	1G	1H	1J	2A	2B	2C	2D	2E	2F	2G	2H	2J
I. Formatting	2	2	2.5	2	1.5	1.5	1.5	3	2.5	2.5	2	3	2	3	2.5	2.5	3	3
II. Variables/Symbols	2.5	3	2.5	2	2	1.5	2	2.5	2.5	3	3	3	2	3	2.5	2.5	3	3
III. Typesetting	2	3	3	1	2	1	2	3	3	3	3	3	3	3	2.5	2.5	2.5	3
IV. Logic	2	1.5	2	2	1.5	1.5	1	3	2	2	1.5	3	2	1.5	2	1	3	3
V. Exposition	2	2.5	3	2	1.5	2	1.5	3	3	2	1.5	3	2	2.5	2	1.5	3	3
totals	10.5	12	13	9	8.5	7.5	8	14.5	13	12.5	11	15	11	13	11.5	10	14.5	15
total change (+/-)										2	-1	2	2	4.5	4	2	0	2

Figure 1: Tabulation of writing sample assessment data, 6/11/2009.

Creativity

In Fall 2008, 1 student was enrolled in MA-180, and this student submitted two solutions to Horizons and was recognized for both submissions. In one case, the published submission was essentially his.

In Spring 2009, 5 students were enrolled in MA-180. It is too early to have results about published/recognized solutions from the spring. Here is an informal assessment.

- Student A produced and submitted a solution to another problem, but the solution did not tie down all the details.
- Student B produced and submitted a solution but it could have used some additional editing.
- Student C produced a solid solution to a problem, but it was too late for official submission. The write up was OK but not particularly clean.

- Student D produced a well-written solution to a simple (Horizons) problem.
- Students C and D wrote up a joint solution to another straight-forward Horizons problem.
- Student E did not produce a solution.

The department met in June 2009 to discuss the performance of students in MA-180.

Christian Connection

Papers reflecting on the connections between faith and mathematics were collected in MA-155 (Fall 2008), an upper-division capstone course within the major. These papers were graded using the department's rubric. The department met together in June 2009 to collectively grade the papers, discuss the rubric, and interpret the results.

Each faculty member graded each paper, assigning scores of 1 (lacking), 2 (adequate), or 3 (superior), and the five scores for each category (connections and perspective) were averaged. Results are summarized in Figure 2; data and rubrics are available from the department's program review web page.

	1A	1B	1C	1D	1E
Substantive Connections	2.1	2.1	2.0	2.4	2.3
Mature Perspective	1.8	1.9	1.7	1.7	1.8

Figure 2: Tabulation of reflective paper assessment data, 6/11/2009.

2. Interpretation of the Results

Core Knowledge

This year's results were somewhat puzzling, as the student whom we all considered the strongest by far (Student X) did not score higher than her cohorts. While we were slightly disappointed by X's performance, her score was still entirely respectable. Perhaps we were more surprised by the score of student Y, whom performed consistently worse than X is coursework. These results led us to wonder about the reliability of the MFT: Does it measure native ability over against academic achievement? Does

it measure mastery of basic concepts, missing the advanced abilities that we aim to teach in our classes?

Despite these concerns, we decided to continue using the MFT, hoping that a larger sample (along with subscores) will prove the test's value.

The CSET scores continue to be high. This is strong evidence that MA-160/165 are serving students well. Hopefully enrollment in this sequence will increase, given that MA-5 no longer satisfies the Reasoning Abstractly component of Westmont's General Education.

Communication

The data on mathematical writing is encouraging: students tend to show progress in writing skills throughout the course of the semester.

As a result of another round of collective paper scoring, we made some slight modifications to the rubric . In addition to making the scoring more consistent, we have found that the rubric helps us communicate our expectations more clearly to students.

We discussed some potential problems with our approach. Sometimes well-formatted papers can make it easier to spot subtle errors in reasoning, while bad formatting can sometimes distract the grader from other issues. Furthermore, we were working from papers that had already been marked by the professor of the course, so those comments could potentially sway our scores. With electronic submissions, it is possible to avoid this source of bias.

We noted that the style of mathematical writing can vary from subdiscipline to subdiscipline. In our two writing-intensive courses (Modern Algebra and Real Analysis), students must learn the conventions of the subdiscipline in order to be competent writers. We therefore affirm the value of our practice of comparing work from early in the semester with later work.

Creativity

We continue to be satisfied with the results of work in MA-180. Students from many levels of ability and preparation take this course, and generally all do well. We believe that these results indicate that students are being taught the skills and concepts necessary for them to attack and solve novel problems in mathematics.

Christian Connection

This learning standard continues to be the most difficult to assess, though it probably corresponds to the loftiest goal we have for our students.

As a result of our collective grading and discussion, we made some minor changes to the rubric for the reflective paper. We also noted that a more detailed prompt would be likely to encourage better results. We decided that future reflective paper assignments would include a copy of the rubric; we hope this will help students write better papers.

3. Learning Outcome Matrix

Table 3 gives a brief overview of our learning outcomes, our assessment strategies, and the relationship to the college-wide outcomes and the departmental curriculum.

Learning Outcome Matrix: Major in Mathematics				
Student Learning Outcomes	Core Knowledge	Communication	Creativity	Christian Connection
Meaning	Demonstrate knowledge of the main concepts, skills, and facts of the discipline.	Be able to communicate ideas from the discipline following the standard conventions of writing or speaking in the discipline.	Demonstrate ability to formulate and attack a novel problem.	Know how to incorporate their discipline-specific skills and knowledge into their thinking about their vocations as followers of Christ.
Introduced	MA 4, 5, 9*, 10*	MA 4, 5, 9*, 10*	MA 4, 5, 9*, 10*, 15, 19, 20*, 160, 165	MA 4, 5, 9*, 10*, 15, 19, 20*, 160, 165
Developed	MA 15, 19, 20, 121, 160, 165	MA 15, 19, 20*, 160, 165, 123, 130, 135, 136, 140, 155	MA 108*, 109, 110*, 111, 123, 130, 135, 136, 140, 155	MA 108*, 109, 110*, 111, 121, 123, 130, 135, 136, 140, 155
Mastered	MA 108*, 109, 110*, 111, 123, 130, 135, 136, 140, 155	MA 108*, 109, 110*, 111	MA 180*	MA 136, 140, 155, 190SS, 191SS
Assessment strategy	Major Field Test in Mathematics	Writing samples scored with rubric	Externally reviewed journal problems	Reflective paper scored with rubric
Benchmark	50% above 75th percentile	75% show improvement during term	50% get correct solutions according to journal	50% Superior
Links to learning standards	Critical-Interdisciplinary Thinking, Active Societal and Intellectual Engagement (Effective Participants)	Written and Oral Communication, Research and Technology	Critical-Interdisciplinary Thinking, Active Societal and Intellectual Engagement (Lifelong Learning, Responsibility)	Christian Orientation, Diversity, Active Societal and Intellectual Engagement (Christian Vocation)

Notes: $*$ = required for major. At least one of 15 and 19 are required for the major, and at least one of 136, 140, and 155 is required.

Table 3: Learning outcome matrix.

III. Using the Results and Next Steps

As a result of many fruitful conversations concerning the assessment of Reasoning Abstractly (RA) courses, we continue to make curricular changes. Last year we decided that MA-005 (Introductory Statistics) should not satisfy the RA requirement, and this year the General Education committee approved its removal from this component of the GE.

We have also decided that the current textbook for Calculus (Ostebee and Zorn) lacks sufficient emphasis on abstract reasoning concepts. We are pilot testing a new text this year in some sections of Calculus, and we will further investigate options in Spring 2010.

The department has revised the major requirements to include MA-015 (Discrete Mathematics) as a required course for the major. We feel this course will help mathematics students learn to write proofs (Learning Outcome #2).

Program review data from the six-year report was helpful in understanding the achievement of first-year students in MA-009 (Calculus I). The data revealed an alarmingly high failure/drop rate. As a result, this year we implemented a new course, MA-008 (Functions and Models) to help prepare students for MA-009.

Table 4 gives a plan for assessment and program review over the next six years.

Year	**Program review overall**	**Details for assessment work**
2009–10	Discuss vision for future department staffing. Discuss alumni survey.	Ongoing annual tasks. Review Core Knowledge learning standard (#1).
2010–11	Review library holdings, check against MAA list.	Ongoing annual tasks. Review Christian Connection learning standard (#4).
2011–12	Review contributions to GE.	Ongoing annual tasks. Review Communication learning standard (#2).
2012–13	Discuss vision for undergraduate research. Discuss quality of preparation for graduate school.	Ongoing annual tasks. Discuss/Revise learning standards.
2013–14	Prepare for six-year program review report, due 9/15/2014.	Ongoing annual tasks. Summarize assessment work from past six years.
2014–15	Submit six-year program review report, 9/15/2014.	Ongoing annual tasks. Review Creativity learning standard (#3).

Table 4: Six-year plan for assessment and program review.

IV. Data for Program Review

The department has four full-time faculty positions in mathematics, but one of these is a shared/split position occupied by Patti Hunter and David Hunter. In the following table, the Hunters are listed separately. Ray Rosentrater held a half-time administrative position in 2008–2009.

(n/a = data not available)

Profile of Full-time Faculty (2008–2009)						
Faculty Member	Date Hired	Sex	Ethnicity	Rank	Tenure Status	Departmental Responsibilities
Howell	1978	M	Caucasian	Full	Ten.	Contest
Hunter, D.	2000	M	Caucasian	Full	Ten.	Chair
Hunter, P.	2000	F	Caucasian	Assoc.	Ten.	DDRS
Leech	1985	M	Caucasian	Full	Ten.	
Rosentrater	1980	M	Caucasian	Full	Ten.	

Table 5: Profile of Full-time Faculty (2008–2009)

Teaching Load: Russ Howell (2008–2009)				
	Classes	# students	# advisees	New preps
Fall	MA-005 MA-005 MA-019	26 26 10	5	
Spring	MA-004 MA-010 MA-108	4 27 9	5	
Average Load	3	17	5	
Mayterm				
Ind. Stud./Intern.				

Table 6: Teaching Load: Russ Howell (2008–2009)

Research Update (Howell):
Publications:

1. Lewis' Miracles and Mathematical Elegance (Chapter in C.S. Lewis as Philosopher, published by IVP)
2. Review of Negative Math: How Mathematical Rules can be Positively Bent (Books and Culture)

In-Progress: Mathematics in Context (to be published with Jones and Bartlett)

Teaching Load: David Hunter (2008–2009)				
	Classes	# students	# advisees	New preps
Fall	MA-010 MA-015 Chair (2 units)	18 15	4	
Spring	MA-130 IS-192 (2 units) Chair (2 units)	9 13	4	2
Average Load	2.25	13.86	4	
Mayterm				
Ind. Stud./Intern.				

Table 7: Teaching Load: David Hunter (2008–2009)

Research Update (D. Hunter):

Book published in November, *Essentials of Discrete Mathematics*, Jones & Bartlett (2008).

Talk at national mathematics meetings (January 2009): "Major League Baseball meets Facebook: Analyzing trades using social network theory."

Teaching Load: Patti Hunter (2008–2009)				
	Classes	# students	# advisees	New preps
Fall	MA-155	5	4	
Spring	MA-005 MA-005 IS-192 (2 units)	30 30 13	4	1
Average Load	1.75	20.43	4	
Mayterm				
Ind. Stud./Intern.				

Table 8: Teaching Load: Patti Hunter (2008–2009)

Research Update (P. Hunter):
Recent publication: Patti W. Hunter, "Gertrude Cox in Egypt: A Case Study in Science Patronage and International Statistics Education during the Cold War," Science in Context 22(1) (2009): 47-83.

Co-Chaired special session on History of Mathematics at 2009 national mathematics meetings.

Contributor to abstracts section of *Historia Mathematica*.

Teaching Load: Ray Rosentrater (2008–2009)				
	Classes	# students	# advisees	New preps
Fall	MA-160 MA-180 (1 unit) Admin (6 units)	20 1		
Spring	MA-020 MA-165 (2 units) MA-180 (1 unit) Admin (6 units)	13 17 5		
Average Load	3	14.33		
Mayterm				
Ind. Stud./Intern.				

Table 9: Teaching Load: Ray Rosentrater (2008–2009)

Research Update (Rosentrater):
Accepted in Math Mag: Representational Efficiency

Completed term as President of ACMS

Participated in Mathematics Through the Eyes of Faith workshop (will be writing one of the chapters)

Teaching Load: Jonathan Leech (2008–2009)				
	Classes	# students	# advisees	New preps
Fall				
Spring				
Average Load				
Mayterm				
Ind. Stud./Intern.				

Table 10: Teaching Load: Jonathan Leech (2008–2009)

Jonathan Leech did not provide information on load or research.

The first sections of MA-190/191SS will be convened in academic year 2009-2010. Planning these courses will involve working with the internship office.

V. Time-Line for Completion of the Six-Year Report

Our next six-year report is due in the fall of 2014. We will continue to collect assessment data each year via the following annual tasks. The department chair has the responsibility of making sure these tasks are accomplished.

1. Administer the Major Field Test to every graduating senior in the spring. Meet to interpret results.
2. Collect mathematical writing samples from MA 108 (Spring, Odd years) or MA 110 (Spring, even years). Apply writing rubric to these samples. Interpret results.
3. Collect data each semester of the number of solutions submitted and published by students in MA 180. Meet to interpret results.
4. Collect a reflective paper or writing sample in MA 136 (Fall, odd years), MA 140 (Spring, even years), and MA 155 (Fall, even years). Apply reflective writing rubric to these samples. Interpret results.
5. Devote two meetings to informal discussions of the Communication and Creativity learning standards in the context of introductory and developmental courses.
6. Monitor course evaluations in introductory and developmental courses for evidence that the Christian Connection learning standard is being addressed.

In addition to these annual tasks, the department plans to address several additional topics over the next six years. A plan for these discussions is given Table 4.