

Mathematics Program 2011 Annual Assessment Update

I. Mission Statement, Program Goals, Student Learning Outcomes, Curriculum Map, AND Multi-Year Assessment Plan

The documents can be found at:

<http://www.westmont.edu/academics/departments/mathematics/LearningStandards.html>

Note that the wording of the Creativity Student Learning Outcome has been modified for the sake of clarity.

II. Follow up on Action Items

As indicated in parentheses after the identification of the action item, some action items come from the program's 2010 annual report and some were specified by the Program Review Committee.

(1) Capstone Course (2010 annual report)

- A. Explore the possibility of a senior capstone course. Department chair charged with overseeing this item.
- B. At a department meeting on 3/1/11, we reviewed our current capstone course offerings with the following observations:

Currently both the BA and the BS require a student to choose one of three capstone courses (Geometry, History, Complex Analysis). Frequently, students take this course as juniors, sometimes as sophomores. In theory, a freshman could take it. That enrollment flexibility works against using the course to tie together and integrate the mathematics courses from the rest of the major.

We would like a Senior Capstone course with the following characteristics:

- Taken by every senior in the major;
- Provides review for the Major Field Test or the Math GRE;
- Connects what the mathematics students have learned with the broader context of philosophy, history, and/or science, the Christian faith;

Such a course would provide a more natural place to assess our student learning outcomes of "core knowledge" and "Christian connection." To assess core knowledge, we currently require seniors to take the Major Field Test (MFT) in mathematics, but they have no extrinsic motivation to do their best on the test. We could use students' scores on the MFT as part of the grade in the Senior Capstone, giving them more incentive to do their best work.

Currently, students write a reflective paper in the capstone course that is used to assess the Christian Connection SLO. Since students do not always take this course as seniors, we are not able to assess every graduate at the end of their program. Incorporating the reflective paper in a Senior Capstone course would solve this problem.

Moreover, for each of those SLOs, the Senior Capstone would provide a natural place for students to reflect on their knowledge and skills in those areas.

The Senior Capstone would also provide a natural place to assess oral communication, an SLO we have stated, but so far not assessed.

In order to close the loop on this assessment, we will offer a version of MA-150 (Topics) in Spring 2012 as a pilot of a Senior Capstone. Russ Howell will teach the course.

Mathematics faculty met for five days in June 2011 to draft the curriculum for the course.

Notes from these meetings and the meeting on 3/1/11 are archived at
myfiles\program_review\mathematics\Records\minutes

At the conclusion of the 2011/12 academic year, mathematics faculty, led by Russ Howell, will evaluate the course and determine whether to make the Senior Capstone Course a permanent part of the major curriculum.

(2)Continued use of MFT. (2010 annual report, PRC)

- A. Decide whether to continue giving the MFT. Request the subscore data after the 2011 graduates complete the test. The department chair was charged with overseeing this action item.
- B. We reviewed the subscore data at our program review meetings in June 2011. We observed that we did not meet our goal that 50% of our students would score at the 75th percentile or higher. However, more than 50% scored above the 70th percentile. Given the scores of some of our better (though not best) students, it seems that motivation is a problem.

In light of our plans to offer a senior capstone course in Spring 2012, **we decided to administer the MFT to the graduates of 2012 as a required, graded component of the course in order to see if the capstone course had an impact on scores.**

(3)Review curricular changes. (2010 annual report, PRC)

- A. Follow up on recent curricular changes: new calculus text, inclusion of MA-015 in the major, reinstatement of MA-008. The department chair was charged with overseeing this action item.
- B. At a department meeting on 2/4/11, we discussed the new calculus text (Rowgawski, *Single Variable Calculus, Early Transcendentals*, 2008) and the reinstatement of MA-008. We reviewed enrollment in MA-008, -009, and -010.

We determined that we should continue using Rowgawski for another year in order to allow students continuing from MA-009 into MA-010 in Fall 2011 to keep their books, and so that more faculty could use it (P. Hunter did not teach calculus in 2011-12 and will teach MA-009 in Fall 2011).

Our review of enrollments in the pre-calculus and calculus sequence suggested that we do not have good answers to the following questions:

Are the right people taking MA-008? How do we move people out of MA-009 into MA-008 if they need better preparation? Why don't more people taking MA-008 go on to MA-009? How many of the people dropping MA-009 in the first week moved into another section that semester? Is the calculus sequence serving the needs of other departments and affecting enrollment in the math major?

During Fall 2011, we will discuss these questions about enrollment in the MA 008 and MA 009 courses as a department and formulate plans for finding answers.

During the 2011-12 year, we will meet with client departments to determine how well calculus is serving their needs.

Early during Spring 2012, we will determine whether Rowgawski is serving the students' needs or whether we need to try a new textbook for 2012/13.

(4)Description of Data in 2011 annual report. (PRC)

- A. Describe data in 2011 annual report in adequate detail for the non-mathematical reader.
- B. The department reviewed the tables in this report during summer 2011 and concluded that it seems adequate. Nothing remains to be done on this action item.

(5)Review library holdings. (PRC)

- A. Review library holdings. The department chair was charged with overseeing this action item.
- B. Beginning in 12/2010, faculty worked with our library liason, Claudia Scott, to add new books to the collection. Claudia provided a list of which books recommended for undergraduate libraries by the Mathematical Association (MAA) are currently in the collection. Mathematics faculty reviewed that list at a meeting on 6/9/11 and began compiling a list of books recommended by the MAA that we would like the library to purchase.

During Fall 2011, we will finalize and prioritize the list of MAA-recommended books that we would like the library to acquire. We will then submit the list to the library acquisition staff.

(6)Review communication SLO. (2010 annual report, PRC)

See section III.

(7)Alumni survey. (PRC)

- A. Use of alumni survey. The department chair was charged with overseeing this action item.
- B. In February 2011, the department chair began to establish contact with alumni of the last 10 years and requested contact information from the Alumni office in preparation for a formal alumni survey.

During the 2011/12 academic year, the department will discuss the possibility of implementing an alumni survey in a future year. The department chair will be responsible for scheduling this discussion.

III. 2010/11 Focus Communication Student Learning Outcome

A. Summary

1. In order to assess the writing component of the Communication Student Learning Outcome, we evaluated student writing samples from MA-108 (Mathematical Analysis), Spring 2011. The data set consisted of
Two samples from each of four seniors in the course, one from February 2011 and one from April 2011.

2. The departmental benchmark is that 75% of students would show improvement from the first sample to the second sample.
3. The prompts and rubric are included in appendix B.
4. The writing samples and summary of evaluations are stored on the archive at Assessment Data\2010_11\writing samples.

B. Interpretation

1. The mathematics faculty discussed the Communication SLO and methods of assessment at meetings on 10/8/2010, 12/3/2010, 2/4/2011, 2/15/2011, 3/22/2011. We assessed the writing samples on 6/7/2011. Minutes of these meetings are stored on the archive at Records\minutes.
2. No external voices have been involved in analyzing the data.
3. In scoring and discussing the writing samples, we found that students in their last semester of the program are writing at or above an acceptable level for the type of writing elicited by the prompts, according to the standards in the discipline of mathematics. They make appropriate choices in the layout, alignment, and formatting of their text. They choose appropriate variable names and make appropriate use of symbols. They generally apply definitions correctly, making only occasional logical errors. Their exposition is generally complete and economical and they make proper use of prose.

In scoring and discussing the writing samples, we determined that our assessment methods are not giving us all the information we need about student learning and the effectiveness of our curriculum and teaching. In particular, we determined that our benchmark is more appropriate for an individual course than for the program as a whole. Moreover, the prompts, which consist of individual problems, do not give students sufficient opportunity to display the full range of their knowledge and skills in the area of written communication. We also found that some categories on the rubric need changing. This assessment work also resulted in the continuation of the departmental discussion about the most appropriate software for students to use in producing their written work. In particular, our assessment of student work has confirmed the value of software that allows students to typeset mathematics. We continue to discuss the relative merits of various software packages in light of their ease of use and their cost.

C. Closing the Loop

In response to what we have learned from assessing this data, our department has decided to do the following:

1. Modify the rubric so that the categories conform more to the outcomes we desire.
2. Make a change to the co-requisite for MA 180. Discrete Mathematics (MA-015) or Linear Algebra (MA-020) will be a co-requisite for students taking the course for the first time. Students will be strongly encouraged in academic advising to take their first writing intensive course in the major (either MA 108 or MA 110) before taking MA 180 for the second time.
3. Collect samples of writing from MA 180 from students taking the course for the second time. These samples will be in response to a prompt that is already being used

- in the course. MA 180 writing is in response to challenge problems published in mathematics journals. Consequently the writing is more sustained and creative.
4. Assess the communication SLO using these samples by collectively using the modified rubric.
 5. Make use of the rubric in writing instruction in lower division courses, specifically MA 019, MA 015, and MA 020.
 6. Upgrade our license for Scientific Workplace (typesetting software we have been using for student writing). The upgrade will allow more students to use the software simultaneously than the previous license. It will also give them access to the complete set of typesetting tools rather than the limited access provided by our previous license.
 7. Continue the discussion in the 2011/12 academic year about how to best use the typesetting software to promote student learning in the area of written communication.

IV. Next Steps

A. **Action Items** The following is a collection of all the Action Items given above.

At the conclusion of the 2011/12 academic year, mathematics faculty, led by Russ Howell, will evaluate MA-150 and determine whether to make the Senior Capstone Course a permanent part of the major curriculum.

We will administer the MFT to the graduates of 2012 as a required, graded component of the capstone course in order to see if the capstone course had an impact on scores. The department chair and the department administrative assistant will oversee this task in cooperation with Russ Howell who is teaching the pilot version of the Senior Capstone course.

During Fall 2011, we will discuss the enrollment issues in the MA 008, 009, and 010 courses as a department and formulate plans for finding answers to our questions (see II.(3)B.). The department chair will oversee this discussion among all the mathematics faculty.

During the 2011-12 year, we will meet with client departments to determine how well calculus is serving their needs.

Early during Spring 2012, we will determine whether the calculus textbook by Rowgawski is serving the students' needs or whether we need to try a new textbook for 2012/13. The department chair will oversee this discussion among all the mathematics faculty.

During Fall 2011, we will finalize and prioritize the list of MAA-recommended books that we would like the library to acquire. We will then submit the list to the library acquisition staff. The department chair will oversee this task among all the mathematics faculty.

During the 2011/12 academic year, the department will discuss the possibility of implementing an alumni survey in a future year. The department chair will oversee this discussion among all the mathematics faculty.

Modify the rubric for assessing writing samples during summer and fall of 2011. The department chair will oversee this discussion among all the mathematics faculty

Make a change to the co-requisite for MA 180. Discrete Mathematics (MA-015) or Linear Algebra (MA-020) will be a co-requisite for students taking the course for the first time. Department chair will submit the necessary paperwork to the records office during fall 2011.

Students will be strongly encouraged in academic advising to take their first writing intensive course in the major (either MA 108 or MA 110) before taking MA 180 for the second time. Department chair will remind mathematics faculty of this policy at the start of the advising period in fall 2011 and spring 2012.

Beginning in the fall of 2011, the instructor of MA 180 will collect samples of student writing from all students taking the course for the second time. Collection will continue each semester until the department revisits the communication SLO in 2014-15.

Make use of the rubric in writing instruction in lower division courses, specifically MA 019, MA 015, and MA 020. Department chair will remind mathematics faculty of this policy at the start of each semester.

By Fall 2011, upgrade our license for Scientific Workplace (typesetting software we have been using for student writing). The upgrade will allow more students to use the software simultaneously than the previous license. It will also give them access to the complete set of typesetting tools rather than the limited access provided by our previous license. Russ Howell will oversee this acquisition.

Continue the discussion in the 2011/12 academic year about how to best use the typesetting software to promote student learning in the area of written communication. The department chair will facilitate this discussion.

B. The updated Multi-Year Assessment Plan is included in Appendix D.

V. Appendices

- A. 2010 response from PRC**
- B. Prompts use to collect writing samples**
- C. Rubric used to assess writing samples**
- D. Multi-year assessment plan**

Appendix A

MEMORANDUM

Date: February 21, 2011
To: Dr. Patti Hunter, Chair
From: Bill Wright for the PRC
Re: 2009-10 Mathematics annual report

On behalf of the PRC, thank you for submitting 2010 annual assessment update for the Mathematics Department dated October 13, 2010. The PRC appreciates the department's work in supporting the College's effort in program review and assessment. Your report is a valuable contribution to the College. I trust department faculty also find this work meaningful.

Summary:

The Mathematics Department has in place all of the essential elements for effective program review – mission statement, program learning outcomes, student learning outcomes, rubrics, curriculum alignment chart, a multi-year plan and a habit of collecting and discussing data. You are to be commended for getting this program in place.

Throughout the report is demonstrated a commitment to working on real, practical issues which if addressed effectively, will contribute to improving instruction for your students. The evidence that department faculty are discussing issues and working together to find a common understanding and solutions is one of the strengths of your work.

Several of the PRC suggestions made regarding the 2009 report were incorporated into the 2010 document, making it easier to understand.

The department has established a good pattern of work. Following the multi-year plan should place the department in a good position to successfully complete a comprehensive 6-year report due in 2014.

Mission Statement / Program Learning Goals / Student Learning Outcomes:

The mission statement has served the department for several years. It functions well standing between broad institutional learning goals and specific department objectives. Although they are not labeled as such in the 2010 report, I am considering the four bullet points found in the mission statement to be the department's program learning goals. The four student learning outcomes follow naturally from the mission statement and program goals and the alignment chart (Appendix A) demonstrates where these are introduced, developed and evaluated within the curriculum.

Appropriately so, SLO assessment data is limited in this report to a few courses and instruments near the completion of the major. If you have not already done so, faculty should be encouraged to have in all the course syllabi where program goals are introduced and developed SLOs stated in terms appropriate to the level of the course.

All of us at Westmont have progressed in our knowledge and understanding for how best to express SLOs. I am not suggesting that you considering rewriting all of your SLOs but you might find it helpful to review some of the useful educational effectiveness resource documents found on the Program Review web page. I think you might want to consider modifying the creativity SLO. Upon further reflection it is not clear to this reader what is meant by “attack” in this statement. You might find some ideas for change that would bring greater clarity to the creativity SLO in the “Relevant Verbs for Developing SLOs” document.

Follow up to 2009:

The department demonstrated evidence of responding to suggestions made by the PRC last year. As a result, it was considerably easier to read the report. Improvements included rubrics in the Appendix and providing additional information explaining the content of Tables. Regarding Tables, good progress has been made but this is an area where additional improvement is warranted. For instance:

Table 2 - Are these means or scores for individual students (one a year)? If these are means, sample size for each year should be included.

Figure 1 and Writing rubric - Take "formatting" - there are two formatting items, each scored 1 to 3. Is the score recorded in Figure 1 the sum of these items (and thus for formatting, a score could range from 2 to 6) or is it the mean of the item scores (thus a 3 indicates the student received a 3 on each individual item)?

Figure 2 - What does the "acknowledge" column indicate?

Figure 3 - What are A, B...? Does each letter identify one student?

It is noted the department committed to continued study and dialogue regarding whether changing the MA 9 textbook and curriculum changes involving MA 8 and MA 15 prove effective in meeting department goals. We will look for further analysis in a future year.

Current Year

Many departments have been encouraged to focus on only one SLO each year. Given the size of many of your upper division classes, you have been wise to collect data for SLOs annually. This will allow you to pool data across several years for each SLO and get a more accurate picture of student learning than if you relied on data from a single year.

As previously mentioned, the evidence of faculty dialogue and collaboration is noteworthy. It is good to see everyone involved. It is also a positive sign that the department is choosing issues to study that are relevant to the program. There is evidence that assessment data is being used to alter major requirements, prerequisites and text book selection. We sometimes hear the cynical question asked around campus if there is value in all this assessment work. The work being performed by Mathematics answers this question in the affirmative. What you are learning about student learning will results in a program that prepares stronger majors.

You continue to modify and revise the assessment instrument for the Christian Connection SLO. First, you are to be commended for desiring to relate your major program to Westmont's Christian orientation program goal. This is not an easy program goal for any department to translate into an SLO and assess. Don't get discouraged and please keep trying. Certainly one legitimate outcome of assessment work is the discovery that the assessment instrument being used is not particularly robust. Please continue to feel free to play with the method of assessment. Your diligence here may reap significant dividends in a couple of years.

The conciseness and brevity of the report is often its strength. You get to the point and move on. The 2010 report left fewer questions in the readers mind than the 2009 report. However, there are still a couple of examples that demonstrate there may be value in having a non-mathematician read your report before submitting. The reader may help you to see areas where the meaning of what is stated is clear to a mathematician but not to the general reader. For instance, on page 5 it states, "In Fall 2009, four students had nonzero scores on the Putnam exam." No explanation is provided as to what significance should be drawn from this result.

The use of rubrics, multiple readers, comparing and resolving inter-rater scoring differences as described should contribute to the collection of reliable data.

Since oral communication is a part of the communication SLO, the passing statement on page 7 that students' oral presentations were "spotty" suggests more work is needed here. You have a writing rubric. Is there a speaking rubric also? If not, there ought to be. Since written and oral communication represent different skills, the department should consider how these two styles of communication will be assessed and documented.

Next Steps

The department has an established multi-year time line that appears realistic and should lead to a successful outcome. However, I do have one question about this plan. The time-line submitted last year indicated that an alumni survey would be discussed during 2009-10. The 2010 report includes no reference to an alumni survey. Realizing time-lines plans can change, I looked for the alumni survey to appear at a later date but there is no reference to an alumni survey in the multi-year plan submitted in 2010. Since alumni surveys can be an important component of a program review, the omission of the alumni survey from the multi-year plan should be addressed.

Appendices

All required elements included.

Program Review Archive

An inspection of the Mathematics folder on the Program Review Archive drive indicates the department is using this site to store important documents and data.

Finally

I hope you have concluded from this memo my belief the Mathematics Department has been doing good and meaningful work and that you are on a trajectory for more of the same. Please

take my comments as suggestions for how future reports may be even better; not that the 2010 report had serious flaws.

Based upon your time-line and my comments, the PRC will be looking for the following from you in 2011:

- An annual report that describes data in adequate detail for the non-mathematic reader.
- As stated in the time-line for 2010-11: review of library holdings; review of communication learning standard
- Administration of the ETS major field exam to seniors
- Addressing follow-up items: Ma 9 textbook; Ma 8 & Ma 15 curriculum changes
- Use of alumni survey in program review plan

(End of Appendix A)

Appendix B

Prompts for gathering writing samples from MA 108, Spring 2011

2/25/11

Let $f : D \rightarrow \mathbf{R}$ be continuous at $c \in D$ and suppose that $f(c) > 0$. Prove that there exists an $\alpha > 0$ and a neighborhood U of c such that $f(x) > \alpha$ for all $x \in U \cap D$.

4/8/11

Prove the following "change of variable" theorem: Let g be differentiable on $[c, d]$ and g' be integrable on $[c, d]$. Suppose the f is continuous on the range of g . If $g(c) = a$ and $g(d) = b$, then

$$\int_c^d (f \circ g)(x)g'(x)dx = \int_a^b f(x)dx.$$

(Hint: Define $F(x) = \int_a^x f(t)dt$ for $x \in \text{range } g$ and $h(x) = (F \circ g)(x)$ for $x \in [c, d]$. Then look at $\int_c^d h'(x)dx$.)

4/20/11

Let $f_n(x) = \frac{x^n}{1+x}$ for $x \in [0, 2]$.

- Find the set S for which $f(x) = \lim f_n(x)$ is defined as a real-valued function.
- Show that if $0 < t < 1$, the convergence is uniform on $[0, t]$.
- Show that the convergence is not uniform on $[0, 1]$.

Appendix C

Rubric for scoring mathematical writing (revised 6/4/2008)

I. Formatting	<i>Weak (1)</i>	<i>Acceptable (2)</i>	<i>Outstanding (3)</i>	<i>Score</i>
General layout.	Poor or inconsistent choices.	Generally appropriate choices.	Consistently good choices.	
Proper alignment in displayed sequences of equations	No discernible alignment protocol	Occasionally inconsistent or non-standard alignment.	Standard alignment used throughout.	
<i>Enter 1, 2, or 3:</i>				
II. Variables/Symbols	<i>Weak (1)</i>	<i>Acceptable (2)</i>	<i>Outstanding (3)</i>	<i>Score</i>
Appropriate variable names.	Poor or inconsistent choices.	Notation sometimes ambiguous or misleading.	Consistently good choices.	
Appropriate use of symbols.	Excessive misuse of symbols.	Occasional misuse of symbols.	Consistently correct use of symbols.	
<i>Enter 1, 2, or 3:</i>				
III. Typesetting (if applicable)	<i>Weak (1)</i>	<i>Acceptable (2)</i>	<i>Outstanding (3)</i>	<i>Score</i>
Use of proper font.	Poor or inconsistent choices.	Generally appropriate choices.	Consistently good choices.	
Use of sub/superscript.	Poor or inconsistent choices.	Generally appropriate choices.	Consistently good choices.	
Formatting as mathematics.	No special formatting.	Generally appropriate formatting.	Consistently good formatting.	
<i>Enter 1, 2, or 3:</i>				
IV. Logic	<i>Weak (1)</i>	<i>Acceptable (2)</i>	<i>Outstanding (3)</i>	<i>Score</i>
Deductions are sound.	Many logical errors.	Only occasional logical errors.	Free of logical errors.	
Appropriate use of definitions.	Seldom applies definitions correctly.	Generally applies definitions correctly.	Consistently applies definitions correctly.	
Deductive steps are justified.	Many steps not justified correctly.	Some nontrivial steps not justified correctly.	All nontrivial steps are justified correctly.	
<i>Enter 1, 2, or 3:</i>				
V. Exposition	<i>Weak (1)</i>	<i>Acceptable (2)</i>	<i>Outstanding (3)</i>	<i>Score</i>
Writing is complete and economical.	Incomplete thoughts or excessive wordiness.	Generally complete and concise.	Always complete and concise.	
Appropriate variation in sentence structure.	Repetitious and rote sentence structure.	Only occasional repetition of sentence structure.	Good variety of sentence structure.	
All variables introduced/defined.	Many omissions.	Only occasional omissions.	Consistent introduction of all variables.	
All assumptions clearly identified.	Many omissions.	Only occasional omissions.	Consistent identification of all assumptions.	
Proper use of prose.	Poor word choice.	Generally adequate word choice.	Consistently good word choice.	
Spelling and grammar.	Many grammatical errors.	Some grammatical errors.	No grammatical errors.	
<i>Enter 1, 2, or 3:</i>				

Appendix D Mathematics Program MULTI-YEAR PLAN 2011

Outcomes	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	Means of Assessment, Benchmark	Who is in charge?	How the loop will be closed /has been closed?
1. Core Knowledge	X				X		Major Field Test in Mathematics, 50% above the 75 th percentile	Department chair coordinates discussion and work among all mathematics faculty	New senior capstone course is being developed in 2011-12 to provide more effective way of insuring students have mastered the material and of assessing the SLO.
2. Communication				X			Writing samples scored with rubric, 75% show improvement during term (will be changed in light of 2010/11 assessment)	Department chair coordinates discussion and work among all mathematics faculty	Corequisite to MA 180 has been changed for 2011-12 to insure that students are able to develop their skills more fully before having them assessed. Course in which SLO will be assessed beginning in 2011-12 has been changed to provide more informative student work. Software license will be upgraded to facilitate student learning and our assessment of their learning.
3. Creativity			X				Externally reviewed journal problems, 50% get correct solutions according to the journal	Instructor of MA 180.	If benchmark is not met, mathematics faculty will review the curriculum.
4. Christian Connection		X				X	Reflective paper scored with rubric, 50% score superior	Department chair coordinates discussion and work among all mathematics faculty	New senior capstone course is being developed in 2011-12 to provide more effective way of insuring students have mastered the material and of assessing the SLO.
GE Projects									
5.									

Changes from 2010 report reflect instructions Align program-level assessment with the Institutional-level assessment.
 NOTE: Six-Year Program Review Report due 9/15/2014