

Assessment of Mathematical Knowledge and Skills
Institutional Student Learning Outcome #6
Report to the Campus
2008-09

Prepared
By
The Executive Committee of the Assessment Commission

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Executive Summary

During the 2008-09 academic year, the OIT Assessment Commission conducted an assessment of mathematics in general education. The assessment was based on three performance criteria, including the ability to perform mathematic computations, the ability to read and comprehend written and/or graphical quantitative information, and the ability to interpret the results of mathematical computations.

The assessment was based on problem sets administered during final exams in math courses selected by the Assessment Commission and the Math Department. The courses included in the assessment were Math 111 College Algebra, Math 243 Introductory Statistics, Math 254N Vector Calculus I, and Math 361 Statistical Methods. For each course, the math faculty wrote three problems of similar difficulty for each of the three performance criteria, i.e. nine total problems for each course.

The results indicate that students in these courses performed at a proficiency or high proficiency level at an acceptable rate overall—77.5% for computation, 71.8% for graphical comprehension, and 74% for interpreting math results. In exploring the data, the math faculty concluded that:

- Students enrolled in Math 111 were weaker in graphing than the faculty would like. The student results for computation and interpretation were acceptable, but not outstanding.
- Students enrolled in Math 243 appeared to be strong in all three performance criteria.
- Two Math 254N graphical comprehension questions were problematic. The faculty were not confident about the results in this area, but thought the students performed acceptably in computation and interpreting math results.
- Students enrolled in Math 361 performed acceptably in computation and graphical comprehension, but were weak in interpreting math results.

To improve the results for graphical comprehension in Math 111, the math faculty will develop performance criteria in spring 2009 for Math 111 and give examples of one or two problems for each criterion. At the start of the fall 2009 term, all faculty teaching Math 111 will be reminded of the criteria, and the assessment process of fall 2008 will be repeated during the term (for the graphing outcome only).

To improve the results for interpreting math results in Math 361, the math faculty will develop performance criteria in spring 2009 for Math 361. The department plans to concentrate on math interpretation through class discussion and assigned problems. At the start of the fall 2009 term, all faculty teaching Math 361 will be reminded of the criteria, and the assessment process of fall 2008 will be repeated during the term (for the interpretation outcome only).

The Executive Committee reviewed cross tabulations of the data by course, class level, major, admissions classification, high school GPA, SAT math score, OIT math placement score, and OIT GPA. While the committee members noted various predictors and relationships in the cross tabulation data, they did not draw significant conclusions from the data in terms of action steps for the future.

The Executive Committee of the Assessment Commission also reviewed a survey of graduating students that was administered in conjunction with the Application to Graduate. The results indicated a high level of agreement among graduating seniors that they are able to perform the computations, graphical comprehension, and interpretation of math results required in their disciplines.

Definition and performance criteria for mathematical knowledge and skills

The Executive Committee of the Assessment Commission approved the following expectations for mathematics:

Mathematical literacy is a vital skill in both professional and everyday life.

Expectations: Graduates should understand and be able to use the basic mathematical concepts relevant to their professions and be able to analyze numerical and statistical data accurately. These expectations may be met through math courses as well as through courses that apply mathematical concepts and skills specific to majors and professions.

In conjunction with the Math Department, the Executive Committee approved the following performance criteria for math:

Students will be able to:

- Perform mathematical computations.
- Read and comprehend written and/or graphical quantitative information.
- Interpret the results of mathematical computations at an appropriate level.

Description of assessment

During the 2008-09 academic year, OIT assessed mathematical knowledge and skills by administering common problem sets during fall 2008 final exams in several math courses. For each course, the math faculty wrote three problems of similar difficulty for each of the three performance criteria, i.e. nine total problems for each course. The courses, selected in consultation with campus assessment coordinators, are required in many curricula and therefore have a broad representation of majors. They are:

- Math 111 College Algebra (five sections)
- Math 243 Introductory Statistics (one section)
- Math 254N Vector Calculus I (two sections)
- Math 361 Statistical Methods I (four sections, including an online section and a Portland campus section)

Prior to this assessment, the Math Department performed a pilot test in the spring of 2008 to test the process and score sheet. Feedback from the pilot was incorporated into the formal assessment in the fall.

Data collection

The Director of Assessment worked with the math instructors participating in the assessment to minimize differences in results due to administration conditions. The problem sets were completed by students during a proctored, two-hour final exam. One online section of Math 361 was not proctored. The instructor examined the results of this section and determined that online students did not perform at a higher level due to lack of proctoring. No students were excused from the exam based on high performance prior to the exam.

The Director of Assessment provided score sheets for the math faculty and compiled all individual score sheets into a data set for each course. The math faculty requested that data by section be kept confidential. The aggregated data for all courses were then submitted to the Director of Institutional Research for analysis.

Data scoring

Each section instructor scored the nine problems as either correct (score of 1) or incorrect (score of zero). No partial credit was given. The Assessment Commission and the math faculty agreed that student proficiency on each performance criteria (three problems) would be defined as:

- Severely deficient: student is unable to answer any questions correctly.
- Some proficiency: student gives correct answer to one of the questions.
- Proficient: student gives correct answer to two of the questions.
- Highly proficient: student gives correct answers to all three questions.

Data elements

The data elements collected in this assessment process included:

- Student ID (from course rosters)
- Student last and first name (from course rosters)
- Course Reference Number (CRN)
- Subject, course, and section number (e.g., Math 111-01)
- Scores for each of the three math computation problems, using zero for incorrect and one for correct on each problem
- Scores for each of the three graphical comprehension problems, using zero for incorrect and one for correct on each problem
- Scores for each of the three interpreting math results problems, using zero for incorrect and one for correct on each problem

In addition, the Director of Institutional Research linked the above data elements to other institutional data, including:

- Major (including pre-majors)
- Admissions classification
- SAT math score
- High school grade point average
- OIT grade point average
- OIT math placement score

Assessment results

Both the Executive Committee of the Assessment Commission and the Math Department reviewed the results of this assessment.

Overall results for all courses

Results for students demonstrating proficiency or high proficiency for all courses combined are shown in Table 1.

Proficiency Level	Math Computation	Graphical Comprehension	Interpreting Math Results	Overall*
Percent proficient (two correct)	37.2	35.9	38.8	
Percent highly proficient (three correct)	40.4	35.9	35.2	
Total proficient or highly proficient	77.6	71.8	74.0	47.4%*

Table 1. Overall proficiency levels

*Percentage of students performing at proficiency or high proficiency for all three criteria.

The Mathematics Department and the Executive Committee of the Assessment Commission reviewed these overall results and found them to be acceptable for each of the three performance criteria. The percentage of students performing at proficiency or high proficiency for *all criteria* (47.4%), however, led to further exploration of the data.

Analysis by course

To determine strengths and weaknesses in student performance in each course, an analysis of student proficiency by course was completed, as shown in Table 2.

Proficiency Level	Math Computation	Graphical Comprehension	Interpreting Math Results	Overall*
Math 111 (<i>n</i> = 98)				
Percent proficient (two correct)	44.9	38.1	39.8	
Percent highly proficient (three correct)	28.6	16.5	40.8	
Total proficient or highly proficient	73.5	54.6	80.6	38.1*
Math 243 (<i>n</i> = 31)				
Percent proficient (two correct)	19.4	50.0	32.3	
Percent highly proficient (three correct)	77.4	43.3	58.1	
Total proficient or highly proficient	96.8	93.3	90.4	83.9*
Math 254N (<i>n</i> = 38)				
Percent proficient (two correct)	39.5	39.5	42.1	
Percent highly proficient (three correct)	50.0	28.9	42.1	
Total proficient or highly proficient	89.5	68.4	84.2	60.5*

Math 361 (n = 83)				
Percent proficient (two correct)	33.7	26.5	38.6	
Percent highly proficient (three correct)	36.1	59.0	16.9	
Total proficient or highly proficient	69.8	85.5	55.5	38.6*

Table 2. Proficiency levels by course

*Percentage of students performing at proficiency or high proficiency for all three criteria.

The Math Department reviewed the data by course above and revisited the exam questions for instances where there were apparent weaknesses. They concluded that:

- Students enrolled in Math 111 were weaker in graphing than the faculty would like. The student results for computation and interpretation were acceptable, but not outstanding.
- Students enrolled in Math 243 appeared to be strong in all three performance criteria.
- Two Math 254N graphical comprehension questions were problematic. The faculty were not confident about the results in this area, but thought the students performed acceptably in computation and interpreting math results.
- Students enrolled in Math 361 performed acceptably in computation and graphical comprehension, but were weak in interpreting math results.

Analysis by class level

The Executive Committee performed an analysis by class level as shown in Table 3.

Proficiency Level	Math Computation	Graphical Comprehension	Interpreting Math Results
Freshmen, % at proficiency or high proficiency, $n = 82$	81.7	59.2	78.1
Sophomores, % at proficiency or high proficiency, $n = 71$	78.9	71.4	73.3
Juniors, % at proficiency or high proficiency, $n = 33$	75.7	81.9	63.6
Seniors, % at proficiency or high proficiency, $n = 51$	72.6	84.3	70.6
Non-admits and post-baccalaureate, % at proficiency or higher, $n = 13$	69.3	77.0	92.3

Table 3. Proficiency levels by class level.

Echoing the Math 111 results above in the analysis by course, the Executive Committee noted that freshmen did as well as other groups in math computation and interpreting math results, but performed noticeably lower (59.2%) than all others in graphical comprehension. Of those enrolled in Math 111, 67.9% were freshmen.

Analysis by major

Because of small sample sizes for each major, students were clustered in four major categories for this analysis, including engineering, information technology/management, health, and arts and sciences. The percentage of students performing at proficiency or high proficiency by major is shown in Table 4.

Major	Math Computation	Graphical Comprehension	Interpreting Math Results
Overall results by major			
Engineering majors	83.7	65.9	74.8
IT/Management majors	65.7	85.7	54.2
Health majors	79.2	76.1	91.7
Arts and sciences majors	68.1	72.7	68.2
Math 111			
Engineering majors	84.3	52.9	78.5
IT/Management majors	75.0	50.0	75.0
Health majors	64.3	62.9	89.3
Arts and sciences majors	53.3	46.7	73.3
Math 243			
Engineering majors (none)			
IT/Management majors	100.0 (1)	100.0 (1)	100.0 (1)
Health majors	100.0	100	94.1
Arts and sciences majors	92.3	84.7	84.7
Math 254			
Engineering majors	89.2	67.5	83.7
IT/Mgmt majors (none)			
Health majors (none)			
Arts and sciences majors	100.0 (1)	100.0 (1)	100.0 (1)
Math 361			
Engineering majors	77.1	82.9	60.0
IT/Management majors	63.4	90.0	50.0
Health majors	100.0 (3)	66.7 (2)	100.0 (3)
Arts and sciences majors	60.0	86.7	46.7

Table 4. Proficiency by major category, including percentage at proficiency or high proficiency. Numbers in parentheses indicate small cell values.

The faculty concluded that:

- No category of majors clearly outperformed all other majors.
- No category of majors clearly underperformed compared to others.
- IT/management majors performed strongly in graphical comprehension in Math 361, perhaps due to enrollment in major courses that reinforce this area of learning.
- Health majors demonstrated strengths in interpretation of math results.
- Engineering majors, as might be expected, excelled in math computation.

While the data are not shown here, an analysis was done to compare pre-health majors versus all other majors, with the hypothesis that pre-health students are more competitive than others prior to admission to sophomore professional programs. Health pre-majors did not perform significantly better than other majors in computation or graphical comprehension, but did perform significantly better in interpretation of math results.

Other Analyses

The Executive Committee also analyzed other factors related to this assessment, including admissions classification, high school GPA, SAT math scores, OIT math placement scores, and OIT GPA. In some cases, these independent variables were good predictors of performance on particular performance criteria. For example, the higher the OIT GPA, the better students performed in interpreting math results. While the committee noted various predictors and relationships, they did not draw significant conclusions from the data in terms of action steps for the future.

Indirect assessment from Application to Graduate

The Executive Committee collected indirect assessment information from graduating seniors on their math knowledge and skills, using a survey attached to the Application to Graduate. The compiled results from the survey are shown in Table 5.

I am able to:	Strongly agree	Agree	Disagree	Strongly Disagree
1. Perform the mathematical computations required by my major.	66.7%	33.3%	0%	0%
2. Read and comprehend written and graphical quantitative information relevant to my major.	69.6%	30.4%	0%	0%
3. Interpret the results of mathematical computations at an appropriate level encountered in my major.	67.6%	32.4%	0%	0%

Table 5. Level of agreement by graduating students on math knowledge and skills.

These results indicate a high level of agreement among graduating seniors that they are able to perform the computations, graphical comprehension, and interpretation of math results required in their disciplines.

Math Faculty Recommendations

The Math Department made the following recommendations to improve student learning in the areas noted above:

- With regard to graphical interpretation in Math 111, the Math Department will develop performance criteria in spring 2009 for Math 111 and give examples of one or two problems for each criterion. At the start of the fall 2009 term, all faculty teaching Math 111 will be reminded of the criteria, and the assessment process of fall 2008 will be repeated during the term (for the graphing outcome only).
- With regard to interpretation of math results in Math 361, the Math Department will develop performance criteria in spring 2009 for Math 361. The department plans to concentrate on math interpretation through class discussion and assigned problems. At the start of the fall 2009 term, all faculty teaching Math 361 will be reminded of the criteria, and the assessment process of fall 2008 will be repeated during the term (for the interpretation outcome only).

The Math Department made the following recommendations to improve the ISLO assessment in the future:

- Before the next assessment of the Math ISLO, the department needs to determine core outcomes for each math course and establish performance criteria for these outcomes. In addition, the department will establish performance sub-criteria for the ISLO to use as a basis for assessment.
- The department will develop a pool of questions, vetted by the entire department, to select from for assessment of each ISLO performance sub-criteria.
- If the ISLO is assessed entirely within the Math Department again, the department plans to revisit the performance criterion on interpreting results. The department suggests that this criterion be changed to “applications,” and that interpreting results would become a sub-criterion under applications.

Assessment Reporting

The Director of Assessment, along with the Executive Committee of the Assessment Commission, will report the results of this assessment to the campus by email to the faculty list serve, by posting the final report on the assessment web site, and by a convocation presentation to the faculty.

Documentation

The Assessment Office will retain the final report and documentation of this assessment indefinitely.