

**Bachelor's Degree in Mathematics & Mathematics Minor**  
**Assessment of Student Learning Program**  
 Kansas State University

**A. College, Department, and Date of This Submission**

College: Arts and Sciences  
 Department: Mathematics  
 Date of Submission: June 21, 2017

**B. Contact Person(s) for the Assessment Plans**

Andrew Bennett, Department Head  
 John Maginnis (current), Thomas Muenzenberger, Director of Undergraduate Instruction  
 Chris Pinner, Student Learning Assessment Coordinator

**C. Program – degree, minor, or certification**

B.S./B.A. in Mathematics & Mathematics minor

**D. Annual Progress Reports on Assessment of Student Learning**

- 1. List the Student Learning Outcomes that were assessed during the year, including those for which data were gathered as well as those for which developmental work was done, such as the creation or piloting of assessment measures.**

R-2: Students will be able to compose and explain mathematical proofs and counterexamples; make logical inferences.

K-1: Students will know the standard facts and algorithms of calculus and differential equations.

K-4 Students will know the standard facts and algorithms of a specialized area of mathematics at a basic level (as defined by the student's advisor).

**Relationship to K-State SLO**

Program SLOs	Knowledge	Critical Thinking	Comm.	Diversity	Integrity	Program SLO is conceptually different from K-State SLOs
R-2	X	X	X			
K-1	X					
K-4	X	X	X			

- 2. For each learning outcome, describe the measures used, the sample of students from whom data were collected, the timetable for the collection, and the forum in which the measures were administered. Remember that over a three-year period at least one-half of the measures used must be direct measures.**

R-2

- The assessment for this learning outcome calls for the outcome to be assessed in upper division mathematics courses. Math Majors take a minimum of seven such classes, Math Minors must take 2-4 of them. Our plan is that eventually all students enrolled in these courses will be assessed. Two proof problems on assignments/exams will be designated for evaluation for program assessment. In order to provide consistent scoring, the curriculum committee developed a rubric for grading proofs. This primarily assessed *Critical Thinking*. A second rubric, new this year, grades the two problems for written *Communication*. These rubrics (<https://www.math.ksu.edu/ugrad/assessment/>) were used to evaluate work submitted during the past year in Math 506, a recommended proof courses for math majors planning on attending graduate school, and in Math 511 and Math 572, which are proof courses recommended for (or primarily taken by) math majors planning on working in education.
- Majors are asked during their exit interviews whether they believe they understand how to compose and explain proofs and what examples or reasons they have to support their belief. All graduating seniors are invited for such interviews and over 90% participate. This assesses *Knowledge*.

K-1

- Math 240, Elementary Differential Equations, serves as the capstone course for the calculus sequence. Students taking this course are assigned to complete 18-21 computerized assignments demonstrating their skill in calculus and differential equations (most differential equations are solved by reducing them to calculus problems) during the semester. Success of math majors on these problems will be recorded. Math 240 is a required course and over 90% of majors take the course on campus and so will complete the computerized assessments. Math 240 is not required for the Math Minor but many will take it (in the future we may expand this assessment to other courses in the calculus sequence that are required for the minor).
- Majors are asked during exit interviews whether they believe they have knowledge of basic calculus and differential equations and what examples or reasons they have to support their belief. All graduating seniors are invited for such interviews and over 90% participate.

K-4

- Advisors will be responsible for selecting a performance assessment (if available) for whether students have met this student learning outcome. Because students

take a mathematics degree as preparation for a wide range of careers, many different measures will be appropriate in different circumstances. A list of nine different possible assessments that have been used in the past has been developed, but other measures may be suitable in the future. Since this is not a requirement for our program, current graduates may not have completed any such assessment. Majors were asked during exit interviews about whether they had completed any such performance measures. Exit interviews are not carried out for Math Minors but an online pdf survey has been developed to try to gather this information.

- Alumni surveys and other post-graduation data will follow up on placement after graduation.

**3. Describe the results of the assessment. (What did you learn? What is working well? Where are improvements needed?) If specific results are not available, describe the progress that has been made on the initiatives included in the approved assessment plan.**

For each student learning outcome, we have defined “exemplary,” “proficient,” “acceptable,” and “developing” levels of performance. For our program as a whole, we have the following standards.

The *program* will be *exemplary* in a particular outcome if at least 90% of students are proficient or better in that outcome and at least 50% are exemplary.

The *program* will be *proficient* in a particular outcome if at least 80% of students are proficient or better in that outcome and at least 30% are exemplary.

The *program* will be *acceptable* in a particular outcome if at least 70% of students are proficient or better in that outcome and at least 10% are exemplary.

Otherwise, the *program* will be *developing* in that outcome.

R-2

- **Math Majors:** Rubric-based evaluations of proofs were collected from 26 students in upper-division courses during Fall 2016 and Spring 2017. Note that this double counts some students who took more than one course where evaluations were performed. In each course, two representative problems were evaluated on a 6-point rubric. The *standards of performance* for the sum of the scores on the two problems was

<i>Rating</i>	<i>Score</i>
Exemplary	11-12
Proficient	9-10
Acceptable	7-8
Developing	0-6

With these standards, student performance on *Critical Thinking* was rated as follows

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	16	61.54%
Proficient	6	23.08%
Acceptable	0	0.00%
Developing	4	15.38%

Since 22 out of 26 (84.6%) students are proficient or exemplary (with over 60% exemplary) these numbers are *proficient*. For the last two years we have been *proficient*, a significant improvement on our usual *acceptable* category. Two years ago, in response to our low *developing* ranking for this assessment, the math department created a one credit, 5 week, *introduction to proof* course. It would appear that this has had a positive effect.

This year the two problems selected were also graded on a four point scale using a new *written communication in proofs* rubric. The *standards of performance* for the sum of the two scores was:

<i>Rating</i>	<i>Score</i>
Exemplary	7-8
Proficient	5-6
Acceptable	3-4
Developing	0-2

With these standards, student performance on written *Communication* was rated as follows

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	16	61.54%
Proficient	8	30.77%
Acceptable	2	7.69%
Developing	0	0.00%

Since 24 out of 26 (92.3%) of students are exemplary or proficient (with over 60% exemplary) this rates us as *exemplary*. This is the first year that we have added this component to the assessment.

**Math Minors:** Math minors were also present in Math 511 and Math 572, and 12 students registered as Math Minors were assessed in the same way. Note that this double counts one student who took more than one course where evaluations were performed. Results were as follows:

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	5	41.67%
Proficient	3	25.00%
Acceptable	2	16.67%
Developing	2	16.67%

With these figures 8 out of 12 (66.7%) rate proficient or above on *Critical Thinking*. This is a considerable improvement on last years 41.7% and, while still in the *developing* category, this year we are verging on *acceptable*. Since the math minor is relatively new we have few prior years for comparison. While noticeably lower than the results for math majors, it simply may not be reasonable to have the same expectation for both majors and minors. We also do not expect math minors to typically take the new introduction to proof course (though this will be routinely suggested during initial math advising).

On written *Communication* the scores were as follows:

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	5	41.67%
Proficient	2	16.67%
Acceptable	3	25.00%
Developing	2	16.67%

Since only 7 out of 12 (58.3%) scored exemplary or proficient the math minors rank as *developing*. We have no prior years for comparison.

- Of the 19 graduating math majors in Summer 2015 (3 students), Fall 2015 (3 students) and Spring 2016 (13 students), exit interview data was obtained from 15 (78.9%) students. All 15 said that they understand how to explain and compose proofs, with all but one of them giving either a valid reason (10) or example (4). This seems a satisfactorily high figure. It is the fourth year that this data has been processed.

K-1

- **Math Majors:** Thirty-eight undergraduate math majors took Math 240 in Summer 2016 (6 students), Fall 2016 (12 students) or Spring 2017 (20 students). Their average scores on the online assignments were computed. The following *standards of performance* were specified based on an analysis of student performance among both majors and non-majors.

<i>Rating</i>	<i>Score</i>
Exemplary	90 – 100%
Proficient	80 – 90%
Acceptable	70 – 80%
Developing	0 – 60%

Based on these standards, undergraduate majors' performances were rated as follows:

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	22	57.89%
Proficient	8	21.05%
Acceptable	5	13.16%
Developing	3	7.89%

Since only 78.95% scored in the exemplary or proficient range these values are considered *acceptable* verging on *proficient*. This is down on our usual *exemplary* rating for this assessment but a considerable improvement on last years anomalous (53.8%) *developing* rating. As with last year this data may have included students not completing the course, thus lowering our result. Note that this assessment measures students at the midway point in their work, rather than at exit, so we get feedback on how students are doing in a more timely fashion.

- Exit interviews were obtained from 15 out of the 19 graduating math majors. All 15 (100%) believe they have knowledge of basic calculus and differential equations with all but one of these giving either a valid reason (9) and/or example (5) for believing so. It is satisfying that most of our students have knowledge of calculus and are able to justify it. This is the fourth year that this data has been processed and these results are typical.

**Math Minors:** Ten students identified as Math Minors are recorded as taking Math 240 in Summer 2016 (1 student), Fall 2016 (4 students) or Spring 2017 (5 students):

<i>Rating</i>	<i>Number</i>	<i>Percent</i>
Exemplary	6	60.00%
Proficient	2	20.00%
Acceptable	2	20.00%
Developing	0	0.00%

With 80.0% scoring in the exemplary or proficient range this is considered *proficient*, a great improvement on last years data (*developing* 44.4%). This is only the second year of assessment data for the minor. Math 240 is not a required course for Math Minors and was chosen primarily because of the availability of data for that course.

- Lacking exit interviews for the math minors, their knowledge of basic calculus and differential equations was assessed by gathering the grades obtained by the 20 Summer 2015, Fall 2015 & Spring 2016 graduating minors in any of the courses in the calculus sequence (MATH 220,221 & 221) or differential equations (MATH 240) taken at KSU.

<i>Rating</i>	<i>Grade</i>	<i>Number</i>	<i>Percent</i>
Exemplary	A	18	29.03%
Proficient	B	25	40.32%
Acceptable	C	18	29.03%
Developing	D	1	1.61%

- Since 69.4% were in the A or B category we would regard this as *developing*, verging on *acceptable*. This is slightly down on our previous year (73.7%).

K-4

#### **Math Majors**

- Information on 15 of the 19 math majors who graduated in Summer 2015 (3 students), Fall 2015 (3 students) or Spring 2016 (13 students) was available from exit interviews or other sources. Of these 14 (93.3%) had completed performance assessments tied to their knowledge of a specialized area of mathematics. As this is not a graduation requirement and suitable assessments are not always available depending on the interests of the student, we are happy that most of our graduates voluntarily and successfully complete this requirement.
- Information on all 19 graduating math majors was available from the CES Post-Graduation Statistics, exit interviews or other sources. Placements for the 19 students were

<i>Placement</i>	<i>Number</i>	<i>Percent</i>
Grad School	5	26.32%
High Tech Job	8	42.11%
Teaching	4	21.05%
Low Tech Job	1	5.26%
Cont UG Studies	1	5.26%
Unknown	0	0.00%

We are satisfied with these numbers and pleased that we have information for all of our graduates.

**Math Minors:** Lacking exit interviews for the math minors an online survey was instituted to try to obtain similar information on the graduating Math Minors. Twenty students graduated with the Math Minor in Summer 2015, Fall 2015 or Spring 2016. Data on only one student was obtained from the online surveys (this student demonstrated 'knowledge of a specialized area' and has gone on to graduate studies). Since an upper level math courses can be considered a 'specialized area of mathematics' for a math minor it was decided by the curriculum committee that the grades that these students obtained in 500 level and above courses should be analyzed instead.

<i>Rating</i>	<i>Grade</i>	<i>Number</i>	<i>Percent</i>
Exemplary	A	33	44.59%
Proficient	B	28	37.84%
Acceptable	C	13	17.57%
Developing	D	0	0.00%

Since over 80% of the grades were in the A or B category (with over 40% in the top category) these results should be regarded as *proficient*. This is in line with last year's assessment.

**4. Describe the process by which faculty reviewed the results and decided on the actions and/or revisions that were indicated by them.**

This annual assessment report is brought to the attention of the faculty each spring and is available for them to read in the department office. This report will be posted on the math department website (<https://www.math.ksu.edu/ugrad/>). We have not yet received any comments that actions or revisions are appropriate.

**5. Describe the actions and/or revisions that were (or will be) implemented in response to the assessment results.**

This data is better in some areas and worse in others, but within reasonable fluctuations of previous results. For the last two years the math department has run *an introduction to proof* course in response to repeated low figures in the first R2 assessment. It seems to have produced an improvement in this assessment and we hope to continue to run it. No other revisions were planned or implemented.

**6. Summary**

While there are some fluctuations these results are broadly comparable to previous years. There are no causes for concern. In the R2 assessment our students have maintained last years *proficient* ranking (satisfyingly above our usual *acceptable* level) in their construction of proofs (potentially due to our introduction to proof course). In the K1 assessment we were *acceptable* verging

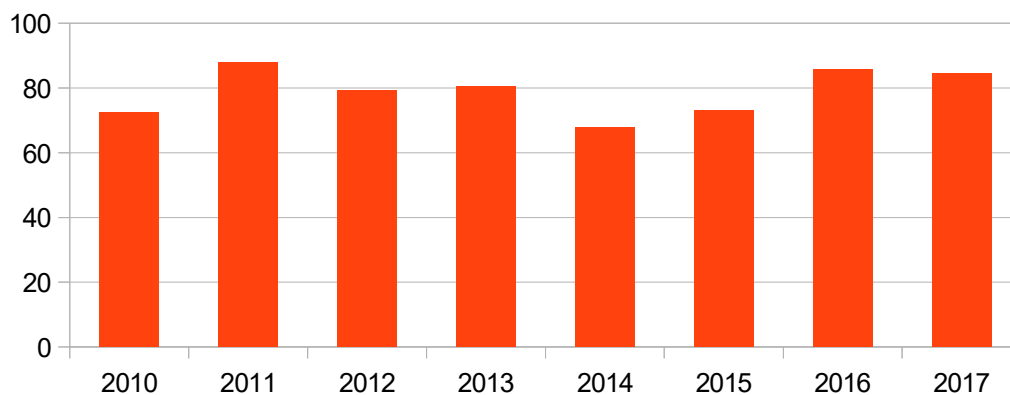


on *proficient*, up on last years anomalous *developing* ranking, though down on our usual *exemplary* range for knowledge of standard calculus and differential equations as measured by online homework scores (this may be due to a change in the method of obtaining data for the last two years whereby students not completing the course may have been included). This is the fourth year that we have implemented second assessments for the R2 and K1 assessment and those results have been encouraging. The proportion of students completing the K4 assessments tied to knowledge of a specialized area of mathematics is a very healthy 93.3% (of those for whom we have data) especially since this is not a requirement for math majors. In the other K4 assessment it is very encouraging that we have placement data for all of our graduates this year (this increase for the last few years is partially explained by our move to include CES Post-graduation statistics as well as our usual exit interviews and other sources). The proportion of our graduates gaining high tech jobs or graduate school is pleasingly high (the total similar to last year, with more this year going into high tech jobs). This is a good indication that we are successfully preparing our students for the job market.

In January 2015 we instituted the Math Minor with 6 students graduating in Spring 2015 and 20 in Summer 15 (0 students), Fall 2015 (5 students) or Spring 2016 (15 students) and 23 in Summer 16 (2 students), Fall 16 (10 students) or Spring 17 (11 students). Data in our assessment of the math minor is inevitably limited and we have only one previous year for comparison. Results are noticeably lower than for the math majors, but perhaps this is to be expected. No conclusions can really be made until we have several full years of data. The math department currently has around 140 Math Majors and 78 Math Minors.

### %-age in Exemplary or Proficient

Math Majors R2 Assessment of Critical Thinking



# %-age in Exemplary or Proficient

## Math Majors K1 Assessment

