Pittsburg State University

General Education Mathematics Assessment Report

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The College of Arts & Sciences
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2014-2015

In the Spring of 2011, the Math Task Force at Pittsburg State University recommended implementation of a system of ongoing assessment that evaluates the mathematical formation of students in general education math courses. The systematic assessment generates results for how PSU students are performing in formulating and solving problems using math, also considered quantitative literacy, and in quantitative reasoning, a dimension of critical thinking.

Year one, AY 2011-12, of the Math Task Force plan called for the assessment of student learning in MATH 133 Quantitative Reasoning (QR). Year two, AY 2012-13, of the plan called for assessment in MATH 143 Elementary Statistics while continuing to assess MATH 133 QR. Year three, AY 2013-14, called for development of assessment methods and materials in MATH 113 College Algebra as well as continued assessment of Quantitative Reasoning and Elementary Statistics. Year four, AY 2014-15, of the plan called for a pilot assessment of College Algebra and continued assessment of Elementary Statistics while QR was dormant after completing its first 3-year cycle. This report describes the math department assessment activities for AY 2014-15.

PSU Undergraduate General Education Goals and Objectives

The goals and objectives related to undergraduate mathematics are:

1. Goal #1: Students should be able to communicate effectively.
   OBJECTIVE
   a. Demonstrate the ability to formulate and solve problems using the tools of mathematics.
2. Goal #2: Students should be able to think critically.
   OBJECTIVES:
   a. Demonstrate the ability to distinguish between relevant and irrelevant information in problem solving.
   b. Articulate a problem and develop a logical and reasonable response to it using appropriate sources.
   c. Apply generalizations, principles, theories, or rules to the real world.
   d. Demonstrate the ability to analyze and synthesize information.

Assessment Plan

Table 1 shows the timetable outlined by the Math Task Force to assess student learning in all general education math courses at PSU. To gather and evaluate baseline data, each course will be assessed for three consecutive years, then every third year thereafter for a three-year frequency cycle.

Table 1
Timetable for Assessing General Education Math Courses

	Year 1 ***2011-12***	***Year 2*** ***2012-13***	***Year 3*** ***2013-14***	***Year 4*** ***2014-15***	***Year 5*** ***2015-16***	***Year 6*** ***2016-17***	***Year 7*** ***2017-18***	***Year 8*** ***2018-19***
Quantitative Reasoning	**Preparation** **Pilot Spring 2012**	**Fall 2012** **Spr 2013**	**Fall 2013** **Spr 2014**	**3-yr cycle**		✓		
Elementary Statistics		**Preparation** **Pilot Spring 2013**	**Fall 2013** **Spr 2014**	**Fall 2014** **Spr 2015**	**3-yr cycle**		✓	
College Algebra			**Preparation**	**Pilot Fall 2014** **Spr 2015**	**Fall 2015** **Spr 2016**	**3-yr cycle**		✓

College Algebra Assessment Development

The College Algebra assessment was developed by a committee of two faculty members from the PSU Mathematics Department who met to create measures of student learning to match the competencies outlined in the PSU General Education Math Rubric. The rubric was intended to measure achievement levels of the associated goals in a variety of assignments. Foremost in the discussions, as committee members worked to develop test items, was that content of the assessment was to be informed by the goals in the rubric: Interpretation, Representation/Application, Computation, Analysis/Synthesis, and Communication. The committee operated with the premise that the goals were not disjoint but rather overlapping.

During the first stage of instrument development, over 10 test items were considered. Each item was mapped to all applicable goals in the PSU General Education Math Rubric. For efficiency, if an assessment item did not match more than one goal in the rubric it was discarded. The second stage of the process required the committee to evaluate item difficulty and possible sources of ambiguity in wording. Instrument length and student motivation were also discussed. To obtain focused students responses, the committee carefully deliberated wording of the prompts. The final result was a group of four test items (Appendix B) with each item mapped to two or more goals in the rubric. These four items will be included on the final exam in all MATH 113 classes during the Fall of 2014 as a pilot run. Table 2 shows the mapping of items to goals.

Table 2
Assessment Items Matched to Goals

Goals	*Items*
Interpretation	1 and 4
Representation/Application	2and 3
Calculation	1 and 2
Analysis/Synthesis	1,2 and 3
Communication	1 and 4

College Algebra Results

All sections of MATH 113 during the Fall of 2014 were used for the pilot project and a random sample of 74 assessments were scored. All sections of MATH 113 during the Spring of 2015 were used for the pilot project and a random sample of 39 assessments were scored. Each test item was evaluated using the PSU General Education Math Rubric as the assessment instrument. The rubric is a matrix of goals, named previously, and achievement levels. Numerical values corresponding to each achievement level used for scoring purposes were used: Exceeds Expectations (3 points), Meets Expectations (2 points), Falls Below Expectations (1 point), and No Credit (0 points).

Further, each item from each sample assessment was scored by two committee members. Finally, the data were aggregated and tabulated.

Information shown in Table 3 summarizes results of the pilot assessment by goal.

Table 3
Fall 2014 Statistics by Goal for MATH 113 College Algebra

	Interpretation	Representation/ Application	Calculation	Analysis/ Synthesis	Communication
Mode	1	3	3	3	1
Median	1	2	3	3	2
Mean	1.63	1.61	1.93	1.89	1.58
St Dev	1.13	1.16	1.28	1.23	1.08
n	293	290	295	290	293
3's	34.8%	32.8%	53.9%	50.3%	25.9%
2's	10.6%	17.9%	9.5%	9.3%	25.3%
1's	37.5%	26.9%	12.2%	19.7%	29.4%
0's	17.1%	22.4%	24.4%	20.7%	19.5%
Below or No	54.6%	49.3%	36.6%	40.3%	48.8%
Meets	10.6%	17.9%	9.5%	9.3%	25.3%
Exceeds	34.8%	32.8%	53.9%	50.3%	25.9%

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In the 74 assessments, with each goal measured in at least two items. Calculation was measured the most often with 295 scores collected. Following that, Interpretation and Communication were each measured 293 times. Representation/Application and Analysis/Synthesis were each measured 290 times.

As presented in Table 3 above, 63.4% of items scored for Calculation were at either Exceeds or Meets Expectations. Interpretation had the lowest percentage of Exceeds or Meets Expectations with 45.4%.

Calculation was the goal with the highest average score of 1.93 followed by Analysis/Synthesis with a mean of 1.89. The lowest mean score of 1.58 was the goal Communication and the second lowest score of 1.61 was for Representation/Application.

Information shown in Table 4 below summarizes results of the Spring 2015 assessment by goal.

Table 4
Spring 2015 Statistics by Goal for MATH 113 College Algebra

	Interpretation	Representation/ Application	Calculation	Analysis/ Synthesis	Communication
Mode	3	3	3	3	3
Median	2	2	3	3	2
Mean	1.87	1.94	2.06	2.17	1.84
St Dev	1.17	1.06	1.30	1.10	1.24
n	116	116	116	116	116
3's	44.8%	40.5%	62.9%	56.0%	46.6%
2's	14.7%	25.0%	4.3%	19.0%	13.8%
1's	23.3%	22.4%	8.6%	11.2%	16.4%
0's	17.2%	12.1%	24.1%	13.8%	23.3%
Below or No	40.5%	34.5%	32.8%	25.0%	39.7%
Meets	14.7%	25.0%	4.3%	19.0%	13.8%
Exceeds	44.8%	40.5%	62.9%	56.0%	46.6%

In the 39 assessments, with each goal measured in at least two items. Each goal was also measured a total of 116 times

As presented in Table 4, 75% of items scored for Analysis/Synthesis were at either Exceeds or Meets Expectations. Interpretation had the lowest percentage of Exceeds or Meets Expectations with 60.5%.

Analysis/Synthesis was the goal with the highest average score of 2.17 followed by Calculation with a mean of 2.06. The lowest mean score of 1.84 was the goal Communication and the second lowest score of 1.87 was for Interpretation.

College Algebra Analysis of Pilot and Spring 2015 Results

The evaluation process indicated that careful analysis of possible student answers before scoring was necessary for consistency. Scoring a sample of student responses and then discussing the results revealed issues that needed clarification.

After individually scoring all items for all assessments, the committee members met to discuss the results. If committee members' scores had a difference greater than 2 on an item, they were discussed. Important differences in the interpretation of student work and/or the scoring rubric were discovered. A few discussions resulted in a committee member or members changing their score for an item. Other discussions resulted in no change.

After reviewing pilot data collected and discussing results the committee decided to include more explicit directions for items 1 and 3 in order to elicit student responses that aligned with the goals in the rubric. It is important to note that scoring of the test items for the course grade was independent of the results of this project. The instructor of record graded test items for a course grade within the grading scheme for the course.

The assessment questions in Fall 2014 were the last 4 questions on the College Algebra final exam. The most pressing issue that the committee discussed was the high number of assessment questions that were left unanswered or partially answered. Our discussions led to a couple of possible for reasons this. First, because the assessment questions were at the end of the College Algebra final exam we thought that it could be due to test fatigue while taking a two hour final exam. Second, we thought it might be that students know what score they need on the final exam to

maintain their grade in the class and don't have incentive to continue with the same effort toward the end of the exam as they did when they started the exam. The assessment questions in Fall 2014 were placed at the end of the College Algebra final exam only for ease of copying.

For Spring 2015 we decided to move the assessment questions to the first two pages of the final exam to eliminate this perceived weakness in our assessment design. It is worth noting that across the board, average scores for every goal were higher and percentages of items scored at either Exceeds or Meets Expectations for every goal were higher in Spring 2015.

Data from one year are not sufficient to make valid conclusions about student learning outcomes over time. The committee will start the discussion of acceptable scores as more data is collected. Results will be analyzed on an ongoing basis to inform the Math Department and the university about actions to improve student learning.

Elementary Statistics Results

Elementary Statistics continued assessment for a third year. A committee of three members of the PSU Mathematics Department developed four assessments items (Appendix D) matched to the PSU General Education Math Rubric in AY 2011-12. These assessment questions were included on the final exams in all sections of MATH 133 during the Fall of 2014 and Spring of 2015 semesters. In the Fall of 2014 a random sample of 64 assessments were scored. In the Spring of 2015 a total of 51 assessments were scored. Each item from each sample assessment was scored using the rubric. The rubric is a matrix of goals, named previously, and achievement levels. Achievement levels on the rubric are Exceeds Expectations, Meets Expectations, Falls Below Expectations, and No Credit. Numerical values corresponding to each achievement level used for scoring purposes were used: Exceeds Expectations (3 points), Meets Expectations (2 points), Falls Below Expectations (1 point), and No Credit (0 points).Finally, the data were aggregated and tabulated.

Information shown in Table 5, Table 6, Table 7, Figure 1, Figure 2, and Figure 3 summarize results of assessments by goal for all three years. Specifically, the committee was interested in the percentage of Exceeds Expectations, Meets Expectations, Falls Below Expectations, and No Credit that were scored for each goal and the number of times each goal was measured.

In the 115 random assessments from 2014-15, with each goal measured in at least two items, Calculation was measured the most often with 345 scores collected. Following that, Interpretation, Representation/Application, Analysis/Synthesis and Communication were each measured 230 times.

In the 101 random assessments from 2013-14, with each goal measured in at least two items, Calculation was measured the most often with 303 scores collected. Following that, Interpretation, Representation/Application, Analysis/Synthesis and Communication were each measured 202 times.

In the 55 random assessments from 2012-13, with each goal measured in at least two items, Calculation was measured the most often with 495 scores collected. Following that, Interpretation, Representation/Application, Analysis/Synthesis and Communication were each measured 330 times.

Table 5
2014-15 Statistics by Goal for MATH 143 Elementary Statistics

	Interpretation	***Representation/ Application***	***Calculation***	***Analysis/ Synthesis***	***Communication***
Range	3	3	3	3	3
Mode	3	3	3	3	3
Median	3	3	3	3	3
Mean	2.50	2.42	2.52	2.62	2.67
St Dev	0.77	0.93	0.89	0.65	0.67
n# times measured	230	230	345	230	230

Table 6
2013-14 Statistics by Goal for MATH 143 Elementary Statistics

	Interpretation	*Representation/ Application*	*Calculation*	*Analysis/ Synthesis*	*Communication*
Range	3	3	3	3	3
Mode	3	3	3	3	3
Median	3	3	3	3	3
Mean	2.55	2.49	2.62	2.61	2.43
St Dev	0.80	0.93	0.87	0.73	0.85
n# times measured	202	202	303	202	202

Table 7
2012-13 Statistics by Goal for MATH 143 Elementary Statistics

	Interpretation	*Representation /Application*	*Calculation*	*Analysis/ Synthesis*	*Communication*
Range	3	3	3	3	3
Mode	3	3	3	3	3
Median	3	3	3	2	3
Mean	2.20	2.07	2.36	2.01	2.14
St Dev	1.08	1.16	1.03	1.09	1.08
# times measured	330	330	495	330	330

As presented in Figure 1, during 2014-15 93.9% of items scored for Communication were at either Exceeds or Meets Expectations. Representation/Application had the lowest percentage of Exceeds or Meets Expectations with 83.5%.

As presented in Figure 2, during 2013-14 88%.2 of items scored for Analysis/Synthesis were at either Exceeds or Meets Expectations. Representation/Application had the lowest percentage of Exceeds or Meets Expectations with 81.7%.

Figure 3 shows that during 2012-13 79.6% of items scored for Calculation were at either Exceeds or Meets Expectations. Representation/Application had the lowest percentage of Exceeds or Meets Expectations with 67.8%.

Figure 1
2014-15 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal

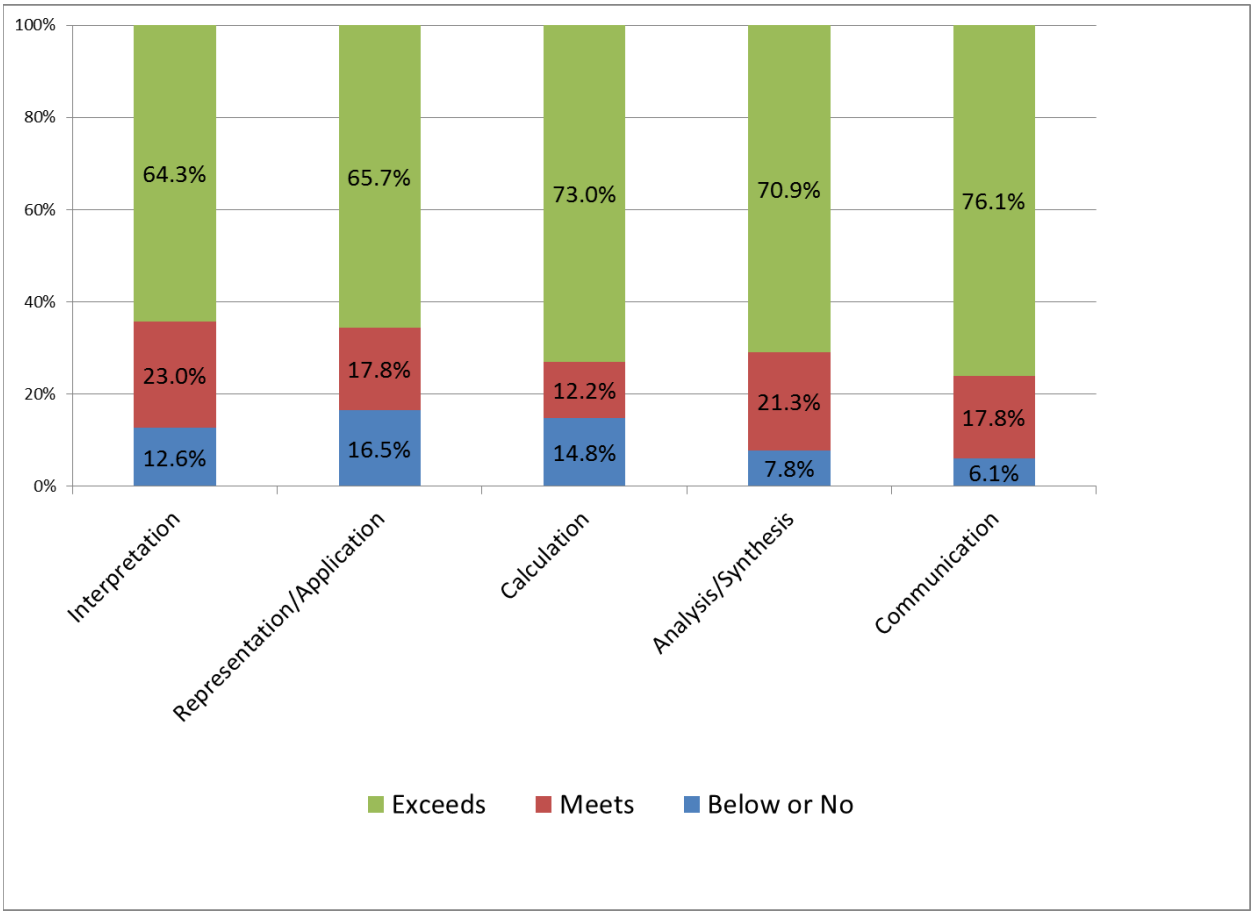


Figure 2
2013-14 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal

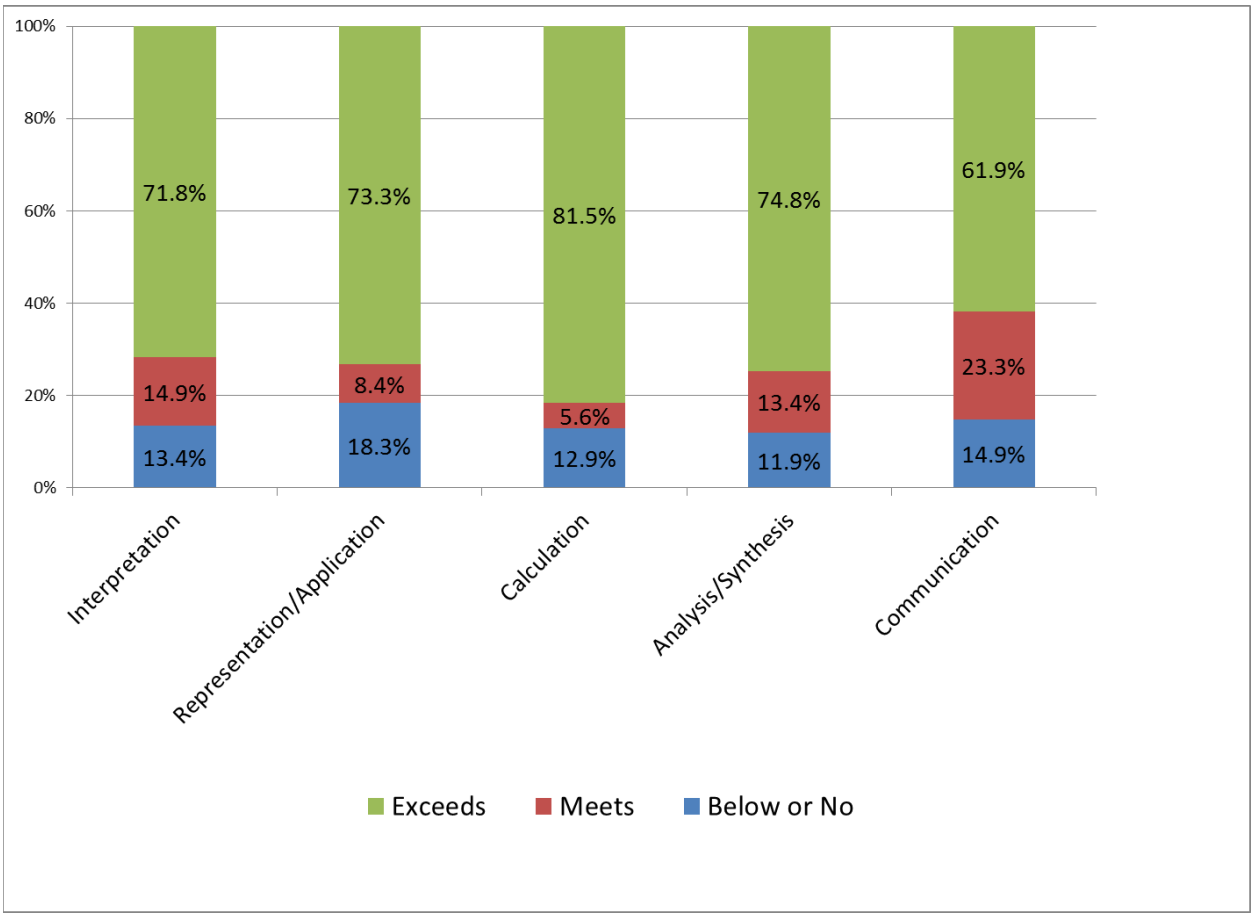
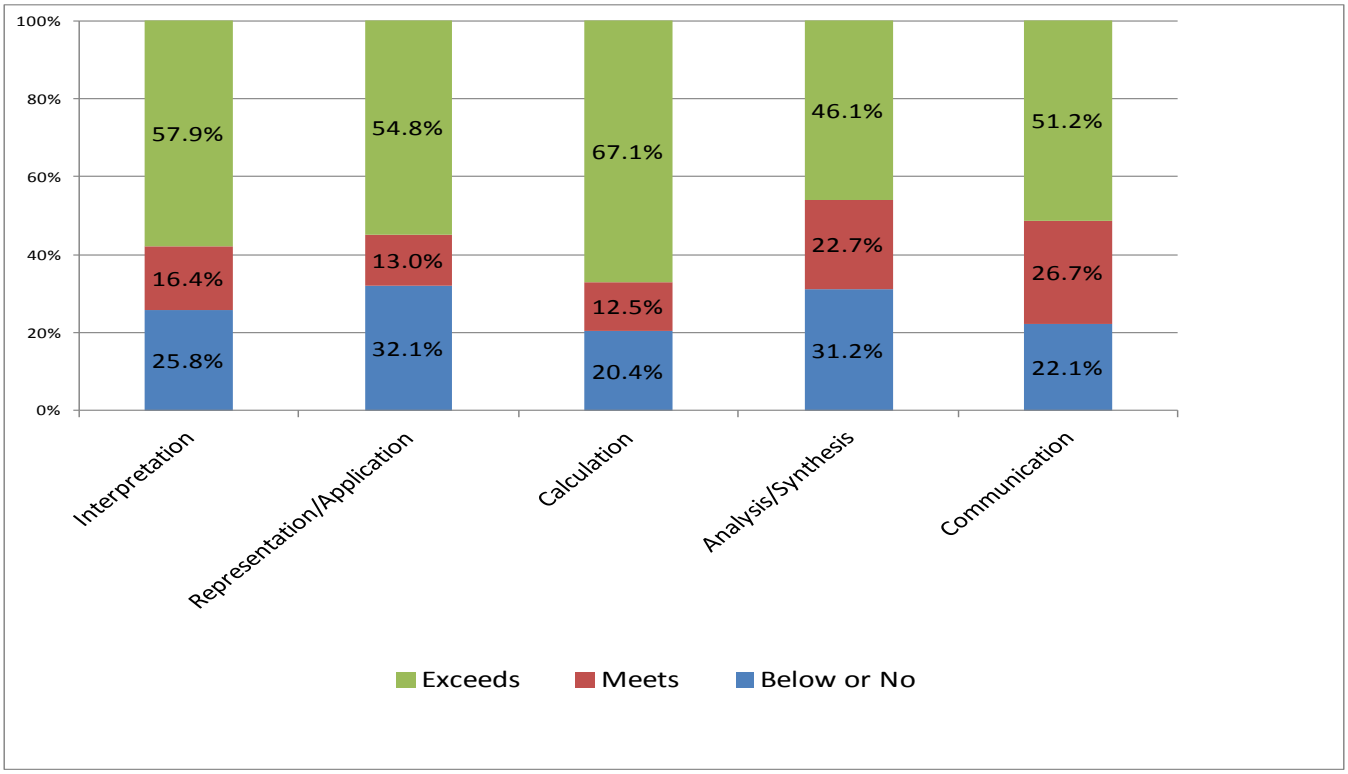


Figure 3
2012-13 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal



The committee found mean values for each goal to begin a baseline data set. Figures 4-6 show the mean values for each goal represented in the rubric. In 2014-15 Communication was the goal with the highest average score of 2.67 followed by Analysis/Synthesis with a mean of 2.62. The lowest mean score of 2.42 was the Representation/Application goal and the second lowest score of 2.50 was for Interpretation.

In 2013-14 Calculation was the goal with the highest average score of 2.62 followed by Analysis/Synthesis with a mean of 2.61. The lowest mean score of 2.43 was the Communication goal and the second lowest score of 2.49 was for Representation/Application.

In 2012-13 Calculation was the goal with the highest average score of 2.36 followed by Interpretation with a mean of 2.20. The lowest mean score of 2.01 was the Analysis/Synthesis goal and the second lowest score of 2.07 was for Representation/Application.

Figure 4

2014-15 Mean Scores for Goals for MATH 143 Elementary Statistics

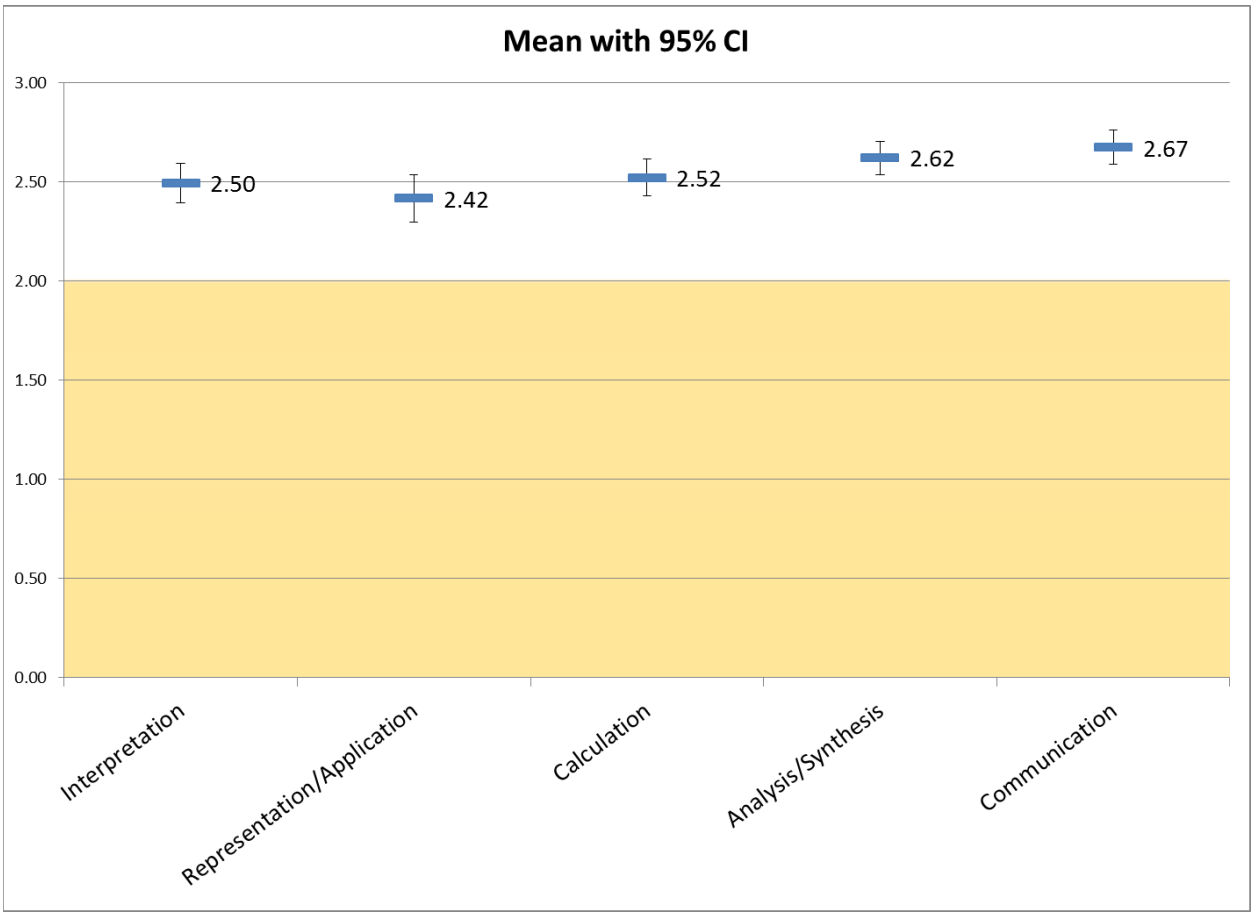


Figure 5

2013-14 Mean Scores for Goals for MATH 143 Elementary Statistics

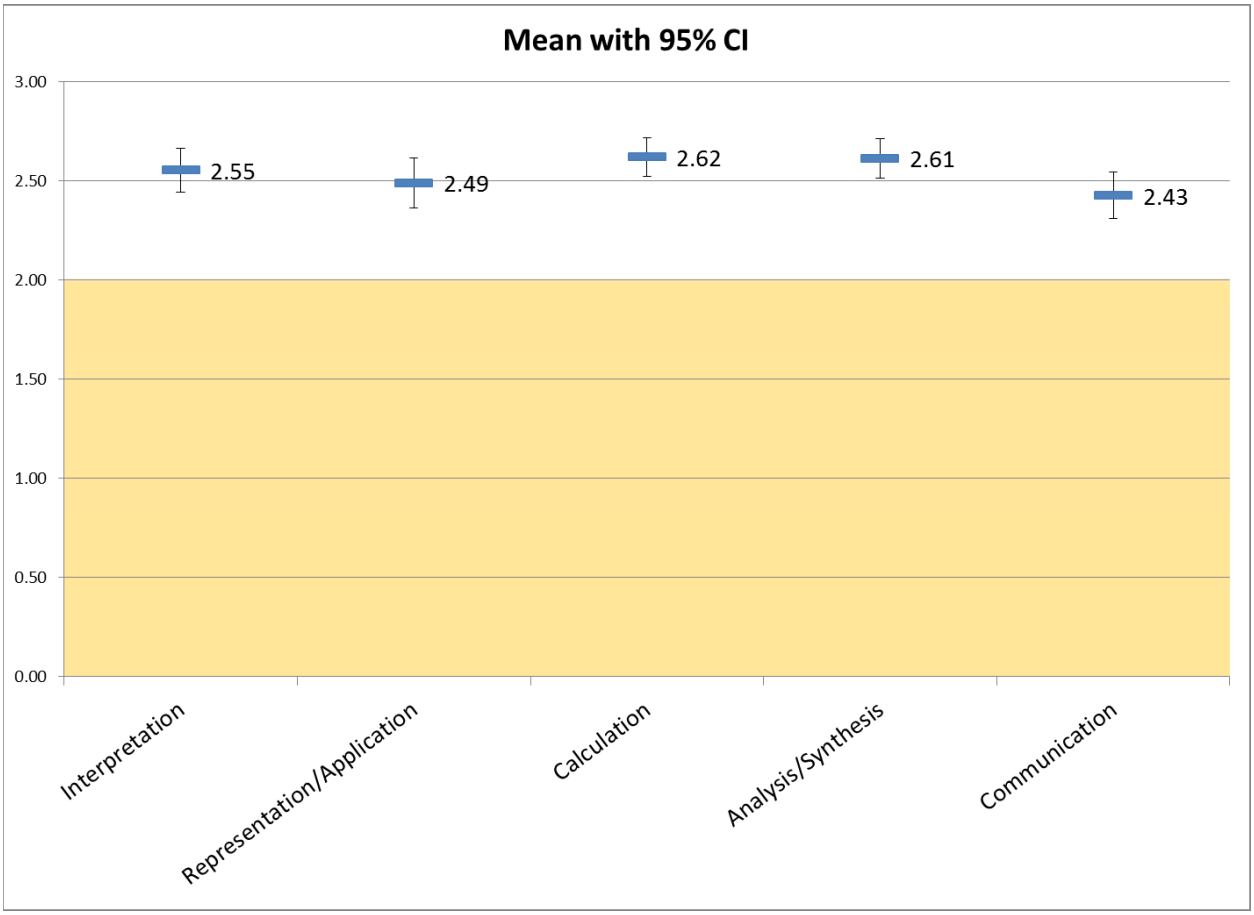
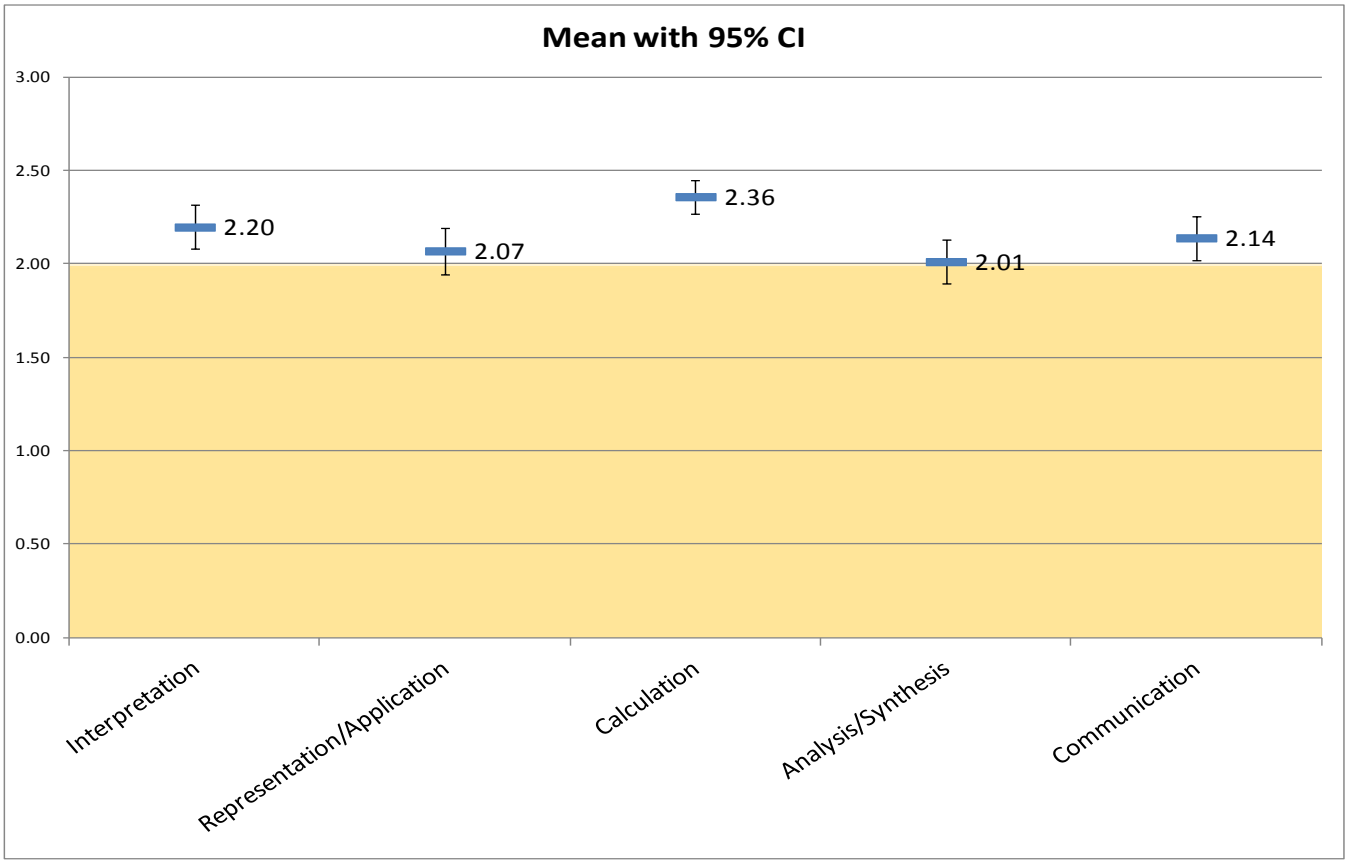


Figure 6

2012-13 Mean Scores for Goals for MATH 143 Elementary Statistics



The information in Figures 7-9 show mean scores for each goal by question.

Figure 7
2014-15 Mean by Question for MATH 143 Elementary Statistics

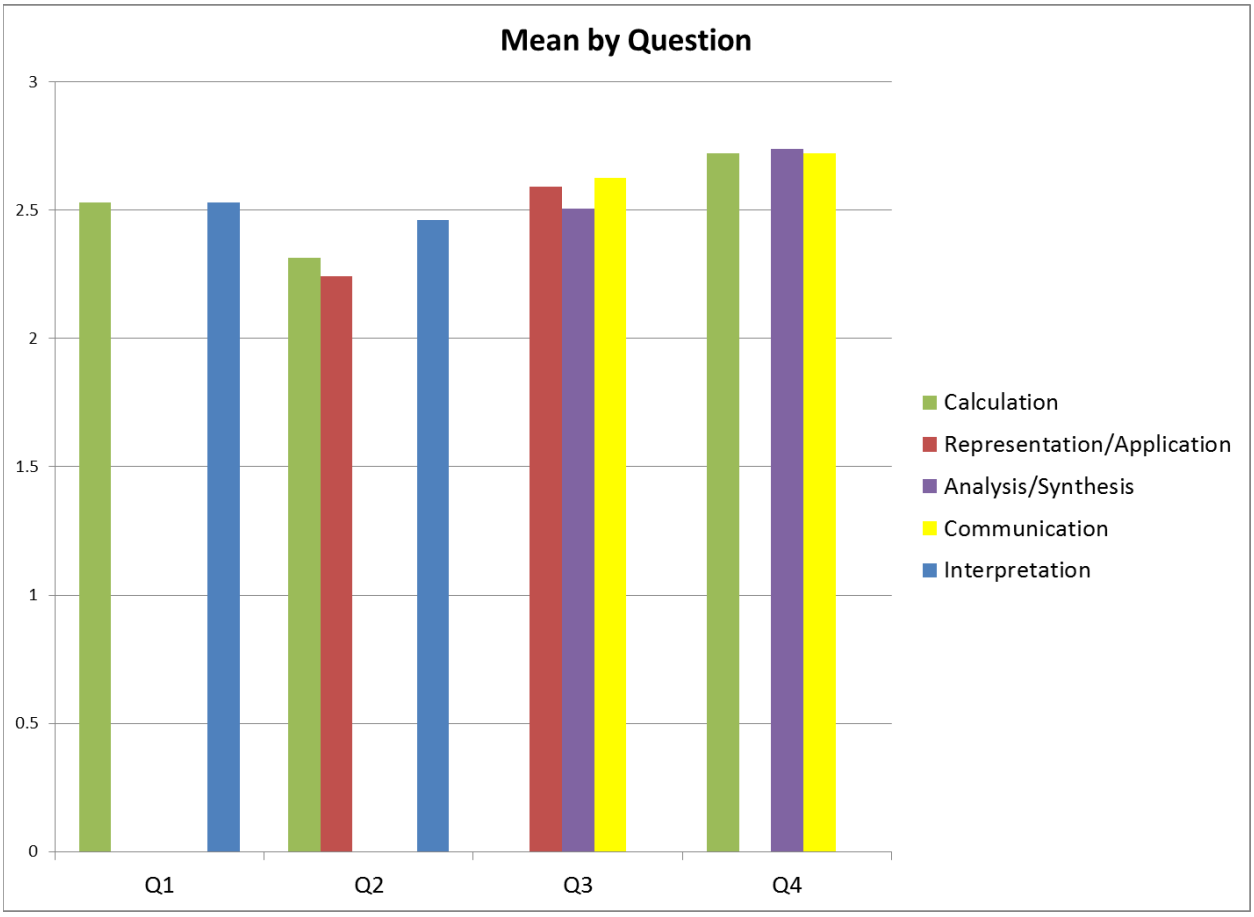


Figure 8
2013-14 Mean by Question for MATH 143 Elementary Statistics

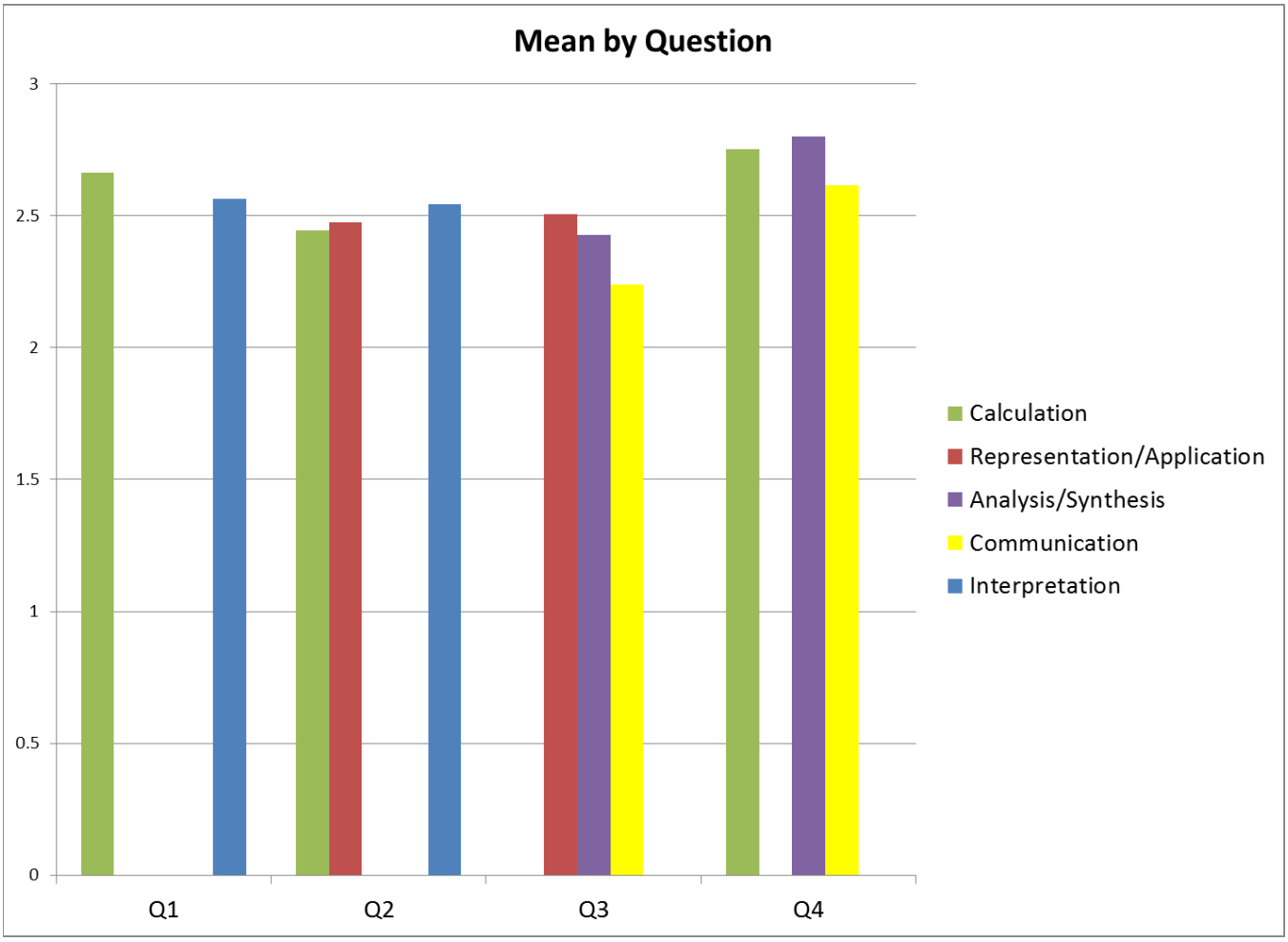
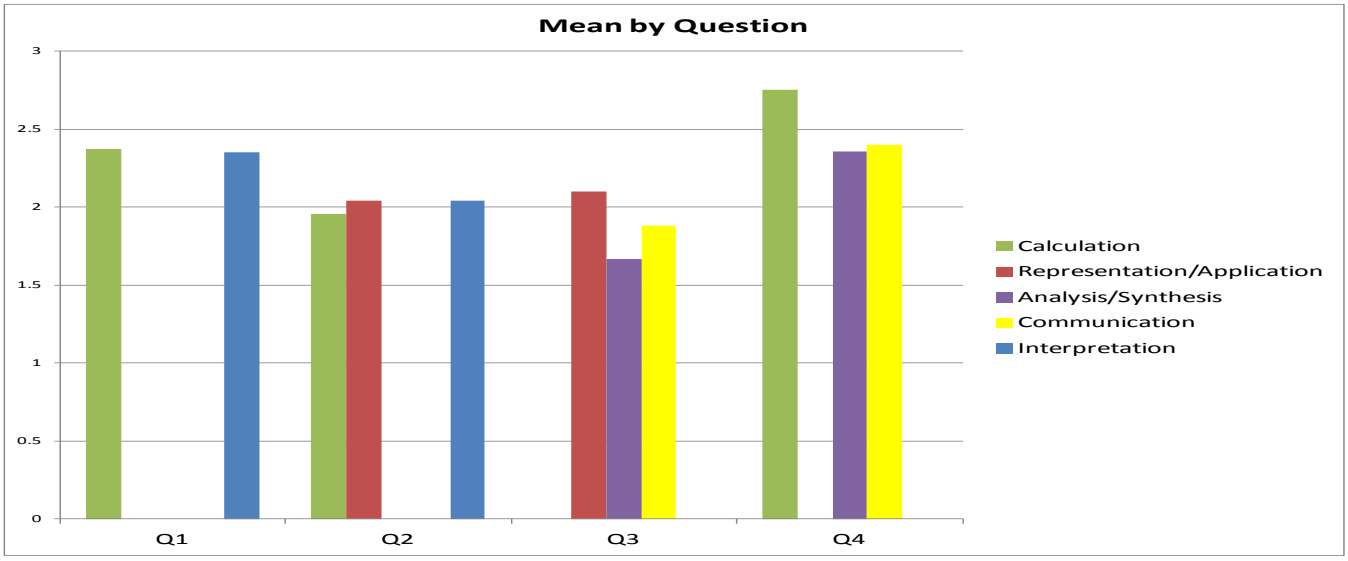


Figure 9
2012-13 Mean by Question for MATH 143 Elementary Statistics



Elementary Statistics Analysis of Results

The same test items were used this year as were use in years 1 and 2.The pilot evaluation process indicated that careful analysis of possible student answers before scoring was necessary for consistency. Scoring a sample of student responses and then discussing the results revealed issues that needed clarification. The committee's careful attention to writing explicit directions in order to elicit student responses that aligned with the goals in the rubric paid off. The time spent in year one to make rubric notes for the open-ended questions made scoring easier than expected.

After individually scoring all items for all assessments, the committee members met to discuss the results. If committee members' scores had a difference greater than 2 on an item, they were discussed. Important differences in the interpretation of student work and/or the scoring rubric were discovered. A few discussions resulted in a committee member or members changing their score for an item. Other discussions resulted in no change.

After reviewing the data collected and discussing results the committee decided to include more explicit directions for item 3 in order to elicit student responses that aligned with the goals in the rubric. It is important to note that scoring of the test items

for the course grade was independent of the results of this project. The instructor of record graded test items for a course grade within the grading scheme for the course.

During the second and third years of assessment one “trained” grader from the original committee scored the items. The committee will start the discussion of acceptable scores now that the 3-year cycle of data collection is complete and report the findings in next year’s narrative. Results will continue to be analyzed on an ongoing basis to inform the Math Department and the university about actions to improve student learning.

Quantitative Reasoning Results

Quantitative Reasoning completed its 3-year assessment cycle in AY 2013-14 and no new data was collected this year. A committee of three members of the PSU Mathematics Department developed four assessments items (Appendix D) matched to the PSU General Education Math Rubric in AY 2011-12. These assessment questions were included on the final exams or in-class quizzes in all sections of MATH 133 during all 3 years. Each item from each sample assessment was scored using the rubric. Finally, the data were aggregated and tabulated.

Information shown in Table 8, Table 9, Table 10, Figure 10, Figure 11, and Figure 12 summarize results of assessments by goal for each of the three years. Specifically, the committee was interested in the percentage of Exceeds Expectations, Meets Expectations, Falls Below Expectations, and No Credit that were scored for each goal and the number of times each goal was measured.

Table 8
2013-14 Statistics by Goal for MATH 133 Quantitative Reasoning

	Interpretation	***Representation/ Application***	***Calculation***	***Analysis/ Synthesis***	***Communication***
Mode	3	3	3	3	3
Median	3	3	2	3	3
Mean	2.41	2.51	2.16	2.43	2.62
St Dev	0.93	0.80	0.96	0.90	0.82
# times measured	92	138	92	138	138

Table 9
2012-13 Statistics by Goal for MATH 133 Quantitative Reasoning

	Interpretation	*Representation /Application*	*Calculation*	*Analysis/ Synthesis*	*Communication*
Range	3	3	3	3	3
Mode	3	3	3	3	3
Median	3	3	3	3	3
Mean	2.45	2.47	2.48	2.53	2.64
St Dev	0.87	0.83	0.88	0.75	0.68
# times measured	176	264	176	264	264

Table 10
2011-12 Statistics by Goal for MATH 133 Quantitative Reasoning

	Interpretation	*Representation /Application*	*Calculation*	*Analysis/ Synthesis*	*Communication*
Range	3	3	3	3	2
Mode	3	3	3	3	3
Median	2	2	3	2	3
Mean	2.11	2.19	2.14	2.28	2.54
St Dev	0.93	0.93	1.00	0.77	0.61
# times measured	135	207	138	204	204

As presented in Figure 10, 91.3% of items scored for Communication were at either Exceeds or Meets Expectations during 2013-14. Calculation had the lowest percentage of Exceeds or Meets Expectations with 78.2%. Figure 11 shows that during 2012-13

93.5% of items scored for Communication were at either Exceeds or Meets Expectations. Interpretation had the lowest percentage of Exceeds or Meets Expectations with 80.1%. Figure 12 shows that during 2011-12 a total of 93.6% of items scored for Communication were either Exceeds or Meets Expectations. Calculation had the lowest percentage of Exceeds or Meets Expectations with 69.5%. There were no scores of 0 on Communication and 6.5% of the items scored for Calculation were scored 0.

Figure 10

2013-14 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal

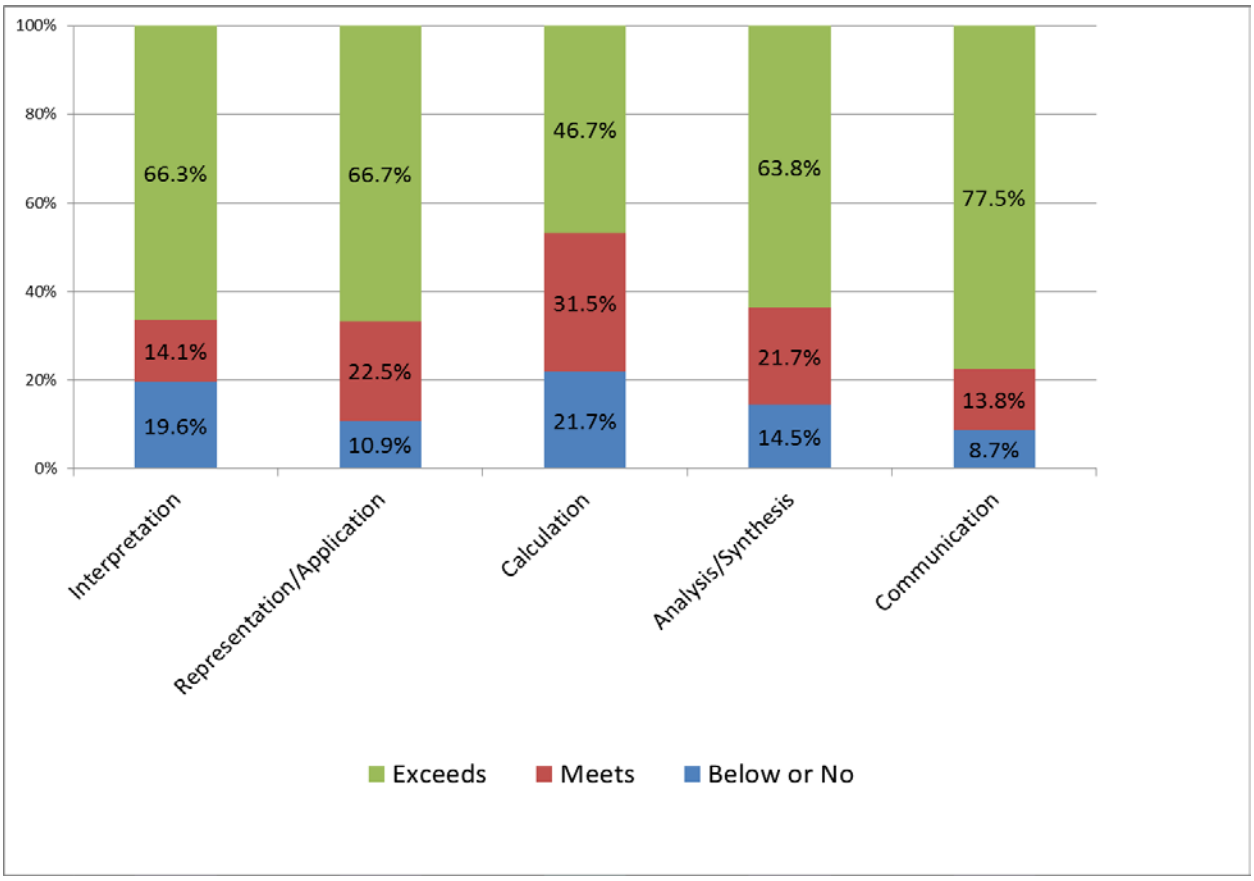


Figure 11

2012-13 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal

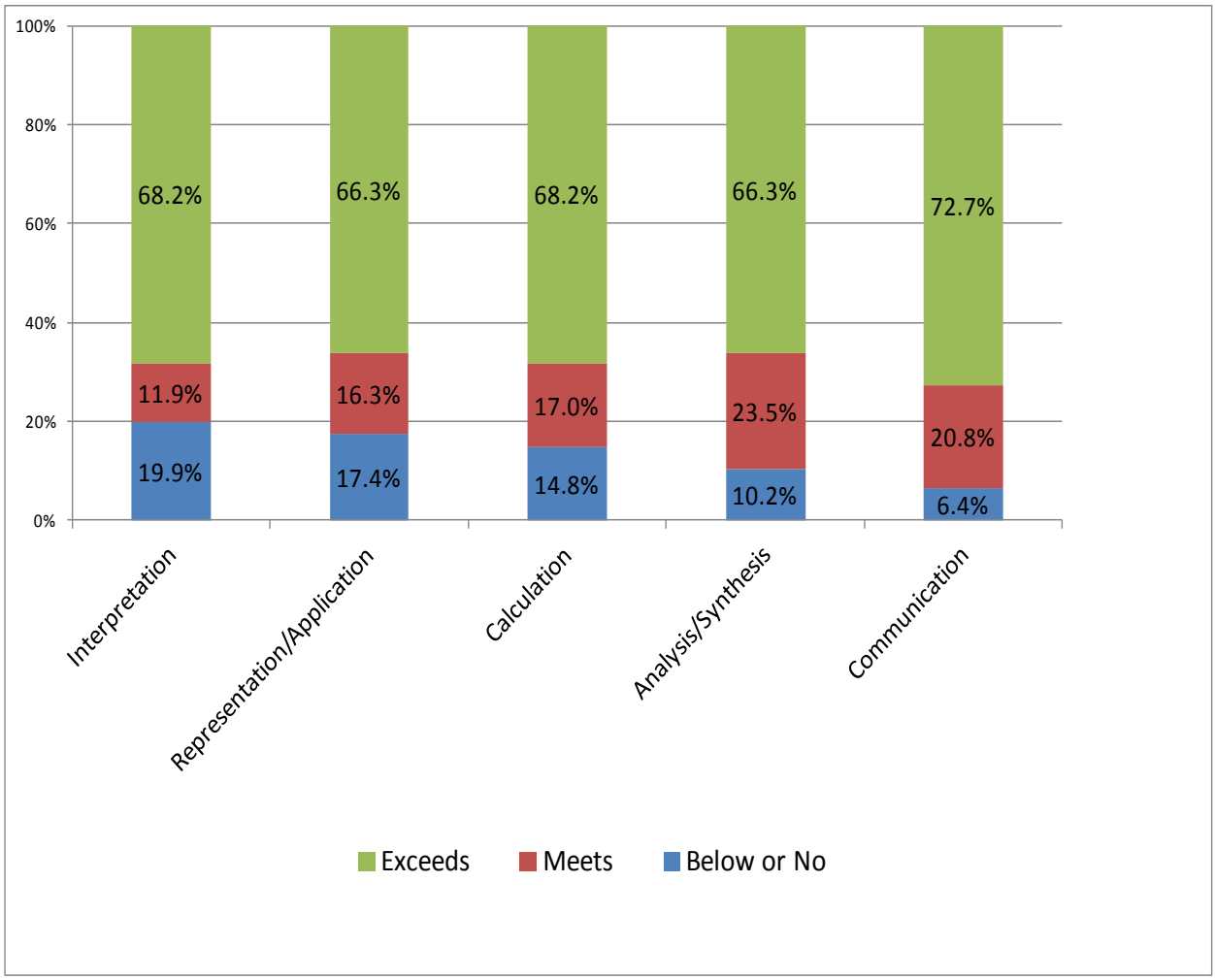


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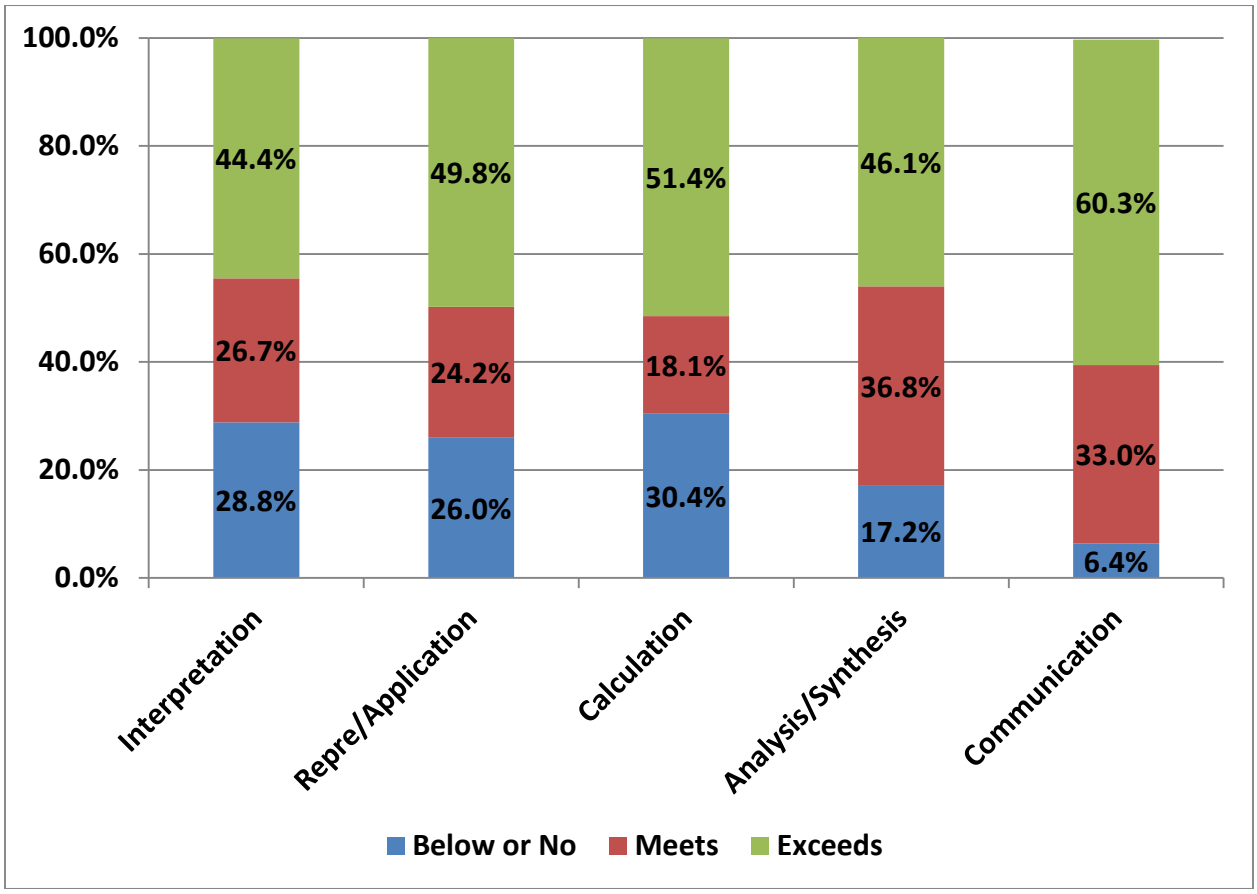
Figure 12

2011-12 Percentage of Exceeds, Meets, or Below Expectations and No Credit by Goal



The committee found mean values for each goal to continue a baseline data set. Figure 13 and Figure 14 show the mean value for each goal represented in the rubric.

Figure 13 shows that in 2013-14 Communication was the goal with the highest average score of 2.62 followed by Representation/Application with a mean of 2.51. The lowest mean score of 2.16 was the Calculation goal and the second lowest score of 2.41 was for Interpretation.

In 2012-13 Figure 14 shows Communication was the goal with the highest average score of 2.64 followed by Analysis/Synthesis with a mean of 2.53. The lowest mean score of 2.45 was the Interpretation goal and the second lowest score of 2.47 was for Representation/Application.

Figure 13

2013-14 Mean Scores for Goals

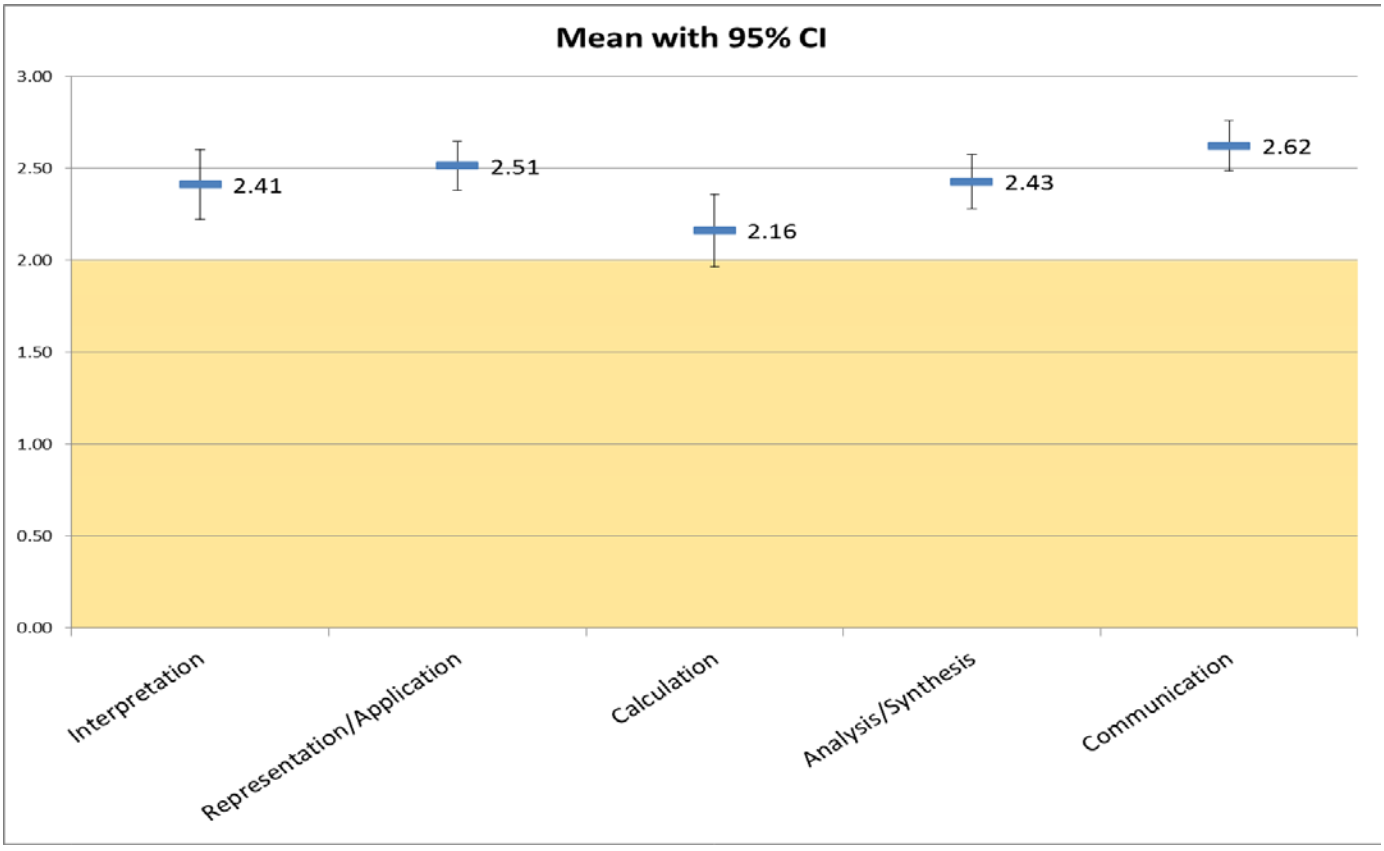
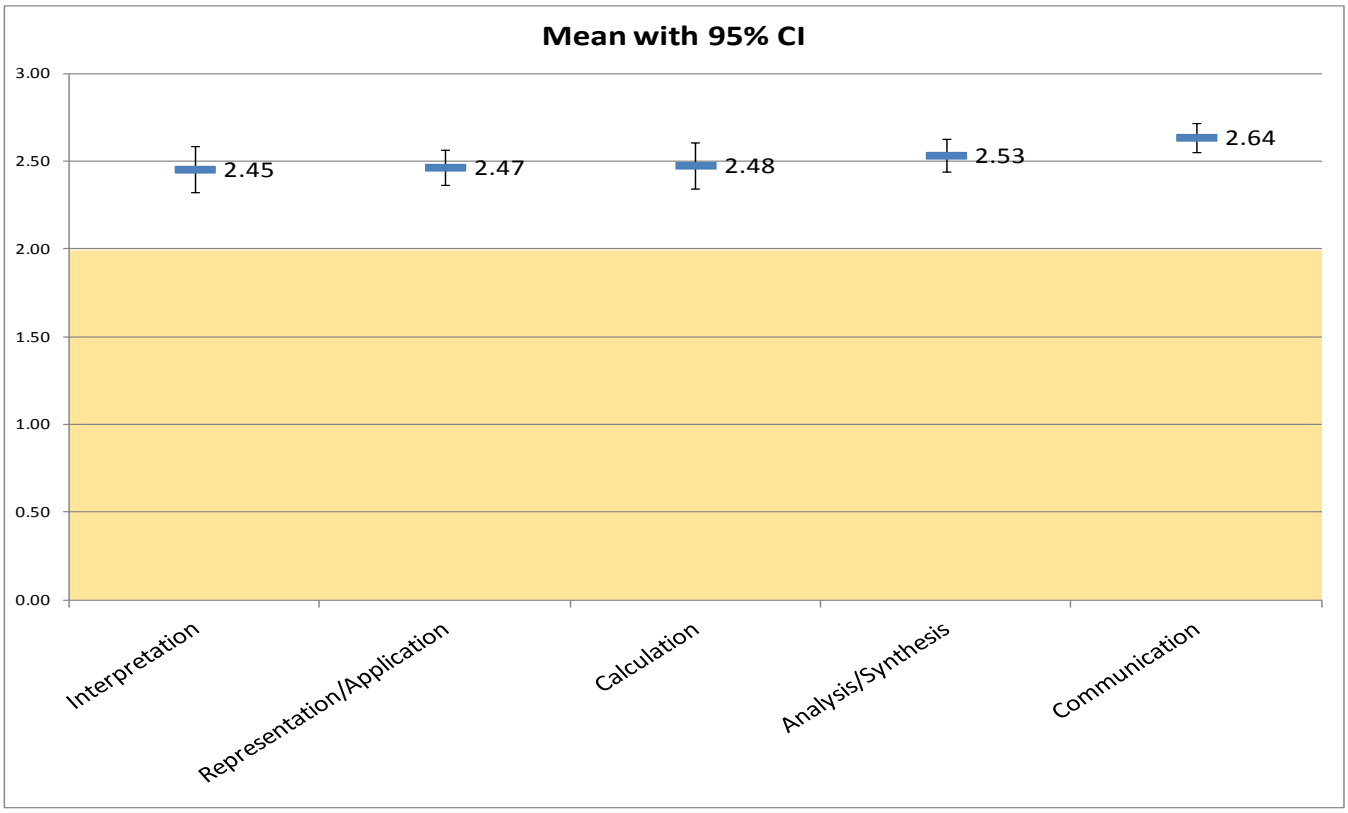


Figure 14

2012-13 Mean Scores for Goals



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The information in Figure 15 and Figure 16 show mean scores for each goal by question.

Figure 15

2013-14 Mean by Question

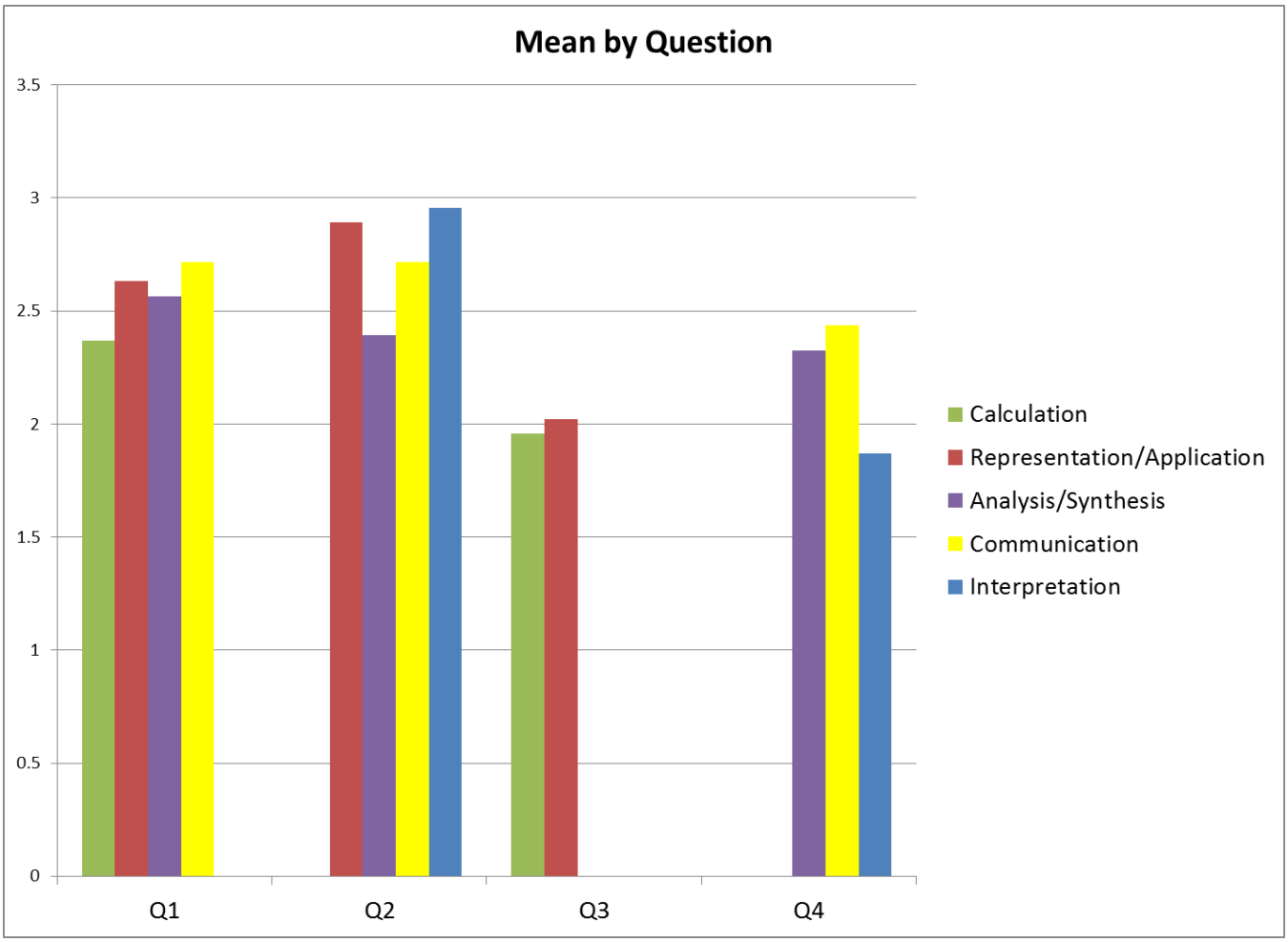
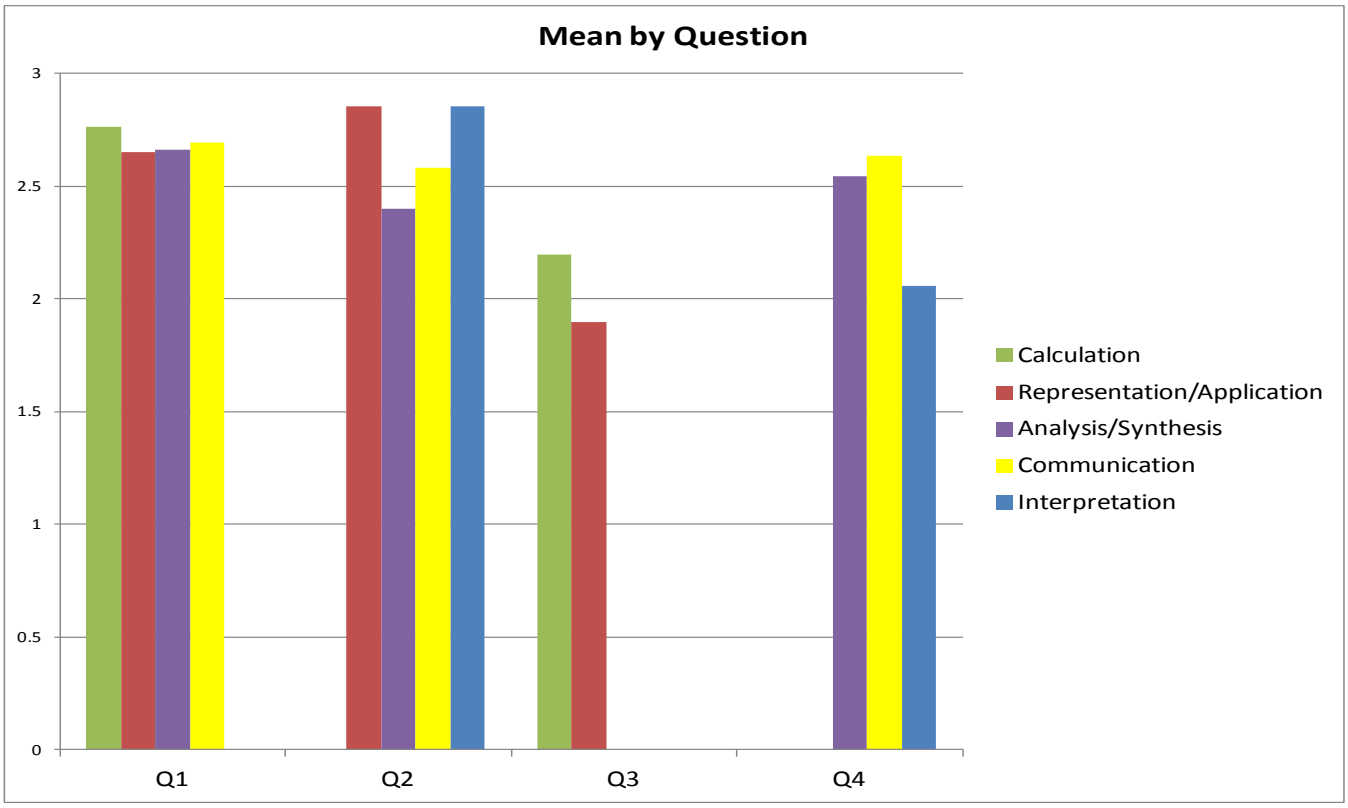


Figure 16

2012-13 Mean by Question



Quantitative Reasoning Analysis of Results

With the 3-year cycle of data collection complete, a committee of three faculty members who all teach Quantitative Reasoning met to analyze the results. Our objective was to make data-based observations to inform the Math Department and the university about actions to improve student learning in QR. We were also interested in identifying areas where our teachers and instructional strategies are producing results.

The committee started the discussion with the question, "What would we consider acceptable results?" In initial talks and after examining the data it was decided that for each goal, 70% of items scored needed to be at Exceeds or Meets Expectations to be considered acceptable. The data for the 2013-14 and 2012-13 assessments showed that more than 70% of the scores as Exceeds or Meets Expectations for all of the five

goals. In 2011-12 all goals met the 70% threshold except for Calculation with 69.5% of items scored as either Exceeds or Meets Expectations. Since we were largely meeting our initial target we asked the question, “Was this an appropriate target?” We agreed to an additional related target of having mean scores for all goals at or above 2.0. This target was met for all goals for all three years.

Next, the committee wanted to examine the data for strengths and weaknesses. Communication was the greatest strength all three years with 91.3%, 93.5%, and 93.6% of items scored as either Exceeds or Meets Expectations. The committee surmised that the results might be due to the unique focus of problem solving skills and critical thinking in QR; those comparable results might not appear in the assessments of other general education math courses. Instructional strategies in QR emphasize the process involved in solving problems and the communication of that process. Additionally, one section of QR during the 2012-13 academic year was designated a Writing to Learn Course.

Interpretation and Calculation were the greatest weaknesses. There is not an emphasis on Calculation in the QR and students use calculators. Instructional strategies that call for attention to precision when making calculations as well as spending more time demonstrating checking solutions to see if they make sense and for accuracy should improve student outcomes in Calculation. The assessment items that measure Interpretation are both statistical graphs that students may or may not have been exposed to during the course. An important outcome of our discussions was the need for an articulated set of core outcomes for Quantitative Reasoning because it is taught be a wide variety of math faculty. This will ensure that all students in QR are exposed to a common set of mathematics topics.

Assessment results will continue to be analyzed on an ongoing basis to keep our focus on improving teaching to impact student learning.

Plan

The Math Department has proceeded with Year 5 of the assessment plan outlined by the Math Task Force by continuing to assess College Algebra. We will also establish a committee to examine and analyze the results in Elementary Statistics.

This assessment plan reflects a model of continuous improvement as assessment results will inform faculty to opportunities to modify assignments and courses. Future modifications will be evaluated with further assessment to determine if improvements were achieved. Students of general education mathematics at PSU will benefit from these efforts.

December,
2015

Appendix A

PSU General Education Mathematics Rubric

December,
2015

Assessment Rubric: General Education Mathematics

Objectives	Exceeds Expectations 3	Meets Expectations 2	Falls Below Expectations 1	No Credit 0
Interpretation *Ability to glean information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)*	Provides accurate explanations of information presented in mathematical forms. *For instance, accurately explains the trend data shown in a graph.*	Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to computations or units. *For instance, accurately explains trend data shown in a graph, but may have a minor error in the slope of the trend line.*	Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means. *For example, attempts to explain the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.*	No meaningful work done.
Representation/ Application *Ability to convert relevant information into various mathematical forms and to apply mathematical generalizations, principles, theories, or rules to real world problems.*	Selects and applies the appropriate mathematical principles to correctly solve an application problem taking into account any important assumptions. . (*In calculating the area of an irregular polygon, student correctly divides the area into simple shapes and correctly uses known formulae to calculate the areas.*)	Chooses appropriate mathematical principles but has minor errors in applying principles to solve problem. (*In calculating the area of an irregular polygon, student correctly subdivides the area into simple shapes and improperly uses formulae to calculate the areas.*)	Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate. (*Student knows some of the technique for subdivision of an irregular polygon but incorrectly divides the area; knows some simple area formulae, but cannot put all the steps together to get a correct result.*)	No meaningful work done.
Calculation *Use the tools of mathematics.*	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. *For example, the student decides to use the quadratic formula to solve and problem and substitutes and simplifies appropriately.*	Calculations attempted represent only a portion of the calculations required to comprehensively solve the problem. *For example, the student decides to use the quadratic formula to solve and problem and substitutes incorrectly or makes a minor simplification error.*	Calculations are attempted but are both unsuccessful and are not comprehensive. *For example, the student decides to use the quadratic formula to solve and problem and substitutes incorrectly and has simplification errors.*	No meaningful work done.
Analysis/Synthesis *Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis*	Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work. (*Interpolates or extrapolates data from a graph or table to calculate information not specifically given; creates a formula from information to predict results for future events.)*	Uses the quantitative analysis of data as the basis for workmanlike (without inspiration or nuance, ordinary) judgments, drawing plausible conclusions from this work. (*Given a problem statement, the correct relationship can be identified and known values used to calculate the desired unknown.)*	Uses the quantitative analysis of data as the basis for tentative, basic judgments, although is hesitant or uncertain about drawing conclusions from this work. (*Given a problem statement, known values can be correctly identified, however, the appropriate relationship is not found or applied correctly and the desired result is not found.)*	No meaningful work done.
Communication *Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is used and how it is formatted, presented, and contextualized)*	Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven. *For instance, effectively uses verbal and/or written skills to explain the quantitative evidence.*	Uses quantitative information, but does not completely connect it to the argument or purpose of the work. *For instance, the quantitative evidence may be correct, but verbal and/or written skills are not completely developed.*	Presents an argument for which quantitative evidence is pertinent, but does not provide adequate explicit numerical support. (May use quasi-quantitative words such as "many," "few," "increasing," "small," and the like in place of actual quantities.) *For instance, does not effectively use verbal and/or written skills to explain quantitative evidence.*	No meaningful work done.

Appendix B

College Algebra Assessment Items

16. The profit of a company is given by $P(x) = -0.0002x^2 + 140x - 250000$ where x is the number of units produced. Is there a production level that will yield a maximum profit? _____

If so, what is the production level that will yield a maximum profit and if not state "none".

_____

Explain how you know this.

17. The following table shows the average yearly in-state tuition charged by American public universities.

DATE	AVERAGE TUITION	ANNUAL CHANGE IN TUITION
2001	$4273	
2002	$4805	
2003	$5337	
2004	$5869	

2005	$6401	

a. Complete the last column with the ANNUAL CHANGE IN TUITION values.
b. Can the data set can be modeled with a linear function? Explain why or why not.

c. If it is linear, write the linear equation.

d. What prediction does this formula give you for tuition at American public universities in 2015?

18. Suppose you have $15,000 to invest. Which of the two rates would yield the larger amount in 5 years: 12% daily or 11.86% compounded continuously? SHOW YOUR WORK.

19. Solve the following system of equations. Does you answer indicate a single point solution, parallel lines, or same line? Explain how you know this?

$x + 2y = 5$

$2x + 4y = 6$

Appendix C

Elementary Statistics Assessment Items

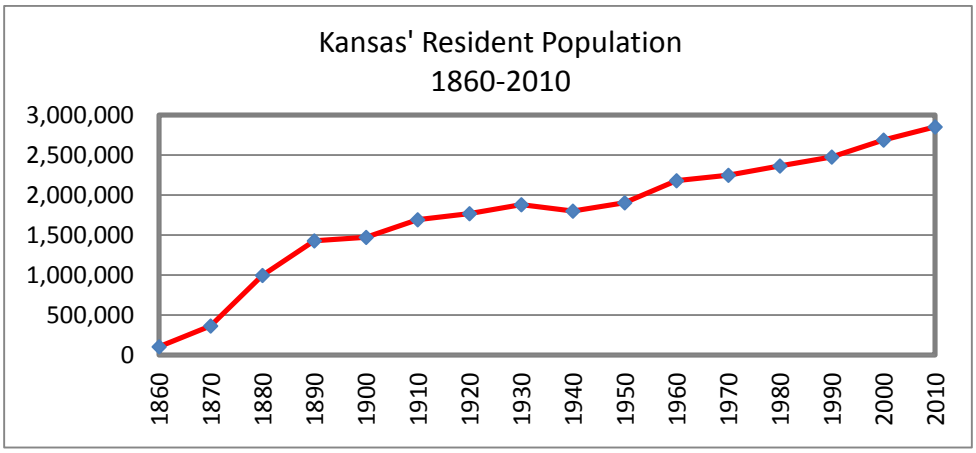
Elementary Statistics Assessment Items

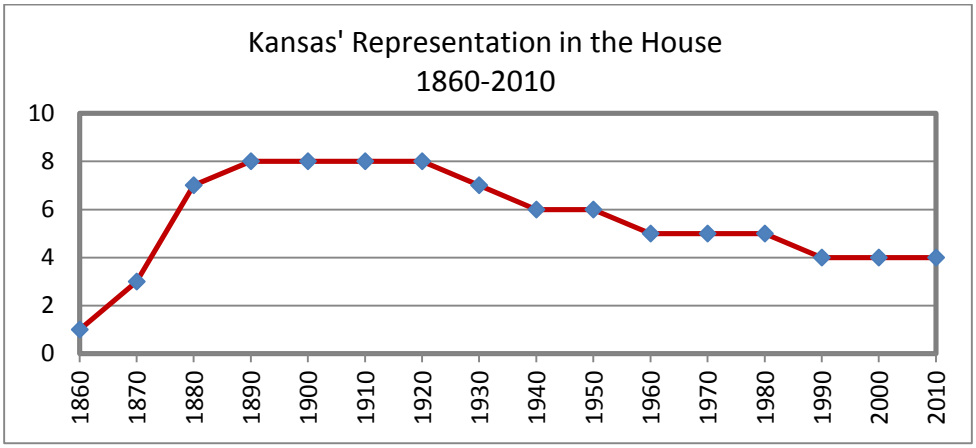
1. A student scored 65 on a calculus test that had a mean of 50 and a standard deviation of 10. She scored 30 on a history test with a mean of 25 and a standard deviation of 3. In which class did she have a relatively higher score? Support your answer.

2. In a recent study of 35 ninth-grade students, the mean number of hours per week that they played video games was 14.2. The population standard deviation is 1.8. Find the 98% confidence interval of the mean of the time playing video games.

3. A sample of Chocolate Chip cookies is taken to test the claim that each cookie contains at least 9 chocolate chips. Since a lot of chips is a good thing, we want to know if the company is being accurate in its advertising. Is this a one-tailed or 2-tailed hypothesis test? Support your answer.

4. The U. S. Constitution stipulates that the House of Representatives must be apportioned among the states proportionally and the apportionment is based on a national census which is to be conducted every ten years. This is to guarantee that each state gets its fair share in the House in the sense that the number of representatives from each state is proportional to the population in that state. The following two time series graphs show respectively Kansas' population and the number of representatives in the House from 1860 to 2010.





a) What is the approximate population of Kansas in year 2000 based on the first graph above?

How many representatives does Kansas have in 2000 based on the second graph?

b) For a comparison, California has 53 representatives in the House in 2000. Use this information and part a) to estimate California's population in 2000.

c) Since 1912, the size of the House has been fixed at 435. Notice that Kansas' representation in the House has been decreasing since 1920, while its population has been generally increasing. How can this happen? Explain.

Appendix D

QR Assessment Items

Quantitative Reasoning Exam #1 Name_____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

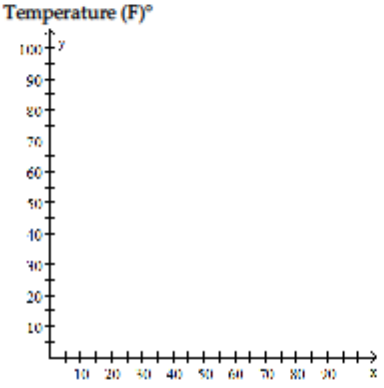
Foreach problem 1–4 analyze the situation. Clearly explain your answer to the question and support your decision with the quantitative reasoning that you used to reach your conclusion. LEAVE ALL YOUR WORK.

1) You want a new car but plan to use it for only 2 years. The cost of leasing is $2,000 down and $300 per month. The cost of buying is $20,000, and you can expect to sell it in two years for approximately $12,000. Which is the better option for you and why?

2) The one–day temperatures for 12 world cities along with their latitudes are shown in the table below.
a) **Make a scatterplot for the data**

City	Temperature (F)	Latitude
Oslo, Norway	30°	59°
Seattle, WA	57°	47°
Anchorage, AK	40°	61°
Paris, France	61°	48°
Vancouver, Canada	54°	49°
London, England	48°	51°
Tokyo, Japan	55°	35°
Cairo, Egypt	82°	30°
Mexico City, Mexico	84°	19°
Miami, FL	81°	25°
New Delhi, India	95°	28°
Manila, Philippines	93°	14°

Temperature (F)°



Latitude (degrees)

b) Describe the correlation between Latitude and Temperature shown by your scatterplot. If there is a correlation, indicate whether it is strong or weak and positive or negative.

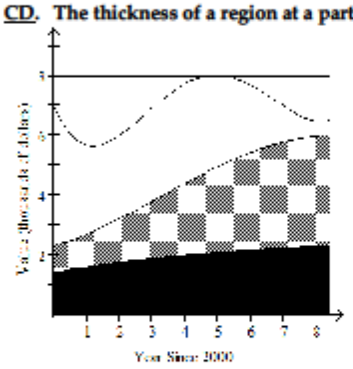
3) Your brother bought some property and wants raise to cattle. He has an 800 ft. x 1200 ft. rectangular area that is fenced for the cattle. According to the recommendations from his county extension office he can keep 2 cows per 1.5 acres.

How many acres is the rectangular fenced area for cattle? **(1 square yard = 9 square ft. and 1 acre = 4840 square yards)**

If he follows the recommendations from the county how many cows should he buy to start his buisness on this land?

3

The stack plot below shows the value of each of your investments. The stack plot contains three regions. The uppermost unshaded region represents the value of your investment in individual stocks. The center shaded region represents the value of your investment in mutual funds and the bottom region in black represents the value of your investment in a CD. The thickness of a region at a particular time tells you its value at that time.



4) What was the **total** initial investment?

How much of that investment was put in:

individual stocks **mutual funds** **CD**

What was the **total** value of the investments at the end of the 8 year period?

At the end of the 8 year period what is the value of each:

individual stocks **mutual funds** **CD**

Describe the performance of each of the 3 types of investments during the span of the 8 years. Explain and be specific.