Analysis and Use of Evidence of Student Learning
General Education and Teacher Preparation Courses
2013-14 Academic Year

The Department of Mathematical, Information and Computer Sciences teaches the General Education mathematics requirement for the entire university. To meet the requirement students have three options:

- MTH144 Calculus with Applications
- MTH164 Calculus I
- MTH303 Problem Solving

The department developed a set of common learning outcomes that are expressed differently in each of the three classes. Early in the data set, there was not consistency across sections and across semesters in the problems being used to measure the outcomes. This can be seen in the data. Over the last three years the department has developed a set of standard questions that are being incorporated into the final exams for each section of each course each semester.

In addition, the department has gathered attitudinal data about MTH303 Problem Solving for many years.

A random sample of student worked is selected and then scored using a rubric with two-reader agreement.

The department also teaches two courses for prospective elementary school teachers MTH213 Fundamentals of Elementary Mathematics I and MTH223 Fundamentals of Elementary Mathematics II. The department developed learning outcomes for these courses that align with the State of California Standards as well as the learning outcomes for the Liberal Studies program. Because of the portfolio system used by the PLNU School of Education the rubric is applied to the work of all students in MTH213 and MTH223.

The data for each assessment is interleaved with commentary.

MICS GE Learning Data
30-May-14

		Students will be able to formulate a mathematical model from a verbal description of a problem.	Students will be able it solve non-routine problems using logic and quantitative techniques.	Students will be able to construct solutions to problems using computational techniques.
MTH144	Spring 2010	3.27	3.17	3.37
MTH144	Spring 2011	2.05	1.88	3.10
MTH144	Summer 2011	3.67	2.83	3.50
MTH144	Spring 2012	1.79	2.77	3.46
MTH144	Spring 2013	3.68	2.66	3.24
MTH144	Spring 2014	2.19	2.80	3.93
MTH164	Fall 2009	2.92	2.85	1.62
MTH164	Fall 2010	2.48	2.52	1.24
MTH164	Fall 2011	1.30	2.93	3.02
MTH164	Fall 2012	3.50	3.28	3.80
MTH164	Fall 2013	3.35	2.80	3.68
MTH303	Fall 2007	2.19	3.14	2.22
MTH303	Spring 2008	3.32	2.82	3.42
MTH303	Fall 2008	3.63	3.30	3.50
MTH303	Spring 2009	3.37	3.07	2.93
MTH303	Fall 2009	2.78	2.78	3.22
MTH303	Spring 2010	3.16	3.26	3.61
MTH303	Fall 2010	3.28	2.73	3.55
MTH303	Spring 2011	2.66	2.79	2.96
MTH303	Fall 2011	3.02	3.23	3.25
MTH303	Spring 2012	2.69	2.95	2.71
MTH303	Fall 2012	3.22	2.70	2.48
MTH303	Spring 2013	3.54	2.89	2.74
MTH303	Fall 2013	2.95	2.97	2.93
MTH303	Spring 2014	2.85	2.65	2.83

Scale Used:

0 Unsatisfactory - Completely Incorrect
1 Low Satisfactory - Missed more than one key concept or step
2 Satisfactory - Missed one key concept or step
3 High Satisfactory - Made a minor error
4 Outstanding - Completely correct

Criteria for Success: **Average sample score of 2.5 or higher for each problem**

Comments:

The question that we have been using to assess #1 for MTH144 and MTH164 has varried over time. It has produced inconsistent results. In 2012 we changed this question to an interest problem which more closely matches one of the questions in the MTH303 assessment for #1.
Some sections of MTH303 were hybrid in the Spring of 2014.

Problem Solving Attidudinal Survey

	Fall 2006			Spring 2007			Fall 2007			Spring 2008			Fall 2008			Spring 2009			Fall 2009			Spring 2010		
	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree
In this class, we have been directly involved in problem solving activities.	97%	3%	0%	98%	2%	0%	95%	3%	2%	99%	1%	0%	95%	3%	2%	99%	1%	0%	96%	4%	0%	97%	2%	1%
This class has contributed to my ability to solve different types of problems.	82%	13%	5%	82%	14%	4%	82%	11%	7%	93%	7%	1%	86%	11%	3%	93%	7%	1%	86%	9%	5%	82%	12%	6%
This class has expanded my methods of exploration in problem solving.	82%	12%	6%	80%	14%	6%	76%	16%	7%	89%	9%	2%	81%	15%	4%	89%	9%	2%	82%	10%	8%	76%	20%	4%
This class has contributed to my ability to make educated guesses and check their correctness by analyzing their implications.	75%	20%	6%	80%	16%	4%	75%	21%	4%	82%	15%	3%	76%	21%	3%	82%	15%	3%	78%	14%	7%	71%	23%	6%
This class has helped me to understand major concepts, methods and applications of critical thinking.	76%	17%	7%	79%	18%	3%	81%	14%	5%	86%	11%	3%	84%	12%	4%	86%	11%	3%	78%	16%	7%	68%	23%	9%
This class has helped me to see the importance of problem solving in our modern society.	79%	13%	8%	79%	17%	4%	85%	10%	5%	86%	10%	3%	79%	15%	6%	86%	10%	3%	82%	9%	9%	81%	12%	6%

	Fall 2010			Spring 2011			Fall 2011			Spring 2012			Fall 2012			Spring 2013			Fall 2013			Spring 2014 - Face to Face			Spring 2014 - Hybrid		
	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree	Agree/ Strongly Agree	Neutral	Disagree/ Strongly Disagree
In this class, we have been directly involved in problem solving activities.	91%	5%	4%	98%	2%	1%	90%	5%	5%	87%	6%	7%	93%	6%	1%	97%	2%	1%	96%	3%	1%	92%	6%	2%	83%	7%	10%
This class has contributed to my ability to solve different types of problems.	71%	18%	11%	77%	16%	7%	69%	21%	11%	71%	12%	17%	79%	13%	8%	87%	7%	6%	85%	9%	6%	71%	23%	6%	63%	17%	20%
This class has expanded my methods of exploration in problem solving.	76%	13%	11%	74%	20%	7%	68%	21%	11%	69%	14%	17%	77%	16%	7%	83%	11%	6%	82%	10%	8%	71%	20%	9%	62%	18%	20%
This class has contributed to my ability to make educated guesses and check their correctness by analyzing their implications.	65%	21%	13%	70%	20%	10%	63%	25%	12%	67%	21%	13%	66%	25%	9%	77%	17%	6%	69%	22%	9%	60%	31%	9%	59%	28%	14%
This class has helped me to understand major concepts, methods and applications of critical thinking.	67%	23%	10%	75%	15%	10%	68%	20%	12%	65%	17%	18%	74%	18%	8%	79%	17%	4%	77%	15%	8%	71%	20%	9%	59%	24%	17%
This class has helped me to see the importance of problem solving in our modern society.	71%	17%	12%	80%	11%	9%	63%	21%	16%	68%	15%	17%	77%	15%	9%	82%	11%	6%	73%	17%	10%	69%	21%	10%	63%	19%	18%

Longitudinal Agree/Strongly Agree

	Fall 06	Spring 07	Fall 07	Spring 08	Fall 08	Spring 09	Fall 09	Spring 10	Fall 10	Spring 11	Fall 11	Spring 12	Fall 12	Spring 13	Fall 13	Spring 14 - F2F	Spring 14 - Hybrid
In this class, we have been directly involved in problem solving activities.	97%	98%	95%	99%	95%	99%	96%	97%	91%	98%	90%	87%	93%	97%	96%	92%	83%
This class has contributed to my ability to solve different types of problems.	82%	82%	82%	93%	86%	93%	86%	82%	71%	77%	69%	71%	79%	87%	85%	71%	63%
This class has expanded my methods of exploration in problem solving.	82%	80%	76%	89%	81%	89%	82%	76%	76%	74%	68%	69%	77%	83%	82%	71%	62%
This class has contributed to my ability to make educated guesses and check their correctness by analyzing their implications.	75%	80%	75%	82%	76%	82%	78%	71%	65%	70%	63%	67%	66%	77%	69%	60%	59%
This class has helped me to understand major concepts, methods and applications of critical thinking.	76%	79%	81%	86%	84%	86%	78%	68%	67%	75%	68%	65%	74%	79%	77%	71%	59%
This class has helped me to see the importance of problem solving in our modern society.	79%	79%	85%	86%	79%	86%	82%	81%	71%	80%	63%	68%	77%	82%	73%	69%	63%

Analysis of Face to Face vs. Hybrid Spring 2014

	Face to Face - Average	Hybrid - Average
Approximately how many hours per week did you spend **reading material in the textbook**?	1.41	
Approximately how many hours per week did you spend outside of class doing the **online reading**?		1.34
Approximately how many hours per week did you spend outside of class doing the **online quizzes**?		1.49
Approximately how many hours per week did you spend working on the **online practice problems**?		2.26
Approximately how many hours per week did you spend on the **written homework**?	1.95	1.44

	Face to Face - Agree or Strongly Agree	Hybrid - Agree or Strongly Agree
I found the **reading** helpful in learning course material.	66%	
I found the online **reading** helpful in learning course material.		58%
I found the online **quizzes** helpful in learning course material.		58%
I found the **online practice problems** helpful in learning course material.		78%
I found the **written homework problems** helpful in learning course material.	91%	69%
I found the **in-class activities** helpful in learning course material.	94%	81%
How did you typically work on course material? One long session	69%	78%
How did you typically work on course material? Several short sessions.	31%	22%
The course technology was easy to use.		73%
Prior to taking this course, I wanted to take a hybrid/blended course.		32%
After taking this course, I would like to take another hybrid/blended course.		56%
The blended/hybrid format contributed to my ability to learn.		48%
For this course, the blended/hybrid format is preferable to traditional lecture.		54%

	Face to Face - Agree or Strongly Agree	Hybrid - Agree or Strongly Agree
In this class, we have been directly involved in problem solving activities.	92%	83%
This class has contributed to my ability to solve different types of problems.	71%	63%
This class has expanded my methods of exploration in problem solving.	71%	62%
This class has contributed to my ability to make educated guesses and check their correctness by analyzing their implications.	60%	59%
This class has helped me to understand major concepts, methods and applications of critical thinking.	71%	59%
This class has helped me to see the importance of problem solving in our modern society.	69%	63%

MTH303	Face to Face	Hybrid
Students will be able to formulate a mathematical model from a verbal description of a problem.	2.81	2.90
Students will be able it solve non-routine problems using logic and quantitative techniques.	2.59	2.73
Students will be able to construct solutions to problems using computational techniques.	2.78	2.90

GE Learning Outcomes Commentary

GE Learning Data:
Some of the variability in the data is based on the fact that initially there was some variability in the problems used to assess learning outcomes. This variability is most evident in the two calculus classes (MTH144 and MTH164).

In the last three years the department has been developing and testing a consistent set of questions to use to assess the learning outcomes. The questions were modified again in May of 2012 after completing the assessment on all the data from the 2011-12 academic year. We believe that we have a solid set of questions that will accurately assess student learning in the three key areas.

Over the last four years, the department has placed a greater emphasis on financial literacy in all of its GE courses and starting in the fall of 2012, outcome #1 was assessed using a financial literacy question in all GE mathematics courses.

We continue to make content and pedagogical shifts based on what is seen from both the GE learning data and the MTH303 attitudinal data. One of those shifts has been to increase the training in and use of Excel to solve problems in all classes.

MTH303 Attitudinal Data:
Looking at the attitudinal data it is clear that students affirm that the class is engaging them in solving problems.

In 2011-12 we tightened some of the requirements in the problem solving class. This includes asking all students to complete a budget for their first year after graduation (students in MTH303 are juniors and seniors). This change increased some of the work in the course including more detailed computations an expectation that each student would research their student loan and credit card debt. It appears that as the result of those increased expectations, there was a short-term decline in attitudinal scores in 2011-12, however in 2012-13 the scores returned to historical norms.

It is worth noting that in Spring of 2014 we experimented with conducting MTH303 in a hybrid format. This change had some negative impact on students attitudinal ratings, but it appears to have a positive impact on the learning outcomes for the students in the hybrid sections.

Based on the learning data scores, this spring's group of students was weaker than some we have seen in the past and that may be linked with the lower scores in the attitudinal survey.

Longitudinal Cross-Disciplinary Studies Scores
30-May-14

MTH213

	Students will be able to demonstrate a facility with operations on the integers (1b, 1c).	Students will be able to demonstrate a facility with operations on the rational numbers (1b, 1c).	Students will be able to apply concepts from number theory to solve problems (1a, 1b, 1c).
Fall 2008	3.40	2.96	3.16
Fall 2009	3.96	3.67	3.00
Fall 2010	3.78	4.00	3.66
Fall 2011	3.07	3.61	2.70
Fall 2012	3.28	3.72	2.93
Fall 2013	3.29	3.44	3.47

MTH223

	Students will be able to construct geometric figures using a compass and straight edge (1b, 1c).	Students will be able to select and use the appropriate units for computing length, area and volume (1b, 1c).	Students will be able to distinguish between the appropriate uses of probability and statistics to solve problems (1a, 1b, 1c).
Spring 2009	4.00	3.11	3.78
Spring 2010	2.32	3.25	3.86
Spring 2011	3.29	3.03	1.81
Srping 2012	2.78	2.50	2.30
Spring 2013	3.70	3.03	1.80
Spring 2014	3.39	2.78	3.58

Note the problem in 2010 was not a construction but a description

Scale Used:

0 Unsatisfactory - Completely Incorrect
1 Low Satisfactory - Missed more than one key concept or step
2 Satisfactory - Missed one key concept or step
3 High Satisfactory - Made a minor error
4 Outstanding - Completely correct

Criteria for Success: **Average class score of 2.5 or higher for each problem**

Comments:
Students appear to need some additional instruction in the are of probability and statistics.

Liberal Studies Data Commentary

This data was built over time from a set of variable questions. The department has been working on refining a consistent set of questions to ask students. We believe that we now have a workable set of questions.

Reviewing the data, it is clear that the students need additional learning in probability and statistics.

We will pilot MTH213 as a hybrid in the Fall of 2014 and MTH223 as a hybrid in the Spring of 2015. The intention is to create a structure where weaker students can spend more time developing their skills through online exercises and content. We hope that this change will improve scores in the area of probability and statistics because students will spend more time studying and practicing the material in the online portion of the course.