CNM ANNUAL STUDENT LEARNING ASSESSMENT REPORT

Due to the Student Academic Assessment Committee by October 15

Central New Mexico Community College

PART 1: REPORT INFORMATION

Report Year and Contact Information			
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Subject of this Report
MSE--MATH_AS--Mathematics Degree

PART 2: CONTEXT IN WHICH THE ASSESSMENT TOOK PLACE

Program/Area Highlights and Successes (Wherever applicable, include course completion rates, job placement outcomes, and licensing examination pass rates. See the program information dashboard at https://livecnm.sharepoint.com/sites/Dashboards/SitePages/Program%20Information%20Dashboard.aspx (access restricted to CNM employees) and other reports at https://www.cnm.edu/depts/opie.)

Our students performed very well in two of the four assessed graduate learning outcomes. MATH 1710 – Calculus I students had mean rubric scores exceeding the benchmark in nearly all of the assessment tools for program-level SLO#1 (for a second consecutive year) and all of the tools for program-level SLO#4.

MATH 1715 – Calculus II students exhibited improvement in program-level SLO#2 compared to last year, potentially due to pedagogical discussions during the formulation of assessment tools for AY2017/18. While the cause is not entirely clear, the department saw a transition from all of the mean rubric scores failing to meet the benchmark in AY2016/17 to solidly making four out of six of them during AY2017/18.

Program-Level SLO#3, assessed within MATH 2710 – Calculus III, yielded mixed results. While AY2016/17 possessed outstanding student performance as all six mean rubric scores exceeded the benchmark, during AY2017/18 only four of the six mean rubric scores met the benchmark. The skill with poor performance across both the fall and spring semesters centered on integrating vector functions.

Changes Implemented During the Past Year in Support of Student Learning
Increased involvement of faculty in formulating assessment questions yielded a solid consensus on what we intended to regard -- and so measure -- as important in MATH 1715 – Calculus II. The spirited discussion and development of the assessment tools for AY2017/18 with their focus on evaluation of series likely put all faculty on the same page regarding the importance of the topic, which then (at least in part) lead to improved student performance.

PART 3: REPORT ON ASSESSMENT OF STUDENT LEARNING

Assessment Method	Type of Assessment Tool	Population or Course(s) Assessed	Graduate Learning Outcome(s) Assessed	Mastery Level (E.g., "Minimum score of 3 on a rubric scaled 0-4" or "Minimum score of 75%")	Targeted % Achieving Mastery	Outcome
Standard Test Questions	Direct & Internal	MATH 1710	Demonstrate competency in the core concepts of single-variable, differential calculus which includes limits, continuity, differentiation, and optimization.	Mean Rubric Score of at least 2.00 on a scale 0-3	N/A	Target met
Standard Test Questions	Direct & Internal	MATH 1715	Demonstrate competency in the core concepts of single-variable integral calculus which includes various integration techniques, separable differential equations, and series.	Mean Rubric Score of at least 2.00 on a scale 0-3	N/A	Target partially met
Standard Test Questions	Direct & Internal	MATH 2710	Demonstrate competency in the core concepts of multivariable and vector calculus which includes level curves and surfaces, partial derivatives, gradients, tangent planes, directional derivatives, multiple integrals, and cylindrical and spherical coordinates.	Mean Rubric Score of at least 2.00 on a scale 0-3	N/A	Target partially met

Standard Test Questions	Direct & Internal	MATH 1710	Construct mathematical strategies using calculus techniques to solve applied problems from a variety of disciplines utilizing appropriate terminology and symbols.	Mean Rubric Score of at least 2.00 on a scale 0-3	N/A	Target met

Summary of Assessment Findings

Program-Level SLO#1 – MATH 1710 Calculus I – Common Final

Academic year 2017/18 was the second and final year of implementing a common final within MATH 1710 Calculus I for the assessment of Program-Level SLO#1. With 21 exam questions comprising the common final assessment tool, in the interest of brevity for the assessment report only the mean rubric scores are reported (see Table 1 in the "Analysis and Interpretation of Assessment Findings" section of this report.) The common final itself is archived for reference for the math department and for other interested parties. Student performance was for a second year in a row strong across an overwhelming majority of the common final questions providing evidence that students are strong in Program-Level SLO#1.

Program-Level SLO#2 – MATH 1715 Calculus II – Standard Test Question 1

1. Find the arc length for the curve below from *y = 2* to *y = 3*.

$$x = \frac{y^3}{6} + \frac{1}{2y}$$

Numerical Assessment Problem #1	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	$3\frac{1}{4}$

MATH 1715 Fall and Spring mean rubric scores were 2.44 and 2.40, respectively.

Program-Level SLO#2 – MATH 1715 Calculus II – Standard Test Question 2

2. Determine whether the series is convergent or divergent. If it is convergent, find its sum.

$$\sum_{n=1}^{\infty}\left[\frac{1}{e^n}+\frac{1}{n(n+1)}\right]$$

Numerical Assessment Problem #2	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	Convergent, $\frac{e}{e-1}$

MATH 1715 Fall and Spring mean rubric scores were 2.04 and 1.74, respectively.

Program-Level SLO#2 – MATH 1715 Calculus II – Standard Test Question 3

3. Determine the Maclaurin series for the function *f(x)* below.

$f(x) = x\cos 2x$

Numerical Assessment Problem #3	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or	Mathematical attempt with minor conceptual or	$\sum_{k=0}^{\infty}\frac{(-4)^k x^{2k+1}}{(2k)!}$

		calculational error	calculational error	

MATH 1715 Fall and Spring mean rubric scores were 2.26 and 1.96, respectively.

Program-Level SLO#3 – MATH 2710 Calculus III – Standard Test Question 1

1. Find $\boldsymbol{u} \cdot \boldsymbol{v}$.

   $\boldsymbol{u} = 3\boldsymbol{i} + 2\boldsymbol{j} - \boldsymbol{k}$

   $\boldsymbol{v} = 4\boldsymbol{i} + 5\boldsymbol{k}$

Numerical Assessment Problem #1	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	7

MATH 2710 Fall and Spring mean rubric scores were 2.60 and 2.59, respectively.

Program-Level SLO#3 – MATH 2710 Calculus III – Standard Test Question 2

2. Evaluate the integral.

$$\int_0^{\pi/4} (\sec t \tan t\, \boldsymbol{i} + t \cos 2t\, \boldsymbol{j} + \sin^2 2t \cos 2t\, \boldsymbol{k})dt$$

Numerical Assessment Problem #2	**0**	**1**	**2**	**3**
Answer	Not answered or non-	Mathematical attempt but major	Mathematical attempt with minor	$(\sqrt{2}-1)\boldsymbol{i} + \left(\frac{\pi}{8} - \frac{1}{4}\right)\boldsymbol{j} + \frac{1}{6}\boldsymbol{k}$

	mathematical 'attempt'	conceptual or calculational error	conceptual or calculational error	

MATH 2710 Fall and Spring mean rubric scores were 1.40 and 1.09, respectively.

Program-Level SLO#3 – MATH 2710 Calculus III – Standard Test Question 3

3. Find the gradient of f.
   $f(x, y, z) = y^2 e^{xyz}$

Numerical Assessment Problem #3	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	$\nabla f(x, y, z) = see\ below$

$$\nabla f(x, y, z) = < y^3 z e^{xyz}, 2y e^{xyz} + xy^2 z e^{xyz}, xy^3 e^{xyz} >$$

MATH 2710 Fall and Spring mean rubric scores were 2.00 and 2.23, respectively.

Program-Level SLO#4 – MATH 1710 Calculus I – Standard Test Question 1

1. A cardboard box with a square base and open top must have a volume of 32000 cm^3.
   a. Find the dimensions of the box that minimize the amount of material used.

Numerical Assessment Problem #1a	**0**	**1**	**2**	**3**
Answer	Not answered or non-	Mathematical attempt but major	Mathematical attempt with minor	40cm x 40cm x 20cm

	mathematical 'attempt'	conceptual or calculational error	conceptual or calculational error	

MATH 1710 Fall and Spring mean rubric scores were 2.26 and 2.19, respectively.

b. What is the minimal amount of material used?

Numerical Assessment Problem #1a	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	4800 cm^2

MATH 1710 Fall and Spring mean rubric scores were 2.21 and 2.03, respectively.

Program-Level SLO#4 – MATH 1710 Calculus I – Standard Test Question 2

2. Water flows from the bottom of a storage tank at a rate of *r(t)* liters per minute where *r(t)* is given below and $0 \le t \le 50$. Find the amount of water that flows from the tank during the first 10 minutes.

$$r(t) = 200 - 4t$$

Numerical Assessment Problem #2	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or	Mathematical attempt with minor conceptual or	1800 liters

		calculational error	calculational error	

MATH 1710 Fall and Spring mean rubric scores were 2.55 and 2.34, respectively.

Program-Level SLO#4 – MATH 1710 Calculus I – Standard Test Question 3

3. The position of a body moving in a straight line is given by *s(t)* below, where *s* is in meters and *t* is in seconds. Find the acceleration of the body at t = π/3 seconds.

$$s(t) = -2t^3 + \frac{1}{3}t^2 + \cos t$$

Numerical Assessment Problem #2	**0**	**1**	**2**	**3**
Answer	Not answered or non-mathematical 'attempt'	Mathematical attempt but major conceptual or calculational error	Mathematical attempt with minor conceptual or calculational error	(-4π + 1/6) m/s^2 or about -12.40 m/s^2

MATH 1710 Fall and Spring mean rubric scores were 2.55 and 2.75, respectively.

Interpretation of Assessment Findings

During AY2017/18, 158 students were assessed in MATH 1710 Calculus I with 91 and 67 students in the Fall and Spring semesters, respectively. All of the students were assessed without the use of notes of any kind, with the use of a calculator, and during the common final exam (AY 2017/18 was the second and final year of implementing a common final.) With few exceptions mean rubric scores exceeded the 2.00 benchmark, highly suggestive of strong student performance on Program-Level SLO#1. As with the preceding year, the presence of so many high mean rubric scores may be due to the common final not testing at a high enough level of difficulty. Nonetheless, not all mean rubric scores met the benchmark. Table 1 below summarizes the results.

Table 1. MATH 1710 Calculus I mean rubric scores of assessment questions AY2017/18.

Program-Level SLO#1: Demonstrate competency in the core concepts of single-variable, differential calculus which includes limits, continuity, differentiation, and optimization.

Fall Spring

	n=91	n=67
Q1a	2.84	2.60
Q1b	2.62	2.40
Q1c	1.95	1.70
Q1d	2.65	2.63
Q1e	2.26	2.21
Q2a	2.35	2.24
Q2b	2.48	2.33
Q2c	2.11	1.78
Q3	2.30	2.03
Q4	2.48	2.34
Q5	2.37	2.04
Q6.1	2.26	2.19
Q6.2	2.21	2.03
Q7	2.55	2.34
Q8	2.55	2.75
Q9	2.32	2.19
Q10a	2.49	1.90
Q10b	2.73	2.72
Q10c	2.52	1.54
Q10d	2.42	1.21
Q10e	2.36	1.73

During AY2017/18, 107 students were assessed in MATH 1715 Calculus II with 50 and 57 students in the Fall and Spring semesters, respectively. All of the students were assessed without the use of notes of any kind, with the use of a calculator, and during the final exam. Last year appears to have been an anomaly where all mean rubric scores failed to meet the benchmark of 2.00, as AY2017/18 mean rubric scores exceeded the benchmark four out of six times (and a mean 1.96 narrowly missing the benchmark.) Of course, Program-Level SLO#2 is large enough in scope for students to exhibit weakness in some competencies while strength in others. Table 2 below summarizes the results.

Table 2. MATH 1715 Calculus II mean rubric scores of assessment questions AY2017/18.

Program-Level SLO#2: Demonstrate competency in the core concepts of single-variable integral calculus which includes various integration techniques, separable differential equations, and series.

	Fall	Spring
	n=50	n=57
Q1	2.44	2.40
Q2	2.04	1.74
Q3	2.26	1.96

AY2017/18 was the second consecutive year of assessing MATH 2710 Calculus III. Seventy-nine students were assessed with 57 and 22 students in the Fall and Spring semesters, respectively. All of the students were assessed without the use of notes of any kind, with the use of a calculator, and during the final exam. Per the observed mean rubric scores, students exhibited adequate to strong performance on standard test questions 1 and 3, but performed poorly on standard test question 2, suggesting that students may have difficulty integrating vector functions. These results contrasted somewhat with AY2016/17 during which all mean rubric scores exceeded the benchmark of 2.00. Table 3 below summarizes the results for AY2017/18.

Table 3. MATH 2710 Calculus III mean rubric scores of assessment questions AY2016/17.

Program-Level SLO#3: Demonstrate competency in the core concepts of multivariable and vector calculus which includes level curves and surfaces, partial derivatives, gradients, tangent planes, directional derivatives, multiple integrals, and cylindrical and spherical coordinates

	Fall	Spring
	n=57	n=22
Q1	2.60	2.59
Q2	1.40	1.09
Q3	2.00	2.23

AY2017/18 was the first year of assessing Program-Level SLO#4. The same 158 students taking the common final for MATH 1710 Calculus I were assessed for Program-Level SLO#4 using three embedded questions within the common final. All mean rubric scores exceeded the benchmark indicating strong performance on Program-Level SLO#4. Table 4 below summarizes the results for AY2017/18.

Table 4. MATH 1710 Calculus I mean rubric scores of assessment questions AY2017/18 associated with Program-Level SLO#4.

Program-Level SLO#4: Construct mathematical strategies using calculus techniques to solve applied problems from a variety of disciplines utilizing appropriate terminology and symbols.

	Fall	Spring
	n=91	n=67

	Q1a (Q6.1 com. final)	2.26	2.19
	Q1b (Q6.2 com. final)	2.21	2.03
	Q2 (Q7 com. final)	2.55	2.34
	Q3 (Q8 com. final)	2.55	2.75

Action Plan in Support of Student Learning (Describe changes to be made that are based at least in part on the assessment interpretation. If the assessment did not yield useful information, describe changes to be made in the assessment methodology and/or criteria.)

Students exhibited strong performance for the second year in a row on Program-Level SLO#1. However, in part due to the sense that the common final was perhaps insufficiently challenging, a return to targeted Program-Level SLO#1 questions will be implemented next cycle plan. Performance on Program-Level SLO#1 will continue to be monitored for consistency across academic years.

Program-Level SLO#2 exhibited improved performance relative to last academic year, but with a potentially remaining need to improve students' ability to evaluate convergent series, which failed to meet the benchmark for the Spring semester only.

Mixed results were observed regarding student performance on Program-Level SLO#3. Standard test questions 1 and 3 suggested strong performance while standard test question 2 suggested weak performance. No pedagogical adjustments are currently planned, rather the assessment criteria will be refined during the next cycle plan.

Program-Level SLO#4, along with SLO#1, also exhibited strong performance with all mean rubric scores exceeding the benchmark. Nonetheless, due to the abandonment of the common final for MATH 1710 the assessment criteria will need to be revised.

Please select all of the following that characterize the types of changes described in the above action plan:

- ☒ Assessment criteria revision
- ☐ Assessment methodology revision
- ☐ Assignment revision
- ☐ Budgetary reallocation
- ☐ Change in teaching approach
- ☐ Course content revision
- ☐ Curricular Revision
- ☐ Faculty training/development
- ☐ Process revision

Recommendations, Proposals, and/or Funding Requests	Budget Needed
None.	

PART 4: REMAINING YEARS IN CURRENT ASSESSMENT CYCLE PLAN (including any revisions) **– OR -- UPCOMING ASSESSMENT CYCLE PLAN** (if this was the final year)

Years of Full Cycle	**Next Year's Assessment Focus** (Describe how the next planned assessment is expected to provide information that can be used toward improving student learning.)
AY2018/19 through AY2023/24	The next six-year cycle plan continues to focus on the five graduate learning outcomes (GLOs) of the math degree. While there will be some overlap with assessed course-level student learning outcomes (SLOs) with the last assessment cycle plan, there will also be new as of yet never assessed course-level SLOs. These new SLOs will facilitate exploring new facets of the GLOs and ideally will help the math department discover new areas in need of increased student achievement as well as potentially provide confirmatory evidence of improvements in GLOs during the last cycle.

Graduate Learning Outcomes to Be Assessed	**Years in which Assessment Is Planned**	**Population/Courses to Be Assessed**	**Planned Assessment Approach**
1) Demonstrate competency in the core concepts of single-variable, differential calculus which includes limits, continuity, differentiation, and optimization.	AY2018/19	MATH 1710	Standard Test Questions
2) Demonstrate competency in the core concepts of single-variable integral calculus which includes various integration techniques, separable differential equations, and series.	AY2019/20	MATH 1715	Standard Test Questions
3) Demonstrate Competency in the core concepts of multivariable and vector calculus which includes level curves and surfaces, partial derivatives, gradients, tangent planes, directional derivatives, multiple integrals, and cylindrical and spherical coordinates.	AY2020/21 AY2023/24	MATH 2710	Standard Test Questions
4) Construct mathematical strategies using calculus techniques to solve applied problems from a variety of disciplines utilizing appropriate terminology and symbols.	AY2021/22	MATH 1710	Standard Test Questions
5) Develop proficiency in using various technological tools including graphing calculators and mathematical programming software (MATLAB).	AY2022/23	MATH 1715	Standard Test Questions