CALIFORNIA STATE UNIVERSITY EAST BAY
College of Science (CSCI)
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2015-2016 CSCI EETF Assessment Year End Report, June, 2016

Program Name(s)	EETF Faculty Rep	Department Chair
Mathematics BS	Kathy Hann	Julie Glass

A. Program Student Learning Outcomes

Students graduating with a Bachelor of Science in Mathematics will be able to:

1. Apply the definitions, techniques and theorems of abstract mathematics
2. Apply the definitions, techniques and theorems of applied mathematics
3. Apply mathematical algorithms to solve problems, both individually and in teams
4. Creatively conjecture and rigorously write, analyze and critique proofs
5. Communicate mathematics to others in written and/or oral form with precision, clarity and organization
6. Apply techniques of at least one area of mathematics in depth

Students taking Option B or C for the Bachelor in Mathematics receive focused emphasis on particular PLOs as follows:

- The Applied Mathematics Option emphasizes PLOs #2, 3 & 6 above.
- The Mathematics Teaching Option emphasizes #1, 2, & 5 above.

B. Program Student Learning Outcome(s) Assessed

SLO 1: Apply the definitions, techniques and theorems of abstract mathematics

SLO 3: Apply mathematical algorithms to solve problems, both individually and in teams

C. Summary of Assessment Process

For each course assessed, a final exam question was identified as a typical problem for the course that assessed the given SLO. Each problem was scored by the undergraduate committee for readability, validity and fluency using the rubric below. The results were organized and discussed by the undergraduate committee. The scoring rubrics are pasted below.

CSU East Bay Mathematics

AY 2015-16

SLO 1: Apply the definitions, techniques and theorems of abstract mathematics

SLO 1 RVF Rubric – Readability, Validity, Fluency

	Missing (0)	Emerging (1)	Developing (2)	Mastering (3)
Readability	Informal or non-mathematical language is used.	Some improper mathematical language or	Mostly proper mathematical language and	Proper mathematical language and

	There is misuse of notation/symbols.	notation is used.	notation is used.	notation is used.
Validity	Significantly inaccurate or irrelevant statements in definitions, techniques and/or theorems are present. Important information is missing.	Mostly accurate statements in definitions, techniques and/or theorems are present. May include some irrelevant or unjustified statements.	Statements in definitions, techniques and/or theorems are accurate and relevant.	Statements in definitions, techniques and/or theorems are accurate and relevant and connected/deduced correctly.
Fluency	No coherent flow of ideas Listing facts without a sense of how to link them to obtain or apply a valid definition, technique or proof of a theorem.	Partially coherent and organized, but inconsistent. Appeals to intuition. Some unjustified or improperly justified statements/ conclusions in definitions, techniques or proofs of theorems are present.	A correct and essentially complete definition, solution, or proof given. Logic and flow overall sound. Some small gaps in presentation may require "benefit of the doubt."	A correct and complete definition, solution, or proof given. Elegance or mathematical maturity present.

SLO 3: Apply mathematical algorithms to solve problems, both individually and in teams

SLO 3 RVF Rubric – Readability, Validity, Fluency

	Missing (0)	Emerging (1)	Developing (2)	Mastering (3)
Readability	Informal or non-mathematical language is used. There is misuse of notation/symbols.	Some improper mathematical language or notation is used.	Mostly proper mathematical language and notation is used.	Proper mathematical language and notation is used.
Validity	Significantly inaccurate or	Mostly accurate steps in algorithms	Steps in algorithms are	Steps in algorithms are

	irrelevant steps in algorithms are present. Important information is missing.	are present. May include some irrelevant or unjustified statements.	accurate and relevant.	accurate and relevant and connected/deduced correctly.
Fluency	No coherent flow of ideas Listing facts without a sense of how to link them to get a correct solution.	Partially coherent and organized, but inconsistent. Appeals to intuition. Some unjustified or improperly justified steps in algorithms are present.	A correct and essentially complete solution given. Logic, steps in algorithms, and flow overall sound. Some small gaps in solution may require "benefit of the doubt."	A correct, fully justified, and complete solution given. Elegance or mathematical maturity present.

D. Summary of Assessment Results

Courses Assessed:

MATH 3100, 3300, 3600, 3750, 3841

SLO's Assessed:

Upon completion of the Mathematics BS degree students will be able to:

SLO 1: Apply the definitions, techniques and theorems of abstract mathematics

SLO 3: Apply mathematical algorithms to solve problems, both individually and in teams

Math 3100 Linear Algebra, SLO 1/Mastered (8 Students)

Problem: Prove a set is a basis for a vector space.

	Missing	Emerging	Developing	Mastering
Readability	0%	25%	37.5%	37.5%
Validity	0%	25%	50%	25%
Fluency	0%	50%	25%	25%

These scores indicate 37.5% of the students have mastered the ability to write a readable proof using a basic definition, 25% mastered the ability to write a valid proof, and 25% of the students mastered the ability to write a proof with fluency.

Math 3300 Real Analysis I, SLO 1/Developed (16 students)

Problem: Establish topological property of the real numbers.

	Missing	Emerging	Developing	Mastering
Readability	0.00%	25.00%	56.25%	18.75%
Validity	0.00%	50.00%	12.50%	37.50%
Fluency	0.00%	37.50%	37.50%	25.00%

These scores indicate most of the students have developed or mastered the ability to write a readable proof of a topological property of the real numbers, half of the students have developed or mastered the ability to write a valid proof and 62.5% of the students have developed or mastered the ability to write a proof with fluency.

Math 3600 Number Theory, SLO 1/Mastered (12 students)

Problem: Use induction to prove a property of the Fibonacci numbers.

	Missing	Emerging	Developing	Mastering
Readability	0.00%	16.67%	16.67%	66.67%
Validity	0.00%	16.67%	58.33%	25.00%
Fluency	0.00%	33.33%	66.67%	0.00%

These scores indicate most of the students have mastered the ability to write a readable and valid proof using induction, 66% have developed and no students mastered the ability to write a proof with fluency using induction.

Math 3750 Numerical Analysis I, SLO 3/Mastered (21 students)

Problem: Apply an algorithmic technique to improving an approximating formula.

	Missing	Emerging	Developing	Mastering
Readability	14.29%	23.81%	9.52%	52.38%
Validity	28.57%	9.52%	19.05%	42.86%
Fluency	19.05%	23.81%	4.76%	52.38%

These scores indicate over 52% of the students have mastered the ability to write a readable solution using an algorithm to improve an approximating formula, more than 42% have

mastered the ability to write a valid solution, and more than 52% have mastered the ability to write a solution with fluency.

Math 3851 Linear Programming, SLO 3/Mastered (23 students)
Problem: Apply the Simplex Algorithm to find production level to minimize cost.

	Missing	Emerging	Developing	Mastering
Readability	0.00%	0.00%	26.09%	73.91%
Validity	0.00%	13.04%	43.48%	43.48%
Fluency	0.00%	4.35%	56.52%	39.13%

These scores indicate all of the students have developed or mastered the ability to write a readable solution using the Simplex Algorithm, more than 43% have mastered the ability to write a valid solution, and almost all have developed or mastered the ability to write a solution with fluency.

Closing the Loop:

This was our second attempt at using the RVF (readability-validity-fluency) rubrics to score authentic student work for attainment levels of PLOs. We learned/improved our process in the following ways:

a) developing a rubric to be used for a variety of courses forced/allowed us to examine common features of successful student work that is not exclusively looking for the right answer = "validity." Working with faculty across the department with different areas of expertise to identify and measure three features, readability, validity and fluency, which characterize quality and maturity in student work created opportunities for conversations about pedagogy and priority of outcomes for our students.
b) identifying appropriate problems for scoring takes some care as the dimensions of the rubric (readability, validity, flow) were not necessarily demonstrated and/or were too interdependent on some types of problems.
c) we will continue to refine the rubrics for greater ease of use and applicability.
d) we will consider sharing the rubrics with math students to further emphasize the importance of each dimension of successful student work.
e) we will consider how the different levels/scores via the rubrics may (or may not) align with I/D/M levels of attainment of PLOs. In particular, we know that not all students in a specific course are at the same point in their major. So, some students taking Math 3600, for example, might be doing so as their first advanced proof-based course while others might be completing their degree and have a higher level of maturity. We see this in the generally lower overall scores for "fluency" since this skill will likely be most developed for those students with experience in proof-

intensive courses. With the move to semesters, some of the courses currently aligned with mastery will align with developing knowledge attainment.

f) we will to continue to explore ways to support instructors unfamiliar with course content to score student work using the RVF rubric. This is needed as the rubric based scoring is most effective when faculty score student work from courses where they were not the instructor.

g) As a department, we will discuss ways to support students in mastering the ability to write proofs with fluency. We will establish more common norms in terms of the practice and expectations for attainment of this element of proof writing.