

STLF Report to CWSEI and Mathematics Department

STLF: Joseph Lo

Period: 2012-09-08 – 2012-10-08

Submitted: 2012-10-09

Specific activities performed by STLF

- 1) Professional development
 - Attended STLF meetings (Sept 12, 19, 26, Oct 3)
 - Attended the Math Education Research Seminar (Sept 28)
 - Presented in the Lunch Series in Teaching and Learning on “Using Clickers in a Math class” with Costanza (Oct 4)
- 2) Math SEI general meetings/activities
 - Met with Math-SEI group to review current projects and discuss future plans (Sept 12, 19, 26, Oct 3)
- 3) Course-specific meetings/activities

Math 200 – Calculus III

- I am responsible for developing graphical illustrations for certain topics in multivariable calculus, together with pre-reading materials and in-class activities. The graphs used in pre-reading materials and in class are posted in UBC Blog where students can give comments or post questions if needed.
- I will run a class survey after the midterm (probably Oct 18) to find out how students think about the graphical illustrations and supplementary materials.
- A diagnostic on first-year calculus materials was given on Sept 6 to measure students’ retention on calculus knowledge. Approximately 56% of the students have completed Calculus II in Spring 2012 and 13% in Spring 2011.

- Demographic:

- Total number of students written the diagnostic: 112
- Among those who finished Calc II in Spring 2012: 60
- Average grades:

| Fall 2011 | <i>N</i> | Average final grade | Spring 2012 | <i>N</i> | Average final grade |
|-----------|----------|---------------------|-------------|----------|---------------------|
| M100/180 | 22 | 69.5 | M101 | 25 | 75.6 |
| M102 | 18 | 74.4 | M103 | 19 | 78.3 |
| M104/184 | 20 | 81.4 | M105 | 25 | 81.4 |

- 7 questions. No students spent more than 20 minutes. They all handed in before class ended.

- Q1: Find the derivative of $x \cdot \exp(-x^2)$.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/almost correct | 52% | 43% |
| Incorrect | 37% | 53% |
| Blank | 12% | 3% |

- Common mistakes:
 - No product rule: 13%
 - No chain rule (incorrect derivative of $\exp(-x^2)$): 7%
 - Incorrect product rule: 6%

- Incorrect chain rule: 6%
- Q2: Find the anti-derivative of $x \cdot \exp(-x^2)$.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/almost correct | 33% | 27% |
| Incorrect | 42% | 43% |
| Blank | 25% | 30% |

- Common mistakes:
 - Unsuccessful attempt of integration by parts: 17%
 - Unsuccessful attempt of substitution: 6%

- Q3: Draw points and tangent lines on a graph. Find the slopes of a tangent line and a secant line.

| | Circle roots on the graph | | Find slope of tangent | | Find slope of secant | |
|------------------------|---------------------------|-------|-----------------------|-------|----------------------|-------|
| | Calc II in 2012 | Other | Calc II in 2012 | Other | Calc II in 2012 | Other |
| Correct/almost correct | 90% | 75% | 85% | 73% | 65% | 67% |
| Incorrect | 10% | 22% | 7% | 22% | 12% | 22% |
| Blank | 0% | 3% | 8% | 5% | 23% | 12% |

- Common mistakes:
 - Circled the points for which $f' = 0$ rather than $f = 0$: 6%
 - Did not take derivatives when finding slope of tangent: 5%

- Q4: Determine whether a series converges or not given that the terms converge to 0.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/partly correct | 12% | 12% |
| Incorrect | 42% | 57% |
| Blank | 47% | 32% |

- Common mistakes:
 - Correct conclusion but no explanation: 10%
 - Correct conclusion but wrong explanation: 7%
 - Wrong conclusion: 30%

- Q5: Given $f(x) = \sqrt{x}$, determine whether a linear approximation exists or not at $x = 0$.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/almost correct | 23% | 25% |
| Incorrect | 38% | 52% |
| Blank | 38% | 23% |

- Common mistakes:
 - Explanation unrelated to the question: 11%
 - $\sqrt{x}(0)$ is undefined: 4%

- Q6: Shade the correct region on the graph given two inequalities.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/almost correct | 22% | 17% |
| Incorrect | 57% | 72% |
| Blank | 22% | 12% |

- Mistakes not categorized yet.

- Q7: Draw the graph of a function with a given limit, a negative derivative and a positive second derivative.

| | Calc II in 2012 | Other |
|------------------------|-----------------|-------|
| Correct/almost correct | 38% | 25% |
| Incorrect | 47% | 55% |
| Blank | 15% | 20% |

- Common mistakes:
 - Irrelevant graph: 17%

- Incorrect concavity: 11%
- Incomplete graph (the graph is drawn on only one side of a given limit): 10%
- Observations
 - Students in general still remember how to draw tangent lines and relate the slope of tangent to derivatives. They are a bit weaker when finding slope of a line through two points.
 - On average, less than half of all students can apply product rule and chain rule properly. Less than 1/3 can integrate properly using simple substitution. Many of these students completed Calc II only 5 months ago and these are above-average students.
 - Students in general did not retain their knowledge in series. Only 12% of students can answer Q4 with a correct or a partly correct explanation. This raises the question on what we should expect students to learn during the 5-week series module in Calc II.
 - Students have poor understanding on linear approximation. Many students cannot relate linear approximation to derivatives.
 - Students in general do not know how to locate a region when defined by a set of inequalities. This concept is necessary for max/min problems and multiple integrals, but is not usually taught in university. Professors expect students to be able to figure out themselves.
 - Most students cannot draw an appropriate graph given a limit and the signs of the first and the second derivative. In general, students have more trouble dealing with second derivatives than first derivatives.

Math 221 – Matrix Algebra

- I am responsible for developing Webwork assignments for all sections of Math 221. One of the instructors decides the homework questions. Most of these questions are chosen from the public problem library. Some of them require modification. The remaining are created based on textbook problems.
- Most questions from the problem library do not treat vectors and matrices as vectors and matrices. Instead, each vector or matrix entry is defined separately. Answer boxes are shown in arrays and the answers in the boxes are taken as separate answers. This creates a few problems:

- If the answer is a vector or a matrix, the dimension of the vector or the matrix has to be given. For many problems though, we want students to determine the dimensions on their own.
- The answer checking procedure becomes tricky when dealing with an answer that does not have a unique form, for example spanning sets of vectors.
- When submitting answers, the answer preview boxes show the vector or matrix entries students have entered as a list rather than a vector or a matrix. This is difficult for students to match the answer boxes with the answer preview, especially when dealing with large matrices or multiple vectors/matrices.

I updated these questions to have vectors and matrices defined as vectors and matrices and rewritten some of the answer-checking procedures. Now we can have questions that require students to input vectors or matrices in a single answer box (so students need to determine the dimension themselves) rather than in an array of boxes. The vector basis checker is also rewritten.

- The numbers of retries are noticeably higher in some types of questions:

- Spanning space (linear dependence, solution space, kernels, column spaces, etc): These are very difficult concepts when learned the first time.
- True or false questions: Some of these questions are conceptual and are not trivial to answer. The instructor, however, wants to discourage trial-and-error by grouping 8 true-false statements into one question and requiring students to answer all correctly without providing hints. Many students have retried more than 50 times and still cannot get the correct answer.
- A survey on Webwork will be given to students during the week of Oct 8 or Oct 15. I hope to find out students' habits, their perceptions towards Webwork and potential difficulties/problems so improvements can be done in the second half of the term.

Mathematics Attitudes and Perceptions Survey (MAPS)

- A revised version is given to Math 100/180, 110, 200 and 253 students. We offer two prizes of \$50 gift card from the bookstore and would like to see if that can attract more responses. The survey will be closed on Oct 12.
- Warren, Sandi and I have finished another round of student validation on the survey. We have done a total of more than 20 interviews so far. Later in the term we will finalize the survey bases on these responses.

Current project status (material prepared by either STLTF or other members of the MATH SEI)

MATH 110:

Learning Goals: 3rd draft of learning goals is complete.

Assessments: MAPS/Study Habit survey and Post-diagnostic was completed

New Methods/Materials: New problem-solving based workshops, remedial work on basic skills

MATH 210:

Learning Goals: Revised after the course is over. A possible new version will be created with the input of the new instructor

Assessments: End-of-term survey was done.

New Methods/Materials: The MATLAB module is new. Redevelopment of course materials on Maple is complete.

MATH 305:

Learning Goals: Complete

Assessments: Final exam done.

New Methods/Materials: None at this point

MATH 200:

Learning Goals: None at this point

Assessments: A diagnostic on calculus materials is given on the first day.

New Methods/Materials: Pre-reading and supplementary online materials are being developed throughout the term.

MATH 221:

Learning Goals: None at this point

Assessments: None at this point.

New Methods/Materials: Webwork assignments will be developed throughout the term.

Plan for immediate future work

MATH 200:

1. Set up a survey about supplementary materials
2. Develop pre-reading materials/graphics for lectures

MATH 221:

1. Set up a survey about Webwork
2. Develop Webwork assignments

Infinite series diagnostic:

1. Code the diagnostic and provide results to the instructor

Mathematics Attitudes and Perception Survey:

1. Finalize the survey with Warren and Sandi