

## STLF Report to CWSEI and Mathematics Department

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Period: 09/09/12 – 06/10/12

Submitted: 06/10/12

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### Specific activities performed by STLF

#### 1) Professional development

- Attended the weekly CWSEI Reading group meetings.
- Attended the weekly STLF meetings.
- Participated in my first MetaSTLF meeting with STLF Brett Gilley (Sept 24).

#### 2) MATH SEI general meetings/activity

- Met with Director Costanza Piccolo and the MATH-SEI group to review the status of our projects (Sept 12, Sept 19, Sept 26, Oct 3).
- Attended the Math-SEI reading group meeting (Sept 28).
- Met with Sarah Gilbert and the MATH-SEI group (Sept 10) to review the status of our projects.

#### 3) Course-specific meetings/activities

### Tracking Proof Skills Project (MATH 220 – Mathematical Proof and subsequent courses)

1. The basic proof skills diagnostic test for MATH 220 was administered on Sept 5, but has not yet been scored. These will be compared with previous term results once this is done. Also, a group of instructors at Queen Mary University, London have administered the test to approx. 280 students and also plan to run it as a post-test at the end of their course. We hope the data obtained from this can help to determine how broadly the diagnostic could be used, as well as to assess whether the difficulties we observe in our courses are common at other institutions.
2. The basic proof skills diagnostic was administered MATH 320 on Sept 12. This course is generally recognized as a difficult proof-intensive course, and the pre-requisite is at least 80% in MATH 220, or at least 68% in MATH 226 (Advanced Calculus I, intended for honours students). The class is thus a mix of majors and honours students, with some from each group having completed MATH 220. More precisely, out of 87 completed tests (nearly the entire class), 44 were from students who had previously taken MATH 220, and 27 had completed both pre- and post-tests in MATH 220. This distribution of students is an ideal situation for us to examine some important questions:

#### Question 1: How well-prepared are students at the start of MATH 320?

The following table shows the mean scores of students on the start-of-term M320 test and the scores on the end-of-term test in M220.

	Math 220 Post-test (N=233, all terms pooled)	Math 320 start-of-term test (N=87)	t-test P-value
Full test (out of 16)	11.40	12.53	0.0005
Precalculus component	2.50	2.72	0.1121

(Algebra etc.) (out of 4)			
Proof skills component (out of 12)	8.90	9.81	0.0002

As we can see here, the mean score for the M320 students is significantly higher than the end-of-term M220 students. In addition, the mean score on the M320 test is 12.53 (78%), so for many of these concepts at least it seems the M320 students are fairly well-prepared. However, performance varied significantly by question and further analysis should be done to determine which concepts they have the most difficulty with.

### **Question 2: How do MATH 220 students' skills compare to those in the “honours stream”?**

In the past, we have talked about the “honours stream” and the “majors stream” of students into MATH 320. The honours stream of students take the honours calculus and linear algebra courses (including the pre-requisite MATH 226), and so it has been assumed that they generally do not take MATH 220. However, there were several students in an honours program in our MATH 220 sample here (of the 44 students who came from MATH 220, 18 were majors, 4 were honours and 22 are unknown), so it is probably more accurate to refer to the “MATH 220 stream” and “no-MATH 220 stream.” The following table shows the mean scores for each of these groups on the start-of-term MATH 320 test:

	<b>Math 220 Stream (N=44)</b>	<b>No-Math 220 Stream (N=43)</b>	<b>t-test P-value</b>
Full test (out of 16)	13.36	11.67	0.0002
Precalculus component (out of 4)	2.91	2.52	0.0814
Proof skills component (out of 12)	10.45	9.14	0.0004

As we can see here, the students that took MATH 220 had a significantly higher mean on the test than those that did not take MATH 220. This suggests that at least in these skills M220 students may be better prepared than those from the no-MATH 220 stream. However, we need to examine how these students ultimately perform in the course to more fully assess this.

### **Question 3: Are skills learned in MATH 220 retained into future proof-intensive courses?**

A major question of interest is whether students retain what they learn in MATH 220 until the start of their proof-intensive courses, such as MATH 320. Some answer to this can be obtained by comparison of the M220 post-test scores with the MATH 320 start-of-term scores. These are shown in the following table:

	<b>Math 220 Pretest (N=27)</b>	<b>Math 220 Post-test (N=27)</b>	<b>Math 320 start-of-term test (N=27)</b>	<b>T-test p-value for M220 pre- and post-test means</b>
Full test (out of 16)	11.70	13.52	13.63	0.0006
Precalculus component (out of 4)	2.59	2.93	3.00	0.1907

Proof skills component (out of 12)	9.11	10.59	10.63	0.0005
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As we can see, the mean score in both groups is nearly identical, suggesting that there is very good retention of these skills to MATH 320. In addition, these are not just skills that students already had coming into MATH 220 because the mean pre-test score for this group is significantly lower.

3. No more work has been done since the last report on the higher-level “proof concept test.” At this stage we have a draft of the first (open-ended) version of the test, and I plan next to collect feedback on the test from faculty members who teach proof-intensive courses, to ensure the overall content of the test is appropriately targeted.

### **MATH 102 (Differential Calculus with Applications to Life Sciences)**

1. The bulk of the work in this course at the moment for me is in developing online homework and pre-lecture quizzes (typically 3 quizzes, 1 lab and 1 homework set each week). For each of these I prepare a draft version, receive feedback from the course instructors via the instructor forum and modify the homework and quizzes as necessary. In general, I find the instructor forum format is a very efficient way to coordinate this feedback and would recommend it to others with multi-section courses.
2. Unfortunately, instructors are finding that an hour before class is not sufficient for data from pre-lecture quizzes to be useful (they do not feel they have time to modify their lecture plans). While I do think the quizzes are functioning to keep students on track with the course and to do the readings, I would recommend that in the future a different approach is used to make pre-lecture quizzes more useful as formative feedback. I will try to make some more specific suggestions by the end of the term.
3. The labs for this course are being converted to WeBWorK (the online homework system), but the majority of this work is now being performed by a GTA.
4. The course forum is still very active. At this time, 371 posts have been made by students (mostly questions) and nearly all have been answered by both students and instructors (for a total of >1500 contributions). I think this is quite active for a course of ~650 students. It seems like it will be possible to retain the data from the forum after the course has ended, so we will make plans to analyze this data for common difficulties and misconceptions after the course has ended.

### **Math Attitudes and Perceptions Survey (MAPS) – joint work with STLFs Warren Code and Joseph Lo**

1. We have now completed 9 student validation interviews on the most recent version of the survey. We plan to conduct at least 3 or 4 more, but are waiting until the first midterm session is finished before soliciting volunteers.
2. The survey was administered at the start of the term in Math 220 and one of the first-year calculus courses in a format that encouraged completion (on paper in class in Math 220 and through the online homework system for the other course), and resulting in very high response rates (I believe >90% in both cases). It will also be run in a range of other courses over the

next few weeks, with the incentive of a draw for a gift card. We have not yet analyzed any of the data from the surveys.

### **Current Project Status (material was prepared by either STLF or other members of the MATH SEI group)**

MATH 220:

**Learning Goals:** Learning goals have previously been created for this course and are in use.

**Assessments:** The basic proof skills diagnostic pre-test was given at the start of term. The results still need to be compiled and analyzed. A proof concept test is in development to assess higher-level proof skills.

**New Methods/Materials:** We have a draft of the first (open-ended) version of the proof concept test.

MATH 102:

**Learning Goals:** Learning goals for this course exist, but are in need of substantial revision. Costanza Piccolo is currently working on more detailed learning goals.

**Assessments:** None yet.

**New Methods/Materials:** A series of online pre-lecture quizzes is being created. Weekly online homework sets are being created. Labs for the course are being substantially modified.

### **Plan for immediate future work**

MATH 220:

1. Continue working on our paper about the basic proof skills diagnostic.
2. Analyze the basic proof skills diagnostic results for both sections of MATH 220 and compare with previous terms. Also, obtain results for Queen Mary University students and compare with the results on the UBC population.
3. Perform student validation on the portions of the basic proof skills diagnostic that have not been validated.

Higher-Level Proof Courses (MATH 320, and MATH 312)

1. Track the performance of students in MATH 320 and compare with their performance on the basic proof skills diagnostic, as well as their MATH 220 grade (when applicable).
2. Get feedback from several faculty members on the proof concept test.
3. Pilot the draft test in think-aloud interviews with students from MATH 312 and revise the test as needed.

MATH 102

1. Continue to create pre-lecture quizzes and weekly problem sets in WeBWorK.
2. Continue to assist with the revisions of the course labs.
3. Continue to monitor the student forum, and keep track of difficulties and misconceptions that are discussed there.

MAPS

1. Examine the responses from MATH 220 students, and compare these with responses we have from first-year calculus courses.
2. Continue student validation interviews.
3. Publish the validated version of the survey online and solicit responses from experts (goal of 50 expert responses).