STLF Report to CWSEI and Mathematics Department

STLF: Sandra Merchant
Period: 06/11/12 – 03/12/12
Submitted: 03/12/12

Specific activities performed by STLF

1) Professional development
   - Attended the weekly CWSEI Reading group meetings.
   - Attended the weekly STLF meetings.
   - Met with Brett Gilley for our MetaSTLF meeting (Nov 19).
   - Met with visitor Marc Fabbri (Penn State U.) to discuss our work transforming our math courses as well as his work developing a suite of Biocalculus courses (Nov 21).

2) MATH SEI general meetings/activity
   - Met with Director Costanza Piccolo and the MATH-SEI group to review the status of our projects and plan future work (Nov 14, Nov 21, Nov 28).
   - Met with Sarah Gilbert and the MATH-SEI group (Nov 7) to review the status of our projects.
   - Attended our department Lunch Series on Teaching and Learning where Eric Cytrynbaum presented a survey of useful online tools being used in this term’s MATH 102 course (Nov 8).
   - Attended the Lunch Series on Teaching and Learning about the TA accreditation program in our department (Nov 27).

3) Course-specific meetings/activities

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

1. In both sections of Math 220 I administered a survey on attitudes and perceptions toward proof. This survey is one that I found in the literature (Almeida, 2000) and although it could use some improvement, I chose to use the questions in their current format so that I could compare the results with baseline data provided from 7 universities in the UK. The survey consists of 16, 5-point likert scale questions. I have scored the results and compared the two sections to each other, as well as with the baseline data.

Overall, students in Math 220 at UBC have similar attitudes toward proof as 2nd year students at the other institutions, and these typically lie somewhere between the attitudes of 1st year students and the expert “ideal” response. I also compared the results of the two sections from this term because students were taught very differently in the two sections. Section A in the table below was taught in a traditional style with the bulk of time taken by lecturing by the instructor and writing on the board, and students taking notes. Section B was taught in more of an interactive engagement style, with very little lecturing and a combination of pre-reading, clicker questions, and group problem solving, as well as critiquing a group’s solution. In analyzing the results, I pooled the “agree” and “strongly agree” responses, as well as the “disagree” and “strongly disagree” responses, so that there were only 3 categories (agree, neutral, disagree) on which I performed Chi-square tests. There were only 2 statements on which the sections may differ significantly, shown in the table below. The Chi-square test is
not actually applicable for these due to the small numbers in the “disagree” category, so I will perform Fisher’s exact tests once I learn this, but I believe they will retain significance.

<table>
<thead>
<tr>
<th>Statement 12: Working through a proof of a result helps me to understand why it is true</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Chi-square p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A (N = 45, 58 registered)</td>
<td>27</td>
<td>15</td>
<td>3</td>
<td>0.000149</td>
</tr>
<tr>
<td>Section B (N = 43, 56 registered)</td>
<td>39</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Statement 16: It is easier to disprove than to prove.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section A (N = 45)</td>
<td>33</td>
<td>9</td>
<td>3</td>
<td>3.11E-06</td>
</tr>
<tr>
<td>Section B (N = 43)</td>
<td>18</td>
<td>15</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

There is in fact no expert response for Statement 16, as it is very dependent on the field of mathematics or even the particular problems being considered. However, this may reflect a difference in the experience of these two groups of students in this course (ex. perhaps students in one section spent more time disproving statements than in the other). For statement 12, section B seems to have a more expert-like attitude to the benefit of working through proofs.

2. I also administered the basic proof diagnostic post-test in Math 220 to assess whether the more interactive engagement style of instruction in Math 220 improves learning gains on this test. As for the pre-test, the short version of the diagnostic (without algebra and graphing problems) was administered in class in this section only, along with the Math Attitudes and Perceptions Survey (MAPS). I have now scored the tests, and am in the process of comparing the results with previous terms. The results are shown in the following table. Note that the short version of the test is out of 12 marks.

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<table>
<thead>
<tr>
<th>Pre-test Mean (Std Error)</th>
<th>Post-test Mean (Std Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter 2012 Term 1 (interactive engagement)</td>
<td>8.04 (0.32)</td>
</tr>
<tr>
<td>(N=55)</td>
<td>N=35</td>
</tr>
<tr>
<td>Historical Values (all data pooled, summer 2011 to summer 2012 inclusive)</td>
<td>7.30 (0.12)</td>
</tr>
<tr>
<td>(N=300)</td>
<td>N=233</td>
</tr>
</tbody>
</table>
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This data is only from a preliminary analysis, and includes students who only wrote one exam. However, at this time there does not appear to be a significant improvement in learning, as measured by this test, in the more interactive course. I plan to investigate this further, on both a question-by-question basis, and also by looking at matched student data. Possible confounding factors to consider include: differing course syllabus from term-to-term, workshops in some terms but not others, and differing student drop rates.

3. Planning has begun for Math 220 for next term and I will be meeting with the instructors next week. So far, my plan for next term is to run workshops in Math 220 with some improvements, possibly including pre-selected groups to improve group dynamics, as well as
additional opportunities to critique proofs (ex. by critiquing solutions created by students in previous terms).

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

1. Costanza Piccolo and I ran study skills workshops with the low-performing students in this course following the first midterm. We then obtained the student scores of all students on the second midterm and Costanza has analyzed them to determine if our study skills intervention was effective. Unfortunately, the target group did not improve significantly more from midterm 1 to midterm 2 than similar groups in the other sections of the course (5 sections, all of whom had identical midterms, homework, labs and quizzes). Therefore, it is unclear whether the study skills workshops were beneficial to the students (in terms of performance).

2. Nearly all my work for the term (WeBWorK assignments, labs, quizzes and review problems) is now done for this course. I plan to meet with the instructor soon to review how these elements of the course worked and make plans for next year. The Math-SEI group also plans to run a WeBWorK survey for students in all first-year calculus courses.

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

1. We are currently advertising for student interview volunteers to complete the student validation of the survey. Following this, we will create a version for experts to complete and solicit expert responses.

2. MAPS was administered on paper in class in both sections of Math 220 this term, as well as in one section at the end of term. I have not yet scored the surveys, but this will give us the first substantial sample of student attitude shifts in this fundamental course in our math program.

**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.
**Assessments:** The following assessments were used this term: basic proof diagnostic (pre and post), MAPS (pre and post), Proof attitude survey (post). A proof concept test is now being developed to assess higher-level proof skills.
**New Methods/Materials:** A new proof attitude survey was used, taken from (Almeida, 2000).

**MATH 102:**
**Learning Goals:** Learning goals for the course are currently being prepared by Costanza Piccolo.
**Assessments:** None.
**New Methods/Materials:** A study skills workshop was created and run this term.

**Plan for immediate future work**

**MATH 220:**

1. Continue working on our paper about the basic proof skills diagnostic.
2. Analyze the results of the MAPS survey and compare with other student groups (ex. 100-level results, applied Math courses).
3. Perform student validation on the portions of the basic proof skills diagnostic that have not been validated.
4. Continue to analyze the results of the basic proof diagnostic run in the interactive section of the course.
5. Begin preparing workshop materials for next term (ex. search for good student proof examples to use for critique activities).

Higher-Level Proof Courses (MATH 320)

1. Once final grades are available, examine the performance of students in Math 320 for the various groups of interest (Math 220 students, honours vs. majors, workshops vs. no workshops, etc.).
2. Get feedback from several faculty on the proof concept test.

MATH 102

1. Meet with the instructor to review the course this term and plan for improvements next year.

MAPS

1. Finish the student validation of the survey.
2. Examine the results of the survey run in Math 220 and compare with other courses.
3. Post the validated version of the survey online and solicit responses from experts (aim for 50 expert responses).