STLF Report to CWSEI and Mathematics Department

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Specific activities performed by STLF

1) Professional development
- Attended the weekly CWSEI Reading group meetings.
- Attended the weekly STLF meetings.
- Attended the "Changing the Culture 2012" conference at SFU.
- 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.

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 for work in the coming year (May 24, May 31, Jun 7, Jun 14, Jun 21, Jun 27, Jul 3).
- Met with Sarah Gilbert and the MATH-SEI group (May 17) to review the status of our projects.

3) Course-specific meetings/activities

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

1. Continued writing a paper about the proof skills diagnostic test. I have now incorporated the summer term diagnostic test results into the analysis and paper. In addition, I computed Item Characteristic curves (ICC) for the pooled pre-test and pooled post-test data. None of the questions on the test display troubling patterns for these curves (ex. a U-shaped curve, indicating low-performing students and high-performing students answer correctly, but those in the mid-range do not), and a typical ICC is shown below. Note that the question in this case is multiple choice with only 3 choices, so random guessing would give 0.33. We did find that two of the questions (Q5 and Q10) have relatively flat curves, which agrees with the low discrimination index for these questions. For the present we will leave these questions in the test and comment on this in our paper.
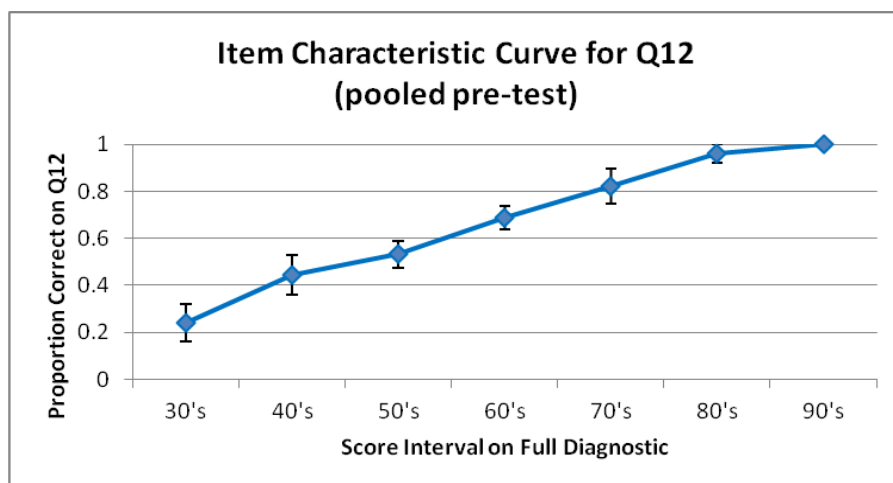
2. In past terms, the diagnostic post-test for Math 220 was administered as a homework assignment and we had some concerns that (a) students may not be taking the test as seriously as they would in class and (b) the low-performing students were not writing the test. Both of these could impact the measurement of learning gains in the course and the validity of the test. Therefore, this term the diagnostic post-test was administered in-class (July 19), and the results are being compared with past cohorts. As the course is not over yet, we do not have results to address concern (b). However, for (a) the following table shows the pre-test, post-test and learning gains for both types of post-test administration. As can be seen, there does not appear to be a significant difference in student performance on the post-test or learning gains over the term.

	Pre-test Mean (Std Error)	Post-test Mean (Std Error)	Normalized Average Learning Gains
Summer 2012 (in-class) N=38	10.11 (0.44)	12.00 (0.32)	0.32
Pooled, 2011S & 2011W terms (homework) N=145	9.51 (0.21)	11.79 (0.23)	0.35

3. I compared student performance on 8 "isometric" final exam questions for terms where there were no workshops (2010 WT1 and 2011 WT1) and the Jan-Apr 2012 term (2011 WT2) that had bi-weekly workshops. Based on the recorded scores, there were no clear differences in performance between the groups. However, the questions were not identical, and neither were their weights on the exam, and the scoring was not consistent between the different sets. Therefore, I choose two questions that were extremely similar, a statement of a mathematical definition and an induction proof, and rescored these by hand with a common scoring rubric. In addition, I coded these two questions for common student errors and tracked the frequency of each type of error. Again, for these two questions I did not find any significant difference in scores between the two groups, nor in the types of errors students made. Unfortunately, these were not very conceptual questions (more of the "recipe" variety) and this may be why we do not see any differences. Unfortunately, in these exam sets there are no truly isomorphic conceptual questions.

4. Analyzed the results of the April 2011 end-of-term survey and compared the results with identical questions from past years. In addition, since the survey was non-anonymous, I looked at the correlation of various responses with course grades. A report has been written, and is available on the MATH-SEI webpage. The most interesting findings were:

    - Students report spending significantly less time on homework in the 2011 WT2 term, with the new workshop format.
    - Students who do better in the course report (on average) starting their homework earlier. This is not surprising, but nice to confirm.
    - The time at which students first find the course challenging is distributed throughout the duration of the course, with a mode after midterm 1, and a second group that comes to this realization following midterm 2.
    - Students report spending more time studying for midterm 2 (mean 9.19 hours) than for midterm 1 (mean 7.49 hours).

- For homework and midterms, students at the top and bottom of the grade range reported spending less time than those in the middle of the distribution. Our sample here is too small to say this difference is statistically significant, but it is in agreement with findings in other courses.

5. Revised the end-of-term survey for Math 220 and administered it in class (July 26). This survey is also non-anonymous and includes a section of questions about the workshops. The results have not been analyzed yet.

6. Began work on a "proof concept test" intended to track proof skills into higher levels. This work will be done jointly with faculty member Brian Marcus. The plan is to create a test of proof methods that can be administered at various points in the math degree program. For instance, at the end of Math 220 and then again at the start of a 300-level course (ex. Math 312 or Math 342) or 400-level course to track retention. Comparison of performance on traditional course assessments (i.e. final exams) may then help us understand whether student difficulties stem from poor retention of the skills or instead from poor transfer of these skills to new contexts. In addition, this test could be used to identify differences in proof skills between students that enter these courses from the "honours stream" versus the "majors stream" of first and second-year pre-requisite courses. At present, a collection of possible problems has been created that we will review. We plan to create a first draft of the test to be used on students in September.

MATH 102 (Differential Calculus with Applications to Life Sciences)

1. One of the instructors of this course (Eric Cytrynbaum) plans to incorporate some "just in time teaching" elements into the course, as well as some improved feedback to students through webwork (online homework system) problems and computer labs.

   The plan is to have two webwork assignment types each week. The first type might be a single assignment or split into three, each due the night before lecture. These would be simpler and more conceptual, and could be reviewed by the instructor for conceptual difficulties prior to class. The other type would be more technical problems to be done after class. There will also be a third type of question that is not on webwork - this would consist of one "thinking" question per week that would require them to write answers in paragraph form and that would be graded by hand.

   As well, the computer labs may be moved into webwork so every student gets a unique version and new labs would be created for the probability and statistics material that has been added to the course. Finally, the instructor would like to add a "pre-calculus" webwork assignment along the lines of the BST.

   So far, I have only begun familiarizing myself with the webwork system and how to develop problems in the system. I have also collected possible problems for homework etc. used by past instructors of the course.

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

1. Based on the factor analysis and student validation interviews we revised the survey again, removing questions that did not group or that were confusing for students to answer. We also added some questions of our own creation intended to probe whether students have a fixed mindset or growth mindset toward learning math.

2. Interviewed 4 faculty members about the attitude survey. We have now interviewed 11 faculty members, to check the clarity and content of each question as well as to determine if there are any major elements missing on our survey (intended to establish content validity). Based on these interviews, we have discarded 3 questions from the survey that do not have consistent responses from these "experts" and are rewording 4 questions that were considered unclear.

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 end of term. The results have been analyzed and are similar to previous terms. A proof concept test is now being developed to assess higher-level proof skills.
New Methods/Materials: The end of term survey was revised, as well as a section on the workshops was added.

MATH 102:
Learning Goals: I do not know the status of learning goals for this course.
Assessments: None yet.
New Methods/Materials: None yet.

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 end-of-term survey for Summer 2012 and compare with previous terms.
3. Perform student validation on the portions of the basic proof skills diagnostic that have not been validated.
4. Decide what data can be collected in Math 220 in the 2012 WT1 and 2012 WT2 terms to more effectively assess the new workshop format.

Higher-Level Proof Courses (likely MATH 312 and MATH 342)

1. Create a draft of the proof concept test, and get feedback from several faculty members.
2. In early September, pilot the draft test (possibly in think-aloud interviews) with students from MATH 312 and revise the test as needed.
3. Examine and possibly code some past MATH 312 and MATH 342 final exams to get additional insight into student errors and misconceptions in proofs.

MATH 102
1. Create a "pre-calculus" webwork problem set to be used at the start of the course.
2. Together with the instructor, make a plan for the conceptual and technical webwork problem sets to be created for each week/lecture.

MAPS
1. Finish revising the survey and then validate the new and modified questions with students.
2. Publish the validated version of the survey online and solicit responses from experts (goal of 50 expert responses).