MATHEMATICS DEPARTMENT

Unit-Level Assessment Liaison Report

Spring 2016

Liaison Project Start Date (Semester/Year): Spring 2015

Liaison Report prepared by Fernando Miranda-Mendoza

Department Buy-In and Outcome Definition

The unit-level work that we began in the spring 2015 term was continued throughout the 2015-2016 academic year. During the spring 2015 semester, a pilot assessment tool was developed and administered to a couple of sections of Math 207 (Calculus and Analytic Geometry I). The main goal of this unit assessment was to determine if students in Math 207 have any mathematical deficiencies at either the developmental, college algebra, or calculus level. Proficiency at all these levels is essential for student success in Math 207. Anecdotal evidence suggests that students struggle with prerequisite skills, yet they are able to understand calculus-level concepts. It is hoped that this project will shed some light on this paradox and will help us understand our students better.

We decided to focus on assessing the following two student learning outcomes from Math 207:

A. "Apply derivatives to problems involving optimization and related rates."
B. "Analyze the behavior of functions and their graphs using first and second derivatives (e.g., determine local and absolute extrema, concavity, and inflection points)."

These two student learning outcomes represent the type of skills that a successful calculus student must demonstrate at the end of Math 207. Moreover, both outcomes require a thorough understanding of basic, intermediate, and college algebra skills (learned in Math 99 and Math 140).

Assessment Research and Design

Students meet outcome A when they can apply the calculus concept of "derivative" to "optimization" problems. Optimization problems are usually exemplified by applied settings, where students need to translate a real-world problem into mathematical terms and use algebraic and calculus skills to achieve a final conclusion. The second outcome (outcome B) is met by applying similar ideas to those from outcome A, but the analysis of graphs does not necessarily involve an applied setting.

Faculty suggested that we design an assessment so that students can work through an applied (real-world) problem even if they cannot translate the sentences from the applied setting into the correct mathematical terms and equations. This suggestion was made due to the possible issues

that our students (some of whom are non-native English speakers) may have with the description of a real world scenario. We followed this suggestion in the development of the pilot and kept it in the revised version of our assessment tool.

Pilot Assessment Tools and Processes

During the spring 2015 semester, we developed a pilot assessment tool. This tool was a short quiz with two main questions, each question based on one of the two student learning outcomes selected. The first question is a purely mathematical problem that assesses outcome B (on the "behavior of functions and their graphs"). The second question is an application (real-world) problem written to assess outcome A (on "optimization").

After the spring 2015 pilot results were received and analyzed, a few revisions were made to improve instructions and enhance the scoring rubric. Instructions to both faculty and student volunteers now specify that performance on the assessment tool will affect neither instructors nor students in an evaluative capacity (see Appendices A and C). The previous instructions to students only specified that performance will not affect their grade and did not mention anything about the instructor. A student wrote the following comment on the second question (which he/she left blank) in the pilot: "I do not remember how to solve this question, but my instructor is great." It appeared that this student regarded the assessment tool as an evaluation of the instructor. We hope that the modified instructions will reassure all students and instructors that assessment tools are not used for evaluation.

Also, with helpful feedback from the liaison coordinator, the scoring rubric was modified to account for insightful answers that are correct but do not quite follow calculus methods (see Appendix B). This change was motivated by a student who was able to get some correct results on the second applied question of the pilot by taking a different route than expected. Math instructors were interested in finding out more detail about the variety of ways in which a student's answer could be "incorrect," so the more detailed rubric is allowing us to capture more complex and meaningful information about student learning as it relates to these two outcomes.

Finally, the language used on the second applied question of the assessment tool has been modified to make it clearer and avoid some apparent confusion on the pilot (see Appendix A). On the pilot, many student responses in the last part did not correspond to the question (they should have provided the "dimensions" of an area, width and length, but instead gave only one dimension, the area, or another unrelated quantity).

Administer Specific Assessment

The pilot assessment was administered in a couple of sections of Math 207 at the end of the Spring 2015 semester. We will be running a revised version of the assessment tool at the end of Spring 2016 in at least four sections of Math 207. As with the pilot assessment, faculty volunteers will be running this revised version of the assessment during the last weeks of the semester (weeks 14, 15, and 16). We hope to obtain a large enough sample size in order to draw significant conclusions from the data.

Data Analysis

The data analysis of the pilot assessment's results was completed during the 2015-2016 academic year. The sample from the pilot assessment consisted of 38 students from two sections of Math 207. As it is evident from the distribution of scores (see Figure 1), overall, students performed well. The proportion of students meeting the learning outcomes was 58% (a student met the assessment outcomes if his/her overall score was 12 points or greater). They obtained high scores on the first purely mathematical question (see Figure 2). Nevertheless, many students performed poorly on the second applied "calculus optimization" question. 45% of them scored fewer than 6 points in that question and, consequently, did not meet the outcome (see Figure 3). Some responses indicate that students may have misunderstood the wording of this second question and, consequently, provided unrelated answers or no answer. However, these applied questions are difficult for students across all calculus classes, so we would like to investigate this issue again as we run a modified version of the assessment tool this semester.

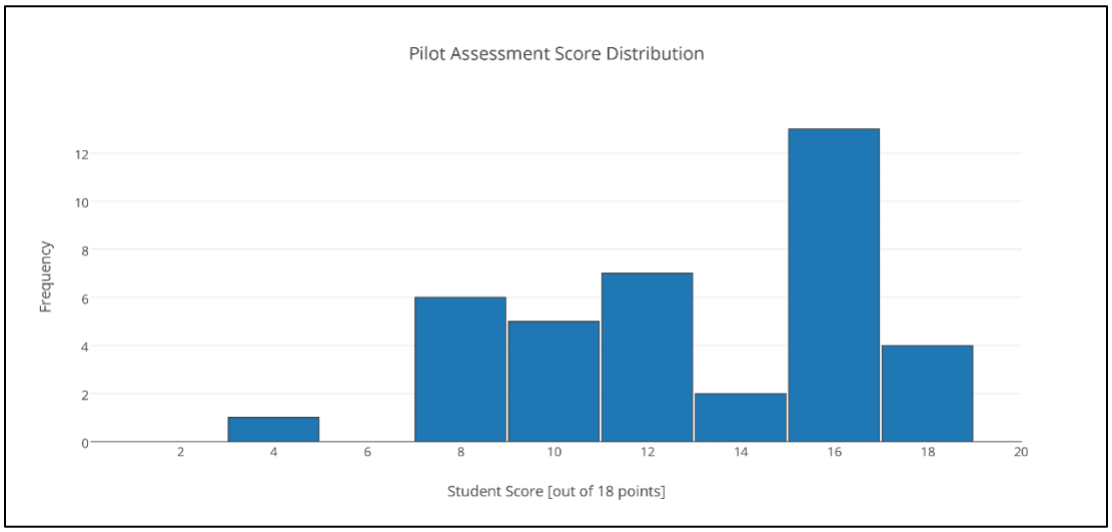


Figure 1: Distribution of scores

OpenBook data was finally incorporated into the pilot's results this semester. Out of the original 38 students that took the assessment pilot, only 35 had valid student IDs. The missing three students provided an incorrect ID number either on purpose (one student ID appeared to be made up) or by accident. We hope that students who volunteer in the future are confident that the assessment tool does not affect their class performance and will therefore provide accurate ID numbers.

One interesting finding from the course history was that several students in this sample had already completed a math class at a higher level than Math 207. In particular, a few students (9 in total) were previously enrolled in Math 208 (the second course in the three-semester calculus series) which requires successful completion of Math 207. It seems that several students were attempting the class for a second time (perhaps to improve their GPA). It will be interesting to keep track of student's course history in future departmental assessments.

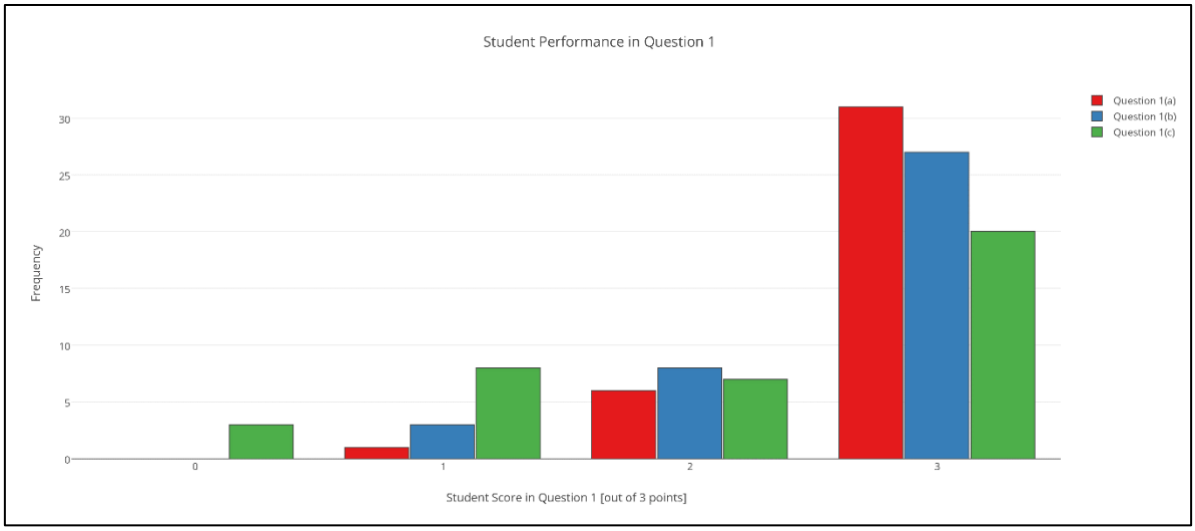


Figure 2: Distribution of scores in Question 1

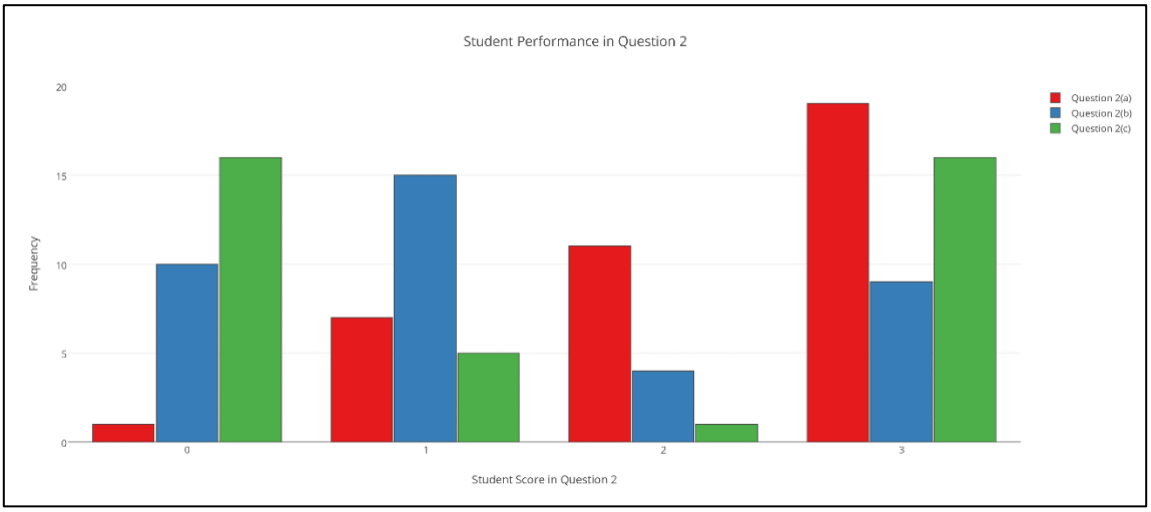


Figure 3: Distribution of scores in Question 2

The data analysis presented here is just a basic exploratory look at the results of the pilot assessment. A more detailed and deep analysis will be performed on the data that we will collect this semester with the full scale assessment.

Supporting Evidence-Based Change (Use of Findings)

Even though it is still too early to draw a definite conclusion, based on the spring 2015 pilot results, we suspect that Math 207 students struggle with applied problems. We hope that the few minor modifications we made to the tool and the instructions will help students better understand the applied question. We will have to wait for the results of the bigger assessment this semester before we make further concrete conclusions.

Success Factors

Overall, the biggest success factor has definitely been the increased awareness of assessment in the Math Department, especially among adjuncts. This semester, one of the faculty volunteers is an adjunct instructor who eagerly volunteered his section and took time to learn more about the assessment activities in our department.

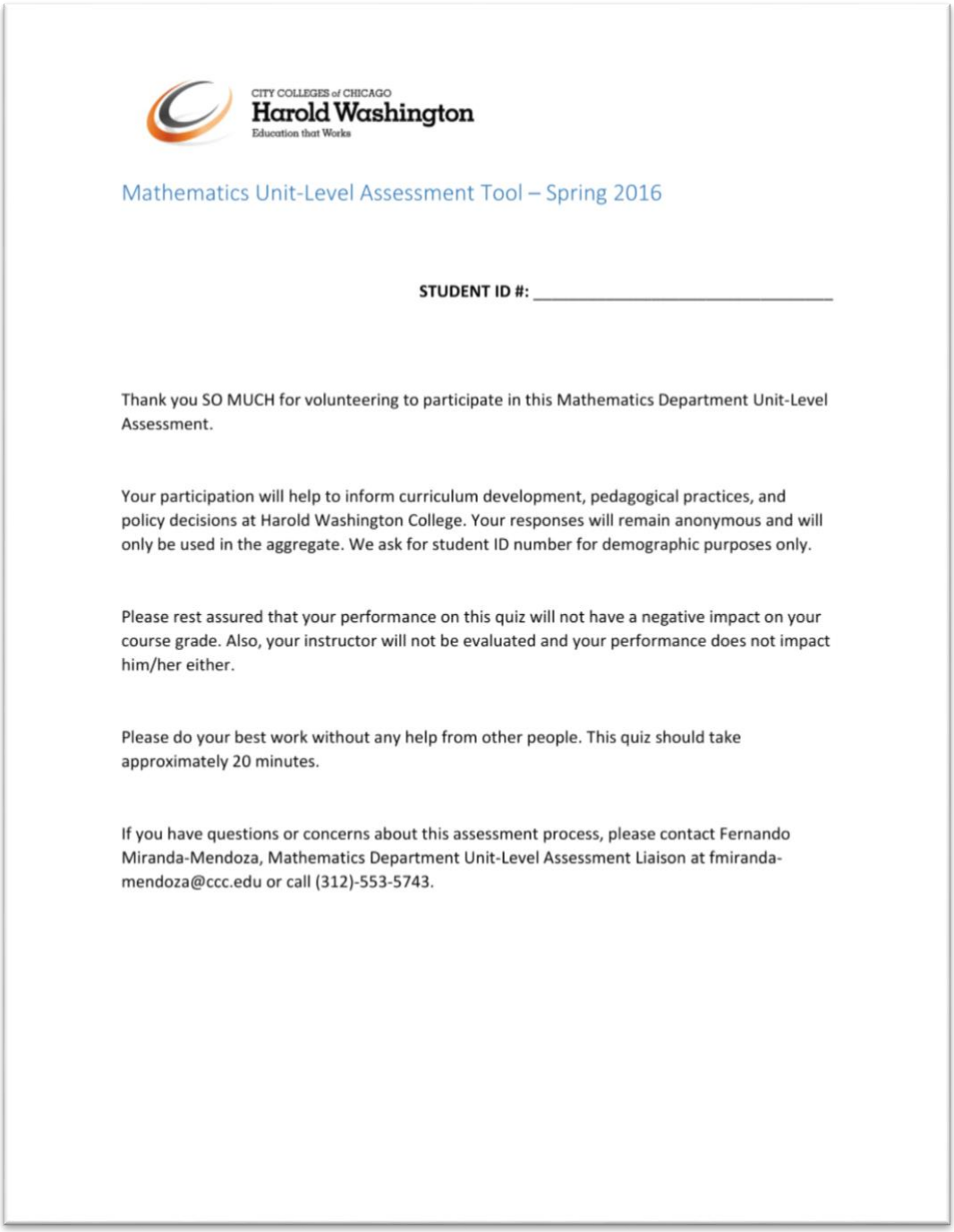
Spring 2015 was the first semester our department engaged in unit-level assessment. Since then, we have now developed a basic assessment framework that we expect will be refined in future departmental unit-level assessment projects.

Recommendations

Recommendations for our next steps will be given based on the analysis of the results from the full-scale assessment this semester and subsequent faculty discussions.

Finally, during the academic year, our department had regular conversations regarding the possible disappearance of the developmental math classes (Math 98 and 99). Some modified pilot classes will be run over the summer and fall semesters this year. A new unit-level assessment project based on these modified classes may begin next semester.

Appendix A: Revised Assessment Tool



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Mathematics Unit-Level Assessment Tool – Spring 2016

STUDENT ID #: _____

Thank you SO MUCH for volunteering to participate in this Mathematics Department Unit-Level Assessment.

Your participation will help to inform curriculum development, pedagogical practices, and policy decisions at Harold Washington College. Your responses will remain anonymous and will only be used in the aggregate. We ask for student ID number for demographic purposes only.

Please rest assured that your performance on this quiz will not have a negative impact on your course grade. Also, your instructor will not be evaluated and your performance does not impact him/her either.

Please do your best work without any help from other people. This quiz should take approximately 20 minutes.

If you have questions or concerns about this assessment process, please contact Fernando Miranda-Mendoza, Mathematics Department Unit-Level Assessment Liaison at fmiranda-mendoza@ccc.edu or call (312)-553-5743.

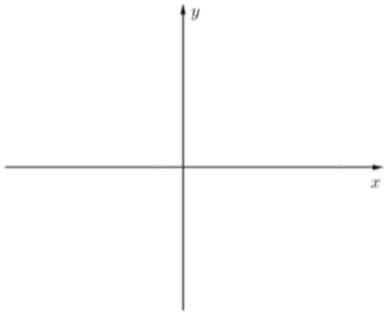
1. The derivative of a function $f(x)$ is

$$f'(x) = x^2 - 5x + 6.$$

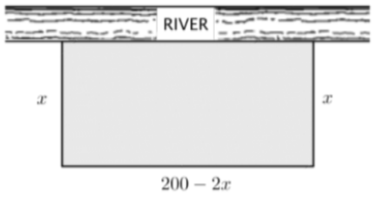
(a) Solve the equation $x^2 - 5x + 6 = 0$ to find all the critical numbers of $f(x)$.

(b) Find the intervals where the graph of the function $f(x)$ is increasing and decreasing.

(c) Sketch the graph of $f(x)$ on the xy-plane below. Label all the critical numbers on the x-axis. Do not try to find any other values.



2. A farmer has 200 feet of fencing material and needs to fence off a rectangular field that borders a straight river. He needs no fence along the river (see the figure below). Let x be the length of the rectangular field. Then the area of this field is given by the function $A(x) = x(200-2x)$.



(a) Find the critical numbers of the function $A(x)$.

(b) Find the value(s) of x that give rise to the maximum area. Use calculus concepts to justify your solution.

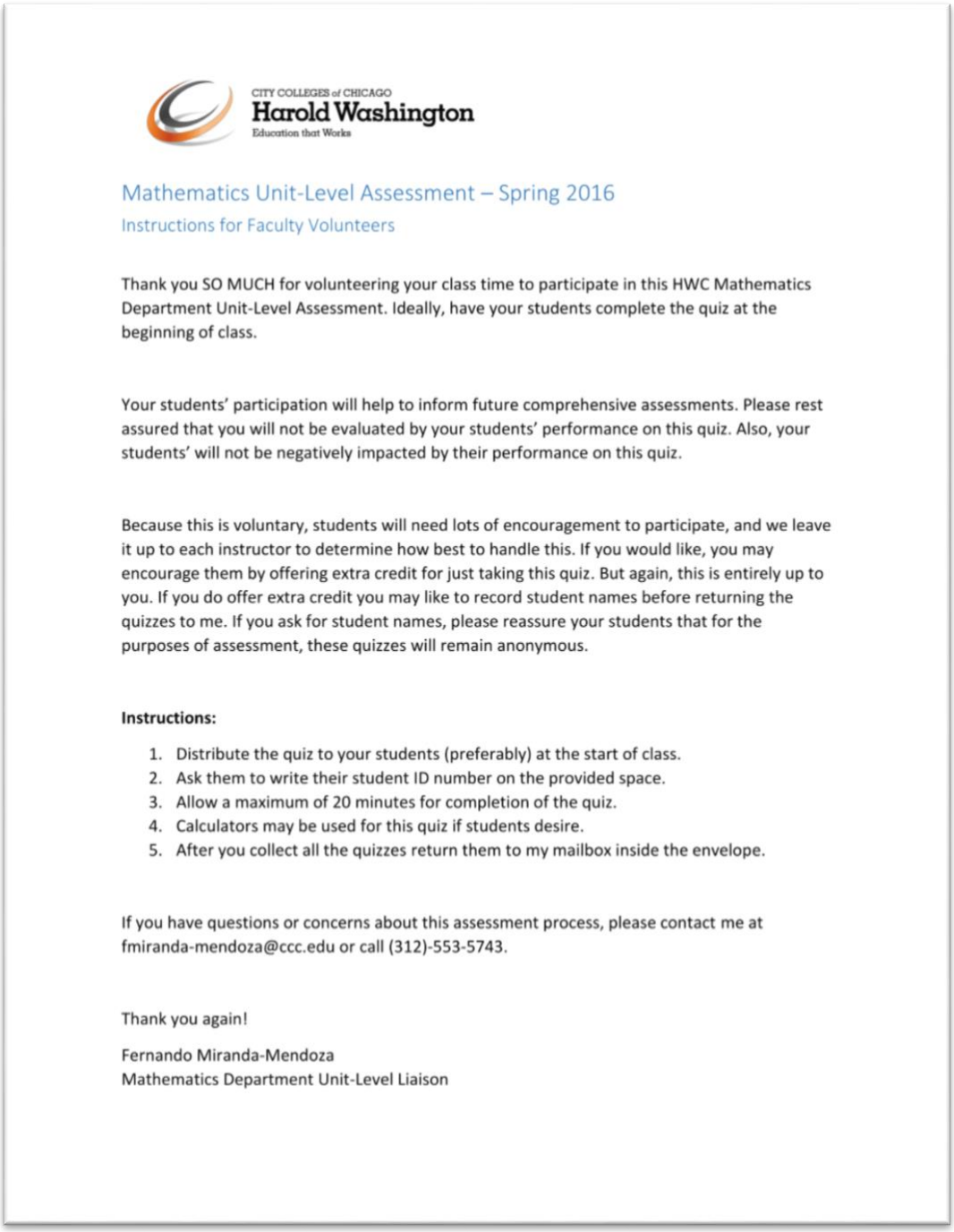
(c) What are the dimensions of the field with the largest area? That is to say, find the base (width) and height (length) of the largest rectangular area.

Appendix B: Revised Scoring Rubric

	3: Calculus skills	2: College algebra skills	1: Developmental skills	0: No attempt
Conceptual understanding	Conceptual understanding apparent. Correct use of calculus concepts.	Conceptual understanding only adequate. Slight misuse of calculus concepts.	Conceptual understanding totally lacking. No use of calculus concepts.	Does not attempt problem.
Notation	Consistent notation, with only an occasional error (minor arithmetic/algebraic errors, for example).	Some consistent notation, but with several errors (arithmetic/algebraic errors, for example).	Inconsistent or incoherent notation.	Does not attempt problem.
Logic	Logical formulation is complete with only an occasional error.	Some logical steps lacking.	Logical or relational steps missing.	Does not attempt problem.
Solution method	Complete or near-complete solution (missing only some arithmetic/algebraic simplifications, for example).	Careless mathematical errors present (arithmetic/algebraic errors, for example).	Procedural errors or correct final answer is found by using purely algebraic/arithmetic methods (simulating values, looking at graphs, for example).	Does not attempt problem

Source: Emert, John W., and Charles R. Parish. "Undergraduate Core Assessment in the Mathematical Sciences." *MAA Notes* 49 (1999): 46-48. Print.

Appendix C: Instructions for Faculty Volunteers



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Mathematics Unit-Level Assessment – Spring 2016

Instructions for Faculty Volunteers

Thank you SO MUCH for volunteering your class time to participate in this HWC Mathematics Department Unit-Level Assessment. Ideally, have your students complete the quiz at the beginning of class.

Your students' participation will help to inform future comprehensive assessments. Please rest assured that you will not be evaluated by your students' performance on this quiz. Also, your students' will not be negatively impacted by their performance on this quiz.

Because this is voluntary, students will need lots of encouragement to participate, and we leave it up to each instructor to determine how best to handle this. If you would like, you may encourage them by offering extra credit for just taking this quiz. But again, this is entirely up to you. If you do offer extra credit you may like to record student names before returning the quizzes to me. If you ask for student names, please reassure your students that for the purposes of assessment, these quizzes will remain anonymous.

Instructions:

1. Distribute the quiz to your students (preferably) at the start of class.
2. Ask them to write their student ID number on the provided space.
3. Allow a maximum of 20 minutes for completion of the quiz.
4. Calculators may be used for this quiz if students desire.
5. After you collect all the quizzes return them to my mailbox inside the envelope.

If you have questions or concerns about this assessment process, please contact me at fmiranda-mendoza@ccc.edu or call (312)-553-5743.

Thank you again!

Fernando Miranda-Mendoza
Mathematics Department Unit-Level Liaison