Name and Title: Sarah Mayes-Tang, Assistant Professor, Teaching Stream  
Department: Mathematics  

TITLE OF RESEARCH PROJECT: Analyzing Conceptual Understanding of Calculus  

Number of 299Y Spots: 2 Number of 399Y Spots: 1  

OBJECTIVES AND METHODOLOGY:  
Brief Background:  
Conceptual understanding in mathematics refers to a deep understanding of relationships between mathematical objects; it is often contrasted with rote or manipulative understanding. Developing conceptual understanding is now considered the primary content goal of a calculus course, as the value of skill-based courses has decreased with the introduction of low-cost and free mobile and computer software that can perform nearly all of the computations traditionally taught in a calculus course. While the Calculus Concept Inventory (CCI) has been widely used as a proxy for understanding, recent analyses have revealed concerns about its usage.  

The objectives of this project are as follows:  
1) Write a literature review on conceptual knowledge in post-secondary math, with a focus on calculus  
2) Determine how responses to conceptual short answer and multiple choice questions are correlated with understanding in a semi-structured interview  
3) Develop recommendations for assessing conceptual understanding in future iterations of MAT135/136 and tracking changes over time  

Methodology  
Students will use both qualitative and quantitative methods in this project. To analyze multiple-choice questions and to determine which ones might be indicative of conceptual understanding, they will calculate correlations. In order to analyze responses on short-answer questions, students will code the data using content analysis. Finally, they will conduct think-alouds or semi-structured interviews, and code this data following the coding of the short answer questions.  

DESCRIPTION OF STUDENT PARTICIPATION:  
ROP299 and ROP399 students will:  
1) Conduct a literature search on conceptual knowledge in post-secondary mathematics, with a focus on calculus. They will summarize the sources that they find in order to assist with the final literature review in the area, using a collaborative bibliographic software.
2) Analyze a sample of MAT135/136 short-answer exam responses from past course iterations intended to assess conceptual understanding
3) Analyze MAT135/136 multiple choice questions intended to assess conceptual understanding
4) Conduct and analyze semi-structured interviews or think-alouds for conceptual understanding of calculus
5) (If time) Compare proposed measures of conceptual understanding to determine what assessments are most accurate
6) Propose specific assessments to track conceptual understanding in future iterations of the course, and create a guide for future Research Assistants that documents work in the course
7) Assist in creating a Research Ethics Board application
8) Attend training related to the research methods used in the project

This project falls at the intersection of education and mathematics research. While it is an education project, it will require very deep knowledge of calculus and mathematics from the research assistants. The project will be accessible from an education point of view, but students will have to have built a very strong conceptual knowledge of calculus ahead of the project. This is why I have classified it as a science project rather than a social sciences or psychology project.

**MARKING SCHEME (assignments with weight and due date):**

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Weight</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions to literature search</td>
<td>10%</td>
<td>June 5</td>
</tr>
<tr>
<td>Analysis of short-answer and multiple-choice questions</td>
<td>10%</td>
<td>July 1</td>
</tr>
<tr>
<td>Interview or think-aloud protocol (joint, written)</td>
<td>10%</td>
<td>July 1</td>
</tr>
<tr>
<td>Report on interviews / think-alouds (written)</td>
<td>10%</td>
<td>August 1</td>
</tr>
<tr>
<td>Guide for Future RAs (joint, written)</td>
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<tr>
<td>Journal documenting regular &amp; consistent effort (written)</td>
<td>30%</td>
<td>end of term</td>
</tr>
<tr>
<td>Professionalism and other contributions</td>
<td>20%</td>
<td>end of term</td>
</tr>
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