Teaching Dossier

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1 Teaching Philosophy

I see teaching as a process of promoting learning and motivating students. Teaching involves constant reassessment of current teaching methods and learning goals, as well as consistent innovation to facilitate student learning. Teaching strategies need to be continuously updated to remain current and relevant.

My aim in teaching math is to put emphasis on problem solving skills and logical thinking. I approach each topics so that student should understand the concepts and context in complete detail. Having the foundational knowledge is essential to problem solving as new information and concepts are added.

One of the best lessons I learned as a student was to be objective. I help students develop the same attitude towards learning. I encourage students to critically assess information, facts should be verified, and the association of knowledge with existing facts and/or their direct application should be discerned. I prepare my lectures focusing on "Why and How" of the concepts so that lectures should promote objectivity. I encourage students to ask themselves questions why this concept is important, what are the important points, how can we use it. Furthermore, I prepare assignment questions keeping in mind that questions should promote active learning.

I understand that students feel more motivated to learn if they can see the associations of a concept with real life applications. In my lectures I try to give students real life applications, anecdotes and historical accounts. For example, when I teach first year number theory, I recognize that the topic is highly abstract and it is often difficult for students to immediately note real world applications of the skills and knowledge they're gaining. However, by giving them the example of the ATM machine and demonstrating that it uses partition number theory to dispense money, this achieves two goals: the first is to motivate students to associate knowledge across disciplines and the second is to reinforce that even very abstract skills and knowledge can be used to solve real life problems. One of the principle tasks I aim to accomplish as a teacher is to understand my students learning goals and keep them motivated to learn.

Last but not the least, building on existent knowledge is one of the most important parts of learning. During lectures I occasionally pose questions about the topic we are discussing and encourage them to find the answers. I ask them to explore the topic and discuss it with their classmates. During class I often find myself offering encouragement by saying things like: "keep trying", "don't give up", "take time to stop and think". Students indicate that this helps them remain motivated and it also continuously reinforces my position as a guide in the learning process. Based on this my teaching goal stresses objectivity in education, independent learning and supporting the students to persist in exploring new ideas. I actively advance this teaching philosophy by continuing to develop innovative ideas to encourage student motivation and enthusiasm for learning.

2 Teaching Responsibilities

Lecturer: I taught two different courses at the University of Waterloo. First, I taught a multi-section second year course *Calculus 3 Math 237* for math honors students in the spring 2011. This course is a required course for all math major students. Next, I taught a multi-section first year course *Calculus 1 Math 116* for Chemical Engineers in the fall 2012. This course is required course for Chemical Engineering students. As a section instructor I was responsible for developing my own examples (See Appendix A.1 A.2 for sample lecture notes), holding office hours, supervising graduate teaching assistant, coordinating with undergrad markers, grading midterm, short test and final exam. I also helped the course coordinator in developing questions for assignments, midterm, short test and final exam.

Teaching Assistant: My graduate teaching assistant experience is outlined in Table 1.

Table 1: Teaching Assistant Experience

Courses	Major topics covered in the course	Responsibility
AMATH 382 Computational Cell Biology Winter 2010	Interdisciplinary course; focus area was applications of ordinary differential equations and linear algebra into Biology.	Tutorial Instructor.
EARTH 310/691/692 Environmental Informatics Fall 2010 and Winter 2012	Interdisciplinary course; focus area was applications of partial differential equations and ordinary differential equations into Environmental science.	I helped in developing R codes (statistical software package) for course and held office hours to help students in assignments.
AMATH 250 Introduction to differential equations Fall 2010 and Winter 2011	Linear differential equation, Qualitative analysis of differential equation, Laplace transform, Solution of differential equation using Laplace transform.	Tutorial Instructor.
MATH 218 Introduction to differential equations Fall 2011	Linear differential equation, Qualitative analysis of differential equation, Laplace transform, Solution of differential equation using Laplace transform.	Tutorial Instructor.
MATH 212 Calculus 3 for Electrical Engineers Fall 2011	Vector Calculus, Complex Analysis	Tutorial Instructor.
MATH 137 Calculus 1 for Math Honors Fall 2009	Functions, Limits, Continuity, Differentiation, Integration.	Tutorial Instructor.
MATH 119 Calculus 2 Spring 2009	Infinite series, Double and Triple Integrals.	Tutorial Instructor.
MATH 118 Calculus 2 Winter 2009	Infinite series, Double and Triple Integrals.	Tutorial Instructor.
MATH 117 Calculus 1 for Engineers Fall 2008 and 2009	Functions, Limits, Continuity, Differentiation, Integration.	Tutorial Instructor and developed tutorial problems for all sections of the MATH 117 class in Fall 2009 (See Appendix A.4 for sample tutorial problems).
MATH 115 Linear Algebra Fall 2008	Vector spaces, Eigenvalues, Eigenvectors, Orthogonality and Least Squares.	Tutorial Instructor.

3 Teaching Strategies

Summarizing previous lecture at the beginning of each class. Initially I expected all the students to come prepared with the materials covered in the previous lectures. However, as I started progressing through the lectures I realized providing brief previous lecture summary is good way to start the next lecture. This has multiple advantages. First students will have clear guidelines to identify connections between new concepts which are based on previous lectures. Second, the learning goals will provide students clear road maps of what they have to learn in the lecture. Third, writing summary will help students who are not able to go through the previous lecture, although I still expect students to review previous lectures.

Stimulate Interest: I believe that students feel more motivated to learn subject when they can see the application of the subject. I consider using examples and historical accounts are good way to stimulate interest. For example, Mirror image is an example of linear mapping, Euler developed the first theorem of graph theory to solve the problem of building bridges in a park which is now famous as the "Seven Bridges of Königsberg" problem and similar examples. As a student I always felt excited by these examples and I try to encourage this same excitement in my students through introducing these examples to students.

Furthermore, I encourage students to do independent learning and find connections between different concepts which can initiate further interest in subject. During lectures I ask questions at different time points to guide students towards main points of lecture. I also prepare extra handouts to enhance students learning (See Appendix A.6 for sample handout). I also believe that using appropriate phrases at different time points during lecture is important to guide students towards exploring the subject. Phrases like, *Convince yourself that this is true, One way of looking at this problem is this; can you think any other way, Can you reformulate the problem in a different way, Can you find connections between theorem 1 and theorem 2 (like connection between continuity and differentiability), Recall that we discussed something similar in previous lecture.*. See Appendix A.1 for representative lecture note.

Developing Reciprocity and Cooperation among Students: I believe developing a sense of shared responsibility towards learning is integral part of university education. Independent learning should not be confused with isolated and competitive learning. So, I encourage student to discuss with each other and understand each others unique learning skills. In first and second year classes I encourage student to form self learning groups and I do classroom discussion spaced at regular intervals through out the term. In higher classes I plan to give group projects to promote collaborative learning.

Regular Assignments to keep Continuity: I strongly believe that continuity and perseverance is key to learning. I believe the use of regular assignments is one way to reinforce continuity. For first-year and second-year courses, I like to assign students weekly problem sheets to allow them to practice the course material. In upper-year courses, I still believe students should do regular assignments, though not necessarily every week as upper-year assignments may have more advanced, in-depth problems requiring more time to complete. I prefer smaller, frequent assignments instead of larger, infrequent assignments, because infrequent assignments mean that students who do not study the

material will fall behind without practice. A sample weekly assignment from MATH 116 is included in Appendix A.3.

Use of Figures, Models and Concept Maps: I consider figures and animations are good lecture supplements to enhance learning. The diagrams aide students in visualizing, and making connections between concepts. This helps the students who are more visual learners and aides those who learn more through equations. I used stick models to illustrate the different coordinate systems (polar, cylindrical, spherical) in MATH 237. (Appendix A.5 for sample figures from MATH 237).

Variation in Lectures: I try to use different learning aides to assist in explaining different concepts. I believe overdoing anything is not good and each learning aide can uniquely support in illustrating the subject. No one teaching tool is universal to explain all concepts. I used concept map to introduce concepts which are logical in nature like limit, continuity, and differentiability. Figures to introduce theoretical results which are derived from geometry of problem like, the concept of a neighborhood. See Appendix A.5 A.2 for representative learning aides I used.

Giving Feedback: I believe each student is an unique learner. I respect each students learning style. Given correct attention and motivation each student can understand the course material at their own pace. I am also realistic that some students learn slowly but given proper guidance these students can understand the concepts very well. Most often in a rush to cover the material many students do not pay proper attention to assignments. So, I keep track of the student progress by reviewing student assignments, quizzes and exams. If a student is repeating the same mistakes then I point out those areas for improvement thereby giving them correct direction to learn. To further motivate these students I provide them with a list of questions. Each of these questions are based on the concept in which they have to improve. Furthermore, the questions are followed by solution guidelines so that they will have proper direction to approach the problem without giving them complete solution. While preparing questions I keep in mind that the questions should stimulate thinking, curiosity and awareness about the concepts. In order to give individual attention I encourage students to show their work if they find anything difficult. Refer to Appendix A.6 for response sheet I prepared for answering students questions.

4 Preparation for Teaching

I started my Certificate in University Teaching (CUT) program in the spring of 2009 and completed the program in summer term 2011. This certification is offered by the Centre for Teaching Excellence at the University of Waterloo in order to learn skills for university teaching. There are three courses required for the program.

Preparing for University Teaching (GS 901): GS 901 requires participation in 6 teaching workshops (each averaging 1.5 hours in length) and the submission of 4 short (2-3 page) response papers. The workshops which I attended for the course are described in table 4. I found all the workshop informative and useful for teaching.

Workshop Title	Description
Course Design	In this workshop I learned skills to effectively design new course. Like, setting course learning goals, choosing teaching strategies, planning assessment and many more.
Understanding the Learner	In this workshop I learned different types of learning styles and accordingly designing relevant instructional activities which will maximize student learning.
Clickers for the Classroom	In this workshop I learned about Clickers and its effectiveness in making class room more interactive.
Interactive Teaching Activities	In the workshop I learned different types of teaching activities for the classroom and making choice of activities according to learning goal.
Midterm Evaluations	In the workshop I learned how to get effective feedback from students and peers regarding teaching.
Academic Interview Skills	In this workshop I learned how to prepare for academic interviews.

Furthermore, I learned Soloman-Felder Index of learning styles in the *understanding the learner* workshop. Soloman-Felder Index has four scales of learning styles and each scale has two opposite preferences. Table 2 summarizes the four scales of learning styles. Everybody uses each of the styles but not with same degree of confidence. I subsequently designed my lectures to strike balance between different types of learning preferences.

Table 2: Soloman-Felder Index

Active Learners: Active learners learn by doing something with information like talking about information.	*Reflective Learners:* Reflective learners learn by thinking about information.
Sensing Learners: Sensing learners like learning facts, solving problems and they are realistic.	*Intuitive Learners:* Intuitive learners like discovering new possibilities, like innovation and abstract information.
Visual Learners: Visual learners learns more through figures, diagrams and similar visual aides.	*Verbal Learners:* Verbal learners learns more through written and spoken information.
Sequential Learners: Sequential learners gain understanding in linear, logical steps.	*Global Learners:* Global learners learn by randomly absorbing the information until suddenly they "get it".

Preparing for an Academic Career (GS 902): GS 902 requires the preparation of a teaching dossier and research project. For each of these requirements, one attends a workshop and subsequent consultation session before submission. I first prepared this teaching dossier for this course. My research project report is entitled "Wiki based collaborative learning environment for system biology." In this project I discussed the idea of developing a Wiki page to train students for interdisciplinary research. On this Wiki page students will write research paper summaries, comment on the summary of other students, learn searching biological database and skills to do interdisciplinary project. I am looking forward to using Wiki portal in a future teaching opportunity.

Teaching Practicum (GS 903): GS 903 consists of three observed teaching events. For each observation, a Graduate Instructional Developer from the CTE office attends the event and provides written feedback consisting of aspects to maintain and targets for change. I have completed two observations for MATH 237 which I was teaching in spring 2011. I have included some comments from these teaching evaluations in Section 5 and additionally in Appendix B.1.

In addition to the certificate program described above, I attended teaching assistant training in the Faculty of Mathematics at the University of Waterloo upon starting my PhD program. In order to improve my teaching skills I also do discussion with my colleagues and professors in the department. I pay special attention to student comments about my teaching styles.

5 Evaluation of Teaching

As an instructor, I have had my teaching observed by faculty members from my department (Department of Applied Mathematics) and trained observers from the Centre for Teaching Excellence at the University of Waterloo.

Student Evaluation: I encouraged students to give feedback on my teaching. The student comments where quite effective in identifying strong and weak points. I designed feedback form for both the courses which I taguht based on the recommendation offered by Centre of Teaching Excellence at the University of Waterloo and Teaching College Level Science course at the MIT open course ware[1].

Representative student comments include "Great prof and fun class, I could tell you cared about your students and tried to help as much as possible", "Maybe more examples and fewer proofs". Students also seemed to enjoy figures and handouts that I brought into lecture. About the figures that I brought into lecture one student wrote "the visual image you brought to lecture helped a lot.". "Figures are very helpful. It would be great if we had more time to draw the figures and not just do a half finished diagram. But aside from that, thank you so much for your patience when I ask stupid questions. It is great when you can return an answer without sounding obvious.". See Appendix C.1 for student comments.

Teaching Observation by Center of Teaching Excellence: While completing the Teaching Practicum course for the Certificate in University Teaching (Section 4), I had three lectures observed by trained observers. Since my observed teaching events were spaced throughout the term, I was able to incorporate feedback from early evaluations into my lectures and gauge my success. In an early observation, it was noted that my strategy to identify important points could be improved. In preparing for subsequent lectures, I identified points in each lecture where I could stress important concepts. In a later observation event, I addressed the issue of the identifying and suggesting important points. I also maintained the logical flow of writing on the black-board which was noted as a target of change in my first observation. The teaching observation report in Appendix

[1]Mahajan, Sanjoy. 5.95J Teaching College-Level Science and Engineering,Spring 2009. (Massachusetts Institute of Technology: MIT OpenCourseWare), http://ocw.mit.edu (Accessed 08 Jan, 2013). License: Creative Commons BY-NC-SA

B.1 gives an example of further comments on my teaching by the trained observer from the Centre for Teaching Excellence at the University of Waterloo.

Evaluation by Department: While I was teaching I was evaluated by my department chair and my supervisor. Both of them appreciated my knowledge of subject material and suggested improvements. They recommended that I should write down the concepts on the board before explaining it. Second, feedback I got is that I should not keep writing for long period of time and do the same while speaking; both of them should be properly balanced. I learned from this feedback and improved my teaching style in the subsequent lectures. Letter from my supervisor Dr. Brian Ingalls about my teaching is included in Appendix B.2.

6 Future Goals

I would like to teach different courses offered at different levels at the University. I enjoyed teaching second year math honors students and would like to teach the course again. I would also like to teach linear algebra and interdisciplinary courses like computational biology.

I would like to incorporate different teaching activities according to class size in my lectures. I would like to use clickers for large classes. Classroom clickers are the student response system designed to engage students for active learning. Clickers are useful for: attendance, student progress, classroom feedback, assessment, creating interest. I would like to integrate some new interactive student activities into my lectures. I would like to do brainstorming and class discussion activities in large classes for some special topics. Furthermore, I would like to do case study activity in smaller classes for some special topics.

I am also interested in teaching senior courses, especially in the area of my research system biology, and in related areas of interdisciplinary science. In particular, I would like to teach third year or graduate-level topics course on computational biology.

Appendices

A Teaching Materials

A.1 Sample Lecture Notes Calculus 3 (MATH 237)

Constrained Optimization course note Section 10.3
Example 1: How do we maximize the area of an enclosure built against an existing wall given that we have 400m of fencing figure 1?

Solution: Aim: How do we maximize $A = xy$, given the constraint,

$$x + 2y = 400$$

So, let us rewrite as $A = (400 - 2y)y = 400y - y^2$
Differentiating with respect to y

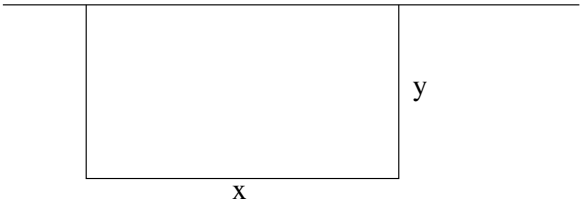


Figure 1: Example 1

$$A^{'}(y) = 400 - 4y$$

Setting $A^{'}(y) = 0$, gives $y = 100$, so the only critical point is at $y = 100$, this gives $x = 300$.

Unfortunately, we will not be able to always solve for x as we did here. So, there is more general method.
Consider the level curve of a function $f(x, y)$ to be maximized or minimized.

1. A constraint function $g(x, y)$ will define a level curve on the xy plane.
2. Extreme values of $f(x, y)$ on the $g(x, y)$ will occur when the two curves meet tangentially. See figure 2. $f(x, y)$ is called as Objective function.

Next question: How can we tell when this will happen? Idea about Gradient Vector.

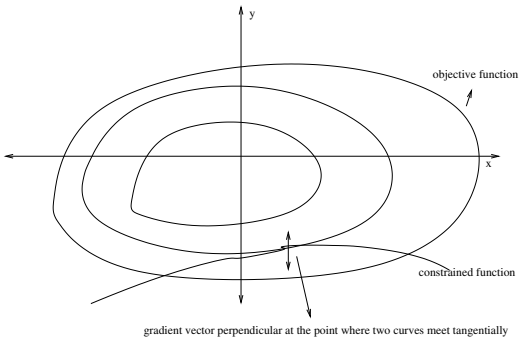


Figure 2: Geometric interpretation

1. We know that ∇f is always orthogonal to level curve.
2. If we view the constraint as one particular level curve of constraint function $g(x, y)$, then ∇g will be orthogonal to the constraint curve. For example for our area problem $g(x, y) = x + 2y$, $x + 2y = 400$ is then one level curve of $g(x, y)$ of g.
3. When the constraint curve is tangential to a level curve of $f(x, y)$, then we ∇g is parallel to ∇f. See figure 2.

This idea leads to the Method of Lagrange.

A.2 Sample Lecture Notes Calculus 1 MATH 116

Learning Objectives Students who have practiced the techniques presented in this lecture will be able to:

- *Related rate problems.* Students who have practiced the techniques presented in this lecture will be able to: Recognize a related rate problem, solve simple related rate problems.

- To motivate thinking process, consider this example we just state the problem here. Find two quantities whose sum is 78 and whose product is 1296 [a].
- We divide the page by a vertical line. On one side we write the verbal statement split into appropriate parts. On the other side, we write algebraic signs, opposite to the corresponding part of the verbal statement.

Stating the problem

in English	**in algebraic language**
Find two quantities	x, y
Whose sum is 78 and	$x + y = 78$
Whose product is 1296	$xy = 1296$

Observe verbal statement translated into mathematical symbols.

[a] "How to Solve it" G. Polya

We provide the following examples as models to solve this type of problem.

Example 1: Air is being pumped into a spherical balloon so that its volume is increasing at a rate of 100 cm^3/min. How fast is the radius of the balloon increasing when the diameter is 50 cm.
Solution:

Given

- The quantities involved are the volume $V(t)$ of the balloon changing with respect to time t and the radius $r(t)$ of the balloon changing with respect to time t.
- The volume is increasing at a constant rate of 100 cm^3/min. That is $V'(t) = dV/dt = 100$.

Required: The value of dr/dt when $2r(t) = 50\,cm$ or $r(t) = 25\,cm$.

- We state an equation which relates the two quantities V(t) and r(t):

$$V(t) = \frac{4\pi r(t)^3}{3}$$

- Then

$$\frac{dV}{dt} = \frac{d}{dt}\left(\frac{4}{3}\pi r(t)^3\right) = 4\pi r(t)^2 \frac{dr}{dt}$$

Isolate $\dfrac{dr}{dt}$, we obtain

$$\frac{dr}{dt} = \frac{1}{4\pi r(t)^2} \cdot \frac{dV}{dt}$$

When $r(t) = 25$ and $\frac{dV}{dt} = 100$ we obtain:

$$\frac{dr}{dt} = \frac{100}{4\pi 25^2} = \frac{1}{25\pi} \text{ cm/s}$$

A.3 Assignment of MATH 116 Which I prepared

[12] 1. Compute the following integrals by substitution.
(a) $\int \sec^4(x)dx$ (Hint: Rearrange, $\sec^2(x) \cdot \sec^2(x) = (1 + \tan^2(x))\sec^2(x)$, now do substitution)
(b) $\int \frac{1}{9x^2+6x+5}dx$ (Hint: Complete the square and recall the derivative of arctan(x).)
(c) $\int (x^3 - 1)^{\frac{1}{3}} x^5 dx$
(d) $\int_0^2 xe^{-x^2}dx$
(e) $\int_0^1 \frac{\arctan(x)}{1+x^2}dx$
(f) $\int_0^2 x\sqrt{x+2}dx$ (Hint: substitute $u = x + 2$)

[4] 2. Find the average value of the following function on the given interval.
(a) $f(x) = \cos^4(x)\sin(x) \quad 0 \le x \le \pi$
(b) $f(x) = x^2(1 + x^3)^4 \quad 0 \le x \le 2$

3. The velocity v of blood that flows in a blood vessel with radius R and length l at a distance r from the central axis is:

$$v(r) = \frac{P}{4\eta l}(R^2 - r^2)$$

where P is the pressure difference between the ends of the vessel and η is the viscosity of the blood (Note these are constants). Find the average velocity *with respect to* r over the interval $0 \le r \le R$. Compare the average velocity with the maximum
[4] velocity *(Hint: when this expression $R^2 - r^2$ will be maximum).*

[10] 4. Curve Length
(a) Find the length of the curve:

$$y = 1 + 6x^{\frac{3}{2}} \quad 0 \le x \le 1$$

(b) Find the length of the curve:

$$y = \int_1^x \sqrt{t^3 - 1}dt \quad 1 \le x \le 4$$

(c) Find the length of the curve:

$$y = \ln(\cos(x)) \quad 0 \le x \le \frac{\pi}{3}$$

Total: /30

A.4 Sample Tutorial Questions from Calculus 1 MATH 117

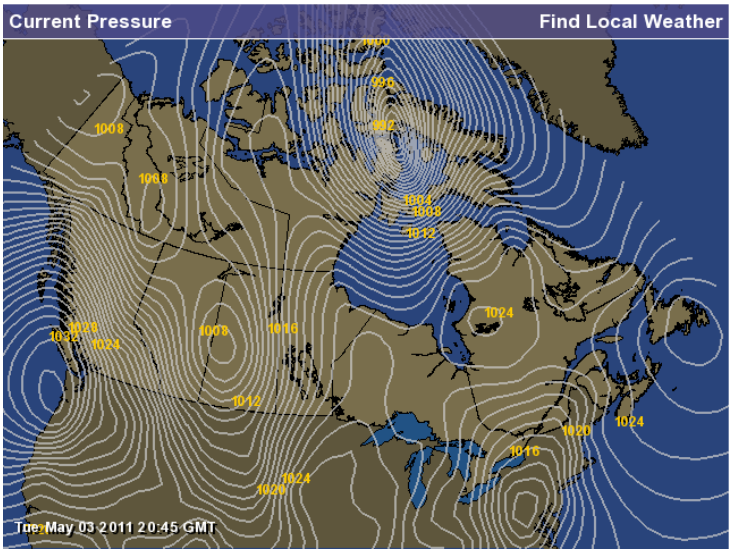
Sample tutorial problems from Tutorial 1 of Math 117 Calculus 1

Example 1: Verify the $f = |x^3|$ is even or odd function
Learning Goal: To learn about verifying even and odd function
Solution: Let us break the question into two case
case 1 $x > 0$
$f(x) = |x^3| = x^3$
case 2 $x < 0$ $f(-x) = |-x^3| = x^3$
hence, $f(-x) = f(x)$ Even function.
Example 2: Find the inverse of function $k(x)$, where $k(x)$ is defined as $k(x) = -3f(x)$
Learning Goal: Learn to find the inverse of implicitly defined functions
Solution: Let $y = k^{-1}(x)$ then:
Multiplying both the sides by function k and noting that$k * k^{-1} = 1$
$x = k(y) = -3f(y)$ x and y are dummy variables
$f(y) = \frac{x}{-3}$ Rearranging the terms
$y = f^{-1}(\frac{x}{-3})$ Multiplying both the sides by function f^{-1} and noting that$f * f^{-1} = 1$
We have assumed $y = k^{-1}(x)$, So,
$k^{-1}(x) = f^{-1}(\frac{x}{-3})$

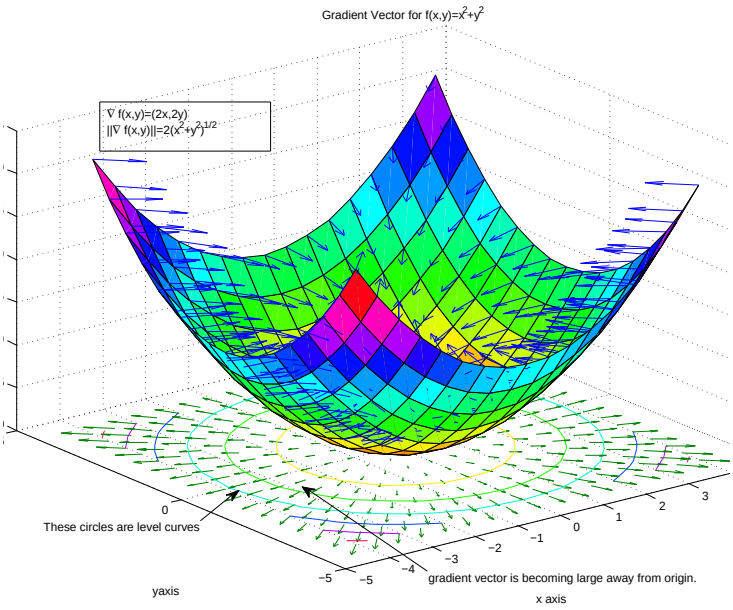
Example 3: Find the inverse of Length contraction equation $L(v) = L_0\sqrt{1 - \frac{v^2}{c^2}}$. This example is for last problem of assignment 1
Learning Goal:To understand the physical significance of variable while finding inverse of the function
Solution: Note here that the input to $L(v) = L_0\sqrt{1 - \frac{v^2}{c^2}}$ is velocity. $L(v) = L_0\sqrt{1 - \frac{v^2}{c^2}}$
Squaring both the sides
$L^2(v) = L_0^2(1 - \frac{v^2}{c^2})$
Rearranging the terms such that:
$v^2 = c^2(1 - \frac{L^2}{L_0^2})$
Neglecting the negative solution since negative part has no physical significance
$v = c\sqrt{1 - \frac{L^2}{L_0^2}}$ this is $f^{-1}(L)$

The input to $f^{-1}(L)$ is length not velocity. If we switch the variable as we do after finding the inverse then the physical meaning of the variable should not be ignored.

A.5 Sample Figures used during Lecture for MATH 237



(a) This figure is used to explain the application of level curve



(b) This figure is used to explain the gradient vector

Figure 3: Sample figures from MATH 237 lecture

A.6 Sample Class Discussion Handout for MATH 116

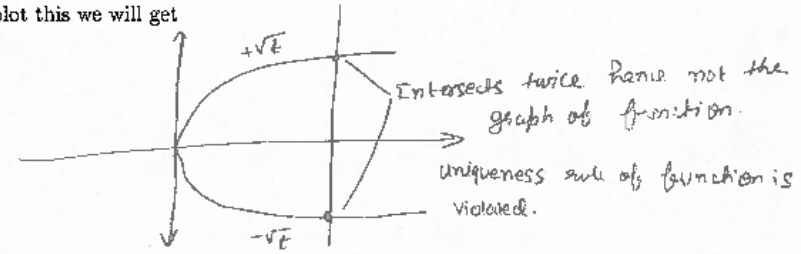
Questions asked in the class

1. Why only one-to-one functions have inverse functions?

   Let us understand this through taking counter example of function $f(t) = t^2$ (page 68 of textbook)
   The inverse function for this (which does not exist but assume it exist?)

   $$f^{-1}(t) = \pm\sqrt{t}$$

   If we plot this we will get

2. When to check for functions to be one-to-one?

   The basic principle is that a student should always be aware that **Only one-to-one functions** have inverse. For standard functions like polynomial functions, rational functions just state the function is one-to-one. For non-standard functions like $\cosh(x^3)$; the general practice is that the domain in which function is one-to-one is stated in the question itself.

3. For exponential functions why we need to have $a > 0$? Again let us see what happens by taking counter example. Let $f(x) = (-2)^x$. Now, what will be the value of $f(\frac{1}{2}) = (-2)^{\frac{1}{2}}$, this is not **real-valued** function.

Reading Memo: Write your comments here.

Acknowledgment and References This question list is dedicated to my wonderful class.

B Letters from Colleagues

B.1 Observation from Certificate in University Teaching Program

Private & Confidential

Observation Report #2
Rahul Rahul – Applied Mathematics

Event Observed:	MATH 237 – Lecture (as course instructor)
Date of Observation:	Friday, July 15th, 2011 at 2:30 – 3:20 PM
Location:	MC 4021
Students Present:	12 Students
Prepared By:	Michael Pyne, Graduate Instructional Developer, Centre for Teaching Excellence

Context of Teaching Event: In this teaching event you were the course instructor for MATH 237 (Calculus 3 for Honours Mathematics), which is a mandatory course for second-year honours mathematics students. Since you are the instructor for this course, the students were already familiar with your teaching style. This particular lecture involved iterated integrals. You aimed to present some concepts and solve problems on the blackboard during this lecture. Your objectives for this lecture was to have the students be able to define and explain the concept of iterated integrals, examine and evaluate techniques of iterated integrals, analyze applications of iterated integrals and discuss the idea of iterated integrals with one variable integrals.

Aspects to Maintain:

- **Rapport.** Rahul, it was immediately evident to me that you have an excellent rapport with the students in your class. As the term was well beyond the halfway mark at the time of this lecture, you had clearly established this rapport earlier on in the semester. I enjoyed how you arrived to class approximately 10 minutes early and engaged in minor conversation with students. You even assisted one student by going over a previous concept on the blackboard. This was excellent because you demonstrated to students that you are kind, compassionate and approachable in the classroom. Overall, you have established an excellent rapport with your students. Congratulations Rahul!

- **Confidence and Credibility.** As part of our pre-observation meeting, you asked that I pay particular attention to your confidence and credibility. Overall, you exhibited a strong and confident presence in the classroom. Although you informed me that the first week of lectures was shaky and nerve-wracking, you appeared confident, positive and calm during this lecture. I am glad to see that you were able to recover so well after an uncertain beginning to the term. Being an instructor for a class can be a daunting task because graduate students often appear much younger than professors and you do not know how the students will react to this observation. Now approximately ¾ through the term, it does not seem that this is a problem for you, as you have clearly established your credibility as the course instructor. Sitting in on this particular lecture, it was very evident to me that the students responded to you and treated you like an experienced instructor. You appeared knowledgeable, comfortable and confident in front of the class and this added to your credibility immensely.

- **Boardwork and Organization.** You also asked me to provide feedback on your boardwork and organization during our pre-observation meeting. I was quite impressed with the structure of your notes and use of board space. Your notes were legible from the back row of the lecture hall, presented from left to right and organized logically. This is important, as too much text or information on the board can be distracting to your students, especially since they did not have the lecture notes ahead of time. Related to your use of chalkboards, I felt your use of coloured chalk to highlight important concepts worked very well. You used white chalk for the majority of your notes and only switched to other colours to emphasize notable points, conclusion statements and important exceptions. Although overuse of this technique can be quite distracting, I feel your use of coloured chalk was very effective at drawing students' attention to the take-home points of your guest lecture. Keep this up Rahul!

- **Highlighting Important Points.** Similar to your use of coloured chalk, I was very impressed with your ability to guide and direct student attention towards the key points of your lecture. You made it very clear to the students what was expected of them with regard to your lecture. I also think it was great that you knew what your students probably wanted most – the information that they needed to be able to succeed in the course exam(s). Considering this fact, I thought it was very helpful that you pointed out the important take-home points within the material that you presented. For example, you made comments such as, "The other thing to notice in this kind of question is…" and "Always start by plotting the domain!". In making these comments, you are helping to ensure that your students come away with the information that you think is vital to them. Highlighting the important points can go a long way for your students. It will capture their attention during the lecture and, if they take good notes, will help them when it comes to studying for the exam. Overall, it is always a good idea to make it clear to your students what you want them to take away from your lecture!

Targets for Change and Methods for Improvement:

- **Vocal Qualities.** Rahul, you lead an excellent lecture that was interesting and informative. Nevertheless, I observed some aspects of your vocal delivery that you may want to consider altering in your future teaching endeavours:

    a) *Pace*: As a result of your expert knowledge of the material, I am concerned that the pace with which you moved through this lecture may have been too fast for some members of the class. This is likely no surprise to you, as you informed me students have provided similar feedback to you during past teaching evaluations. Often I found that you spoke very quickly and this made it difficult for me, and probably many of your students, to follow your presentation. Slowing down your speech will help your students stay on track with your teaching. Interestingly, you tend to speak in English quite rapidly even though it is not your native language. Thus, you will likely need to make a conscious effort to slow down when teaching. I suggest periodically asking your students if they think you are talking too quickly for them to follow.

B.2 Feedback from my Supervisor Dr. Brian Ingalls

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Dear Rahul,

I am writing to reiterate the comments I made to you after attending your Math 237 lecture. Overall, the lecture was well-presented. The students seemed interested, and you showed solid mastery of the material. Some specific aspects of your delivery that you could work on:

i) Oral delivery: It may not have helped that I was in the room, but you were speaking a bit too quickly and softly. If you could slow down and project a little louder, it would help, especially for students toward the back of the classroom.

ii) Blackboard use: Overall, your use of the blackboard was good: the writing was clear at it was well-organized. My one suggestion here is that you could write less – use bullet points and shortened descriptions. There's no need to use full sentences or include all details of a discussion.

Again, overall I was impressed with the lecture and the reception from the students. Well done!

Best regards,

Brian Ingalls
Associate Professor
Department of Applied Mathematics
University of Waterloo

C Course Evaluation

C.1 Student Comments

Please spend 2-3 minutes on the following 2 questions. Your (anonymous) answers will help in improving my lectures. Thank you!

- What was the main difficulty in understanding the lectures and what according to your suggestions could have helped in delivering the lecture appropriately?

I personally think the graphic parts were a bit difficult to understand, but the visual images you brought to the lecture definitely helped a lot.

In terms of course structure, I think the time that spent on the 'extrem values' chapter should be longer. I struggles with this chapter (9 & 10) the most.

- Other comments or suggestions?