Final Report for the 2005-2007 LITRE Project

Creation of Interactive Maple Practice Sessions and QuickTime Video Versions of Maple Lessons

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1 Introduction

During the spring 2007 semester I sought to assess the impact of new Maple learning tools on how well students learn multiple integration in Calculus III, MA 242. The new learning materials created for this study are:

1. Several Quicktime movies that introduce the materials to the students.
2. Interactive Maple worksheets tutorials designed to help the students practice with the concepts of multiple integration, with instant feedback from *eGrader*, the computer that automatically grades each student's Maple homework assignments.
3. Web pages from which students can access all of the above materials.

The impact of these new learning tools was assessed as follows:

1. All MA 242 students were asked to work the same problem on Test #3, with common grading instructions for all graders.
2. Students were asked a survey question on the final exam.

During the 2005-2006 phase of the project we extracted "new mistakes" students made on Maple homework questions that were related to multiple integration. This data was feed back into the grading code used to create the interactive Maple sessions. The goal was to "have an intelligent response from eGrader for as many standard mistakes as possible".

The 2006-2007 phase of the project was concerned with the creation of the learning materials and assessment activities. In sections 2 - 6 I will exhibit the assessment questions and then present a survey and interpretation of the results. A number of screen captures will be included at the end of this report to show some aspects of the new learning materials. The Quicktime movies can be viewed at URL

http://www.math.ncsu.edu/~lkn/MA242_videos/eTutorWebPage.html

2 Communicating with MA 242 Instructors

The new learning tools concentrated on the second Maple homework assignment that deals with double integration. To test the impact of these new learning materials, I involved all MA 242 lecture instructors in the process. Here is a copy of the content of the letter I sent to lecture instructors in early January, 2007.

This spring I have plans to assess how Maple helps MA 242 students learn Calculus III concepts. In particular I will attempt to assess the impact of new Maple learning tools on how well students

learn multiple integration in Calculus III. Fortunately almost all of the assessment work will NOT involve MA 242 Lecture instructors - you will only be asked to make a few announcements in lecture class, and agree to include a standardized problem on multiple integration on tests #3 and one survey question about Maple on the final exam. I will be talking with each MA 242 lecture instructor in the next few days to explain the project and to get your input on the assessment plan.

Here is a brief outline of the assessment activities.

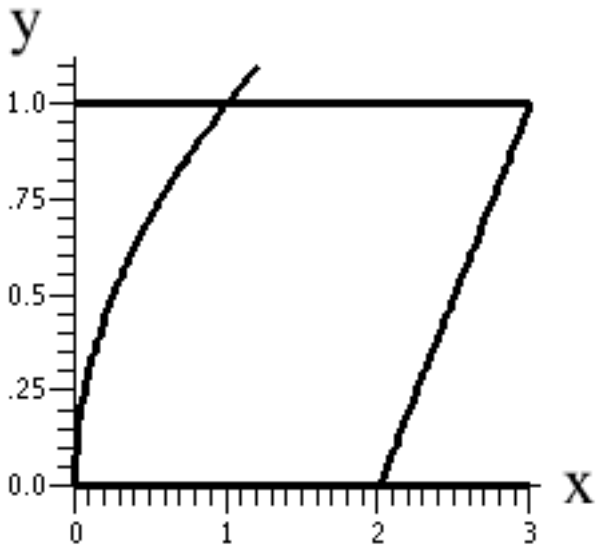
1. *The 12 sections of MA 242 will be divided into two groups, a control group (I) that uses the standard Maple tools already in place in the department, and a study group (II). Students in group (II) will be provided new learning tools on double integration, and our goal is to see what impact these new tools have on student learning.*

2. *To test the impact of the new learning tools all students in MA 242 will work the same problem on mutliple integration on test #3. Each lecture instructor will be provided with the same rubric to follow in grading the problems, and a common "Pre-test Statement" about the problems is listed below with each problem. The average grades, etc will be compared between the two groups.*

3. *All students will be asked a common question concerning Maple on the final exam.*

3 The Problem for Test #3

3.1 The Problem



(10 points) Consider the region $\mathcal{D}$ in the xy-plane bounded by the lines $y = 0$, $y = 1$, $y = x - 2$ and the curve $x = y^2$, which is shown in the above diagram. Considering the region as a Type II region, set up (but DO NOT evaluate) $\int\int_{\mathcal{D}} f(x, y)\ dA$ as a double iterated integral.

3.2 The Grading Instructions

The correct answer for this problem is $\int_0^1 \int_{y^2}^{y+2} f(x, y)\ dx\ dy$. Please apply the following rules in grading this problem.

1. Limits 0 and 1 on the "outer" integral are worth 2 points each.
2. Limits y^2 and $y + 2$ on the "inner" integral are worth 3 points each.
3. If limits are reversed, but otherwise correct, subtract 1 point (-2 possible if both integrals have limits reversed).
4. If students treat the region as type I then -10 points.

Please REPORT to me the following data:

I. Total number of students attempting the problem.
II. The total score on that problem: sum together all students' grades on this problem.

4 The Question for the Final Exam

All MA 242 students were asked to answer the following survey question about Maple.

1. *Did using Maple help you to better understand any aspect of Calculus III?*

5 The Results

Table 1 shows the data collected for the common problem on MA 242 Test #3 for the 4 sections chosen randomly for the study groups. Table 2 below shows the data for the sections chosen as the control groups. Not all sections chose to complete both the problem for test #3 and the question for the final exam, and not all sections chose to participate in the project. The is the main reason the number of students in the control groups and study groups differ by about 100 students.

Table 1: Collected Data and Averages for Study Groups

Section	# of students	total score	average grade	Final Exam "YES"	Final Exam "No"
S-1	80	702	8.8	–	–
S-2	31	245	7.9	16	18
S-3	95	881	9.3	—	—
S-4	42	374	8.9	0	36
Totals for Study Groups	248	2202	**8.9**	**16**	**54**

Table 2: Collected Data and Averages for Control Groups

Section	# of students	total score	average grade	Final Exam "YES"	Final Exam "No"
C-1	47	410	8.7	—	—
C-2	34	267	7.9	17	16
C-3	66	548	8.3	9	51
Totals for Control Groups	147	1225	**8.3**	**26**	**67**

6 Interpretation of Results

6.1 Test #3 Question

From the data in Tables 1 and 2 we see that the average grade for all students in the study groups is 0.6 points higher (out of 10 points) than the average grade for students in the control groups, a 6% increase in average grade for those students who had access to the new learning materials. Three of the four study groups had average grades higher than the average grade of all sections in the control groups, while one of the four had an average grade below the average grade for all sections in the control groups. Thus the students in the study groups did slightly better on the common question on test #3 than their counterparts in the control groups. It should be pointed out that it is unknown how many students in the study groups actually took advantage of the new learning materials.

6.2 Final Exam Survey Question

The results of the final exam question *Did using Maple help you to better understand any aspect of Calculus III?* are listed in the last two columns in tables 1 and 2. Considering all sections together the data shows that by a margin of about 3 to 1 the students felt that Maple did NOT help them to better learn calculus. The same is true if we consider only study groups or control groups. However, the data shows a large deviation from the average in both the study groups and control groups. While the students in study group S-2 and control group C-2 were almost equally divided on this question, the students in study group S-4 and control group C-3 overwhelmingly felt that Maple did not help them better understand calculus. Study group S-4 was a Tuesday-Thursday evening class, while all other sections were M/T/Th/F sections. A consequence of the T/Th schedule is that while all students in regular M/T/TH/F sections took tests on the same day, the T/Th section took the tests on different days. The lecturer for the study group S-2 reported that his students' Maple assignments generally occurred AFTER the test on the corresponding materials, while students in all other sections did their Maple homework BEFORE the test on the corresponding material.

Thus the data is inconclusive about student attitudes about how much Maple helps calculus students to better understand calculus. Moreover, the results suggest that it could be important to assess the impact of Maple activities on student learning when students do Maple Homework related to test materials BEFORE and AFTER the in class tests.

7 The New Learning Materials

The webpage shown below in the screen capture is the portal to the QuickTime videos. The web page can be accessed on the web at the URL

http://www.math.ncsu.edu/~lkn/MA242_videos/eTutorWebPage.html

Figure #1: The eTutor Web Page

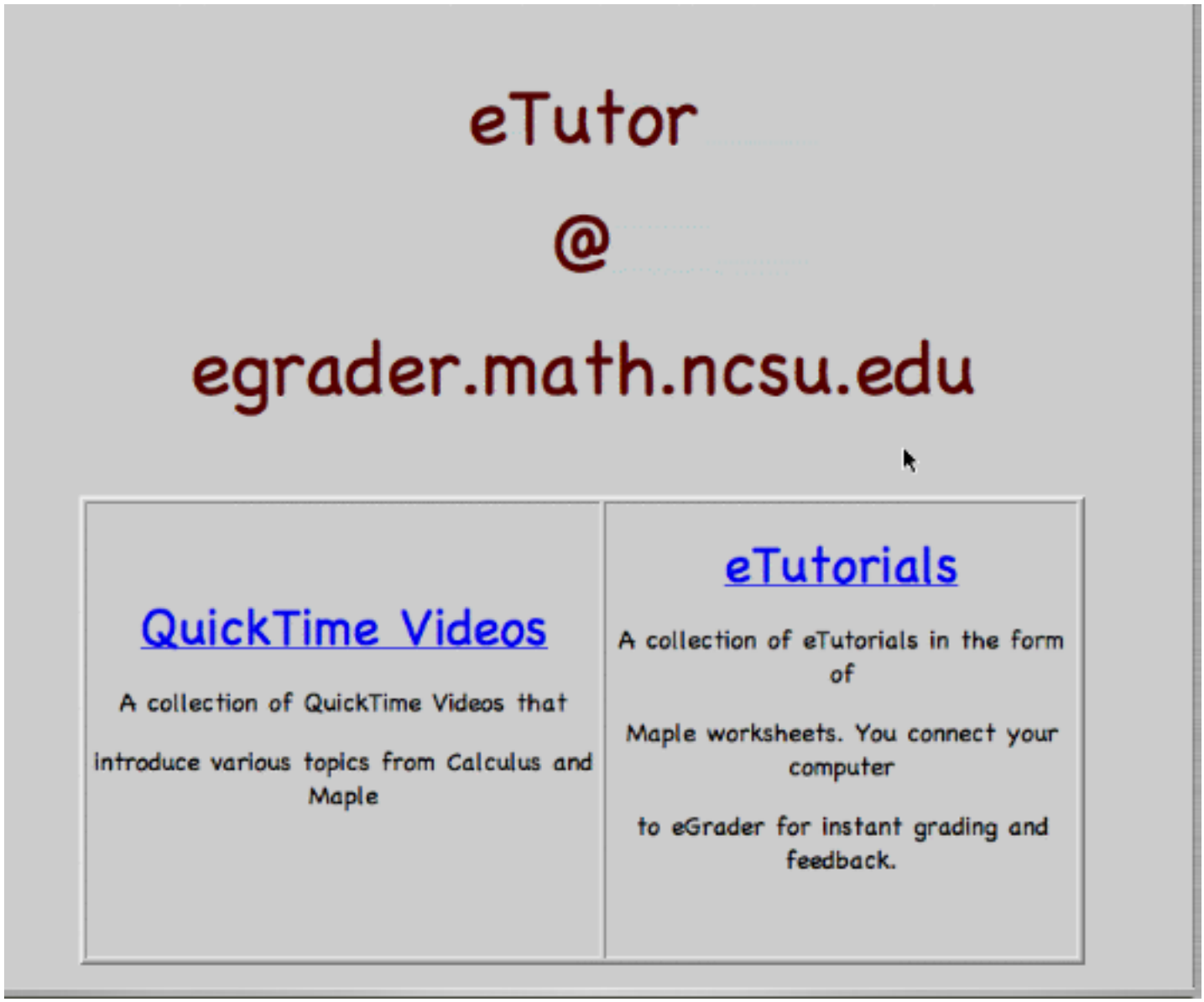


Figure #2: The QuickTime Videos Webpage

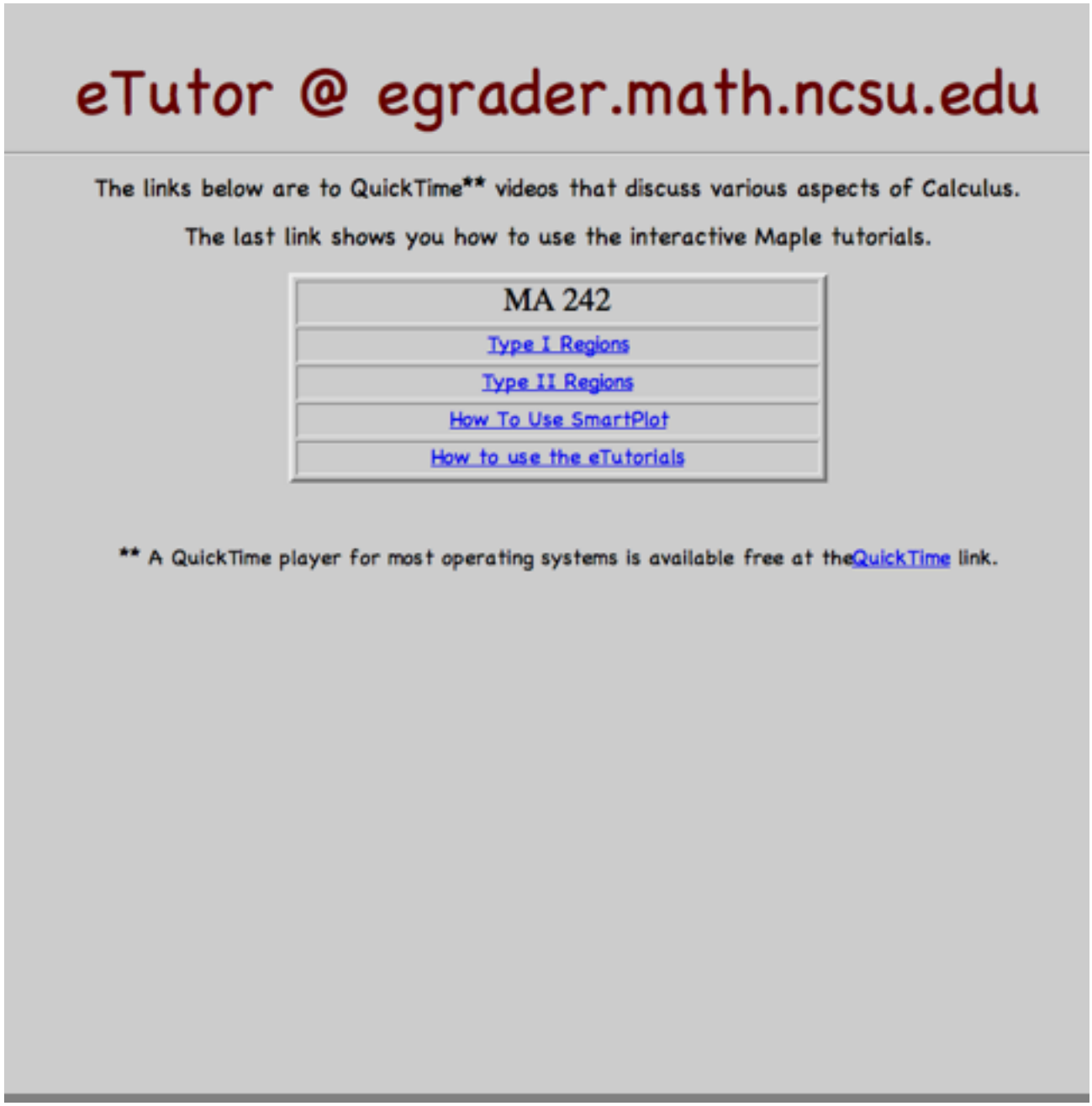


Figure #3: The eTutorials Web Page

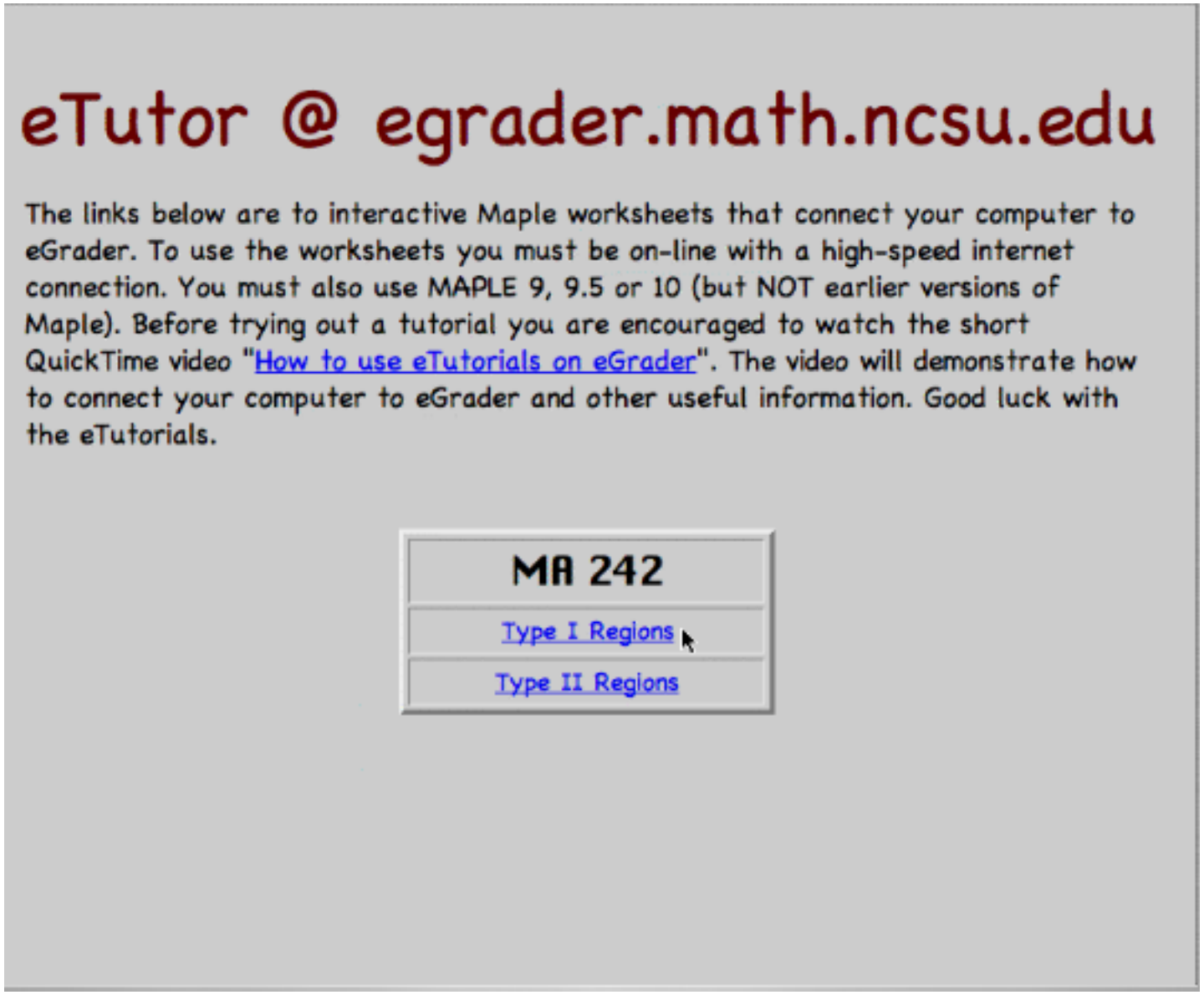


Figure #4: The Type I Regions Web Page

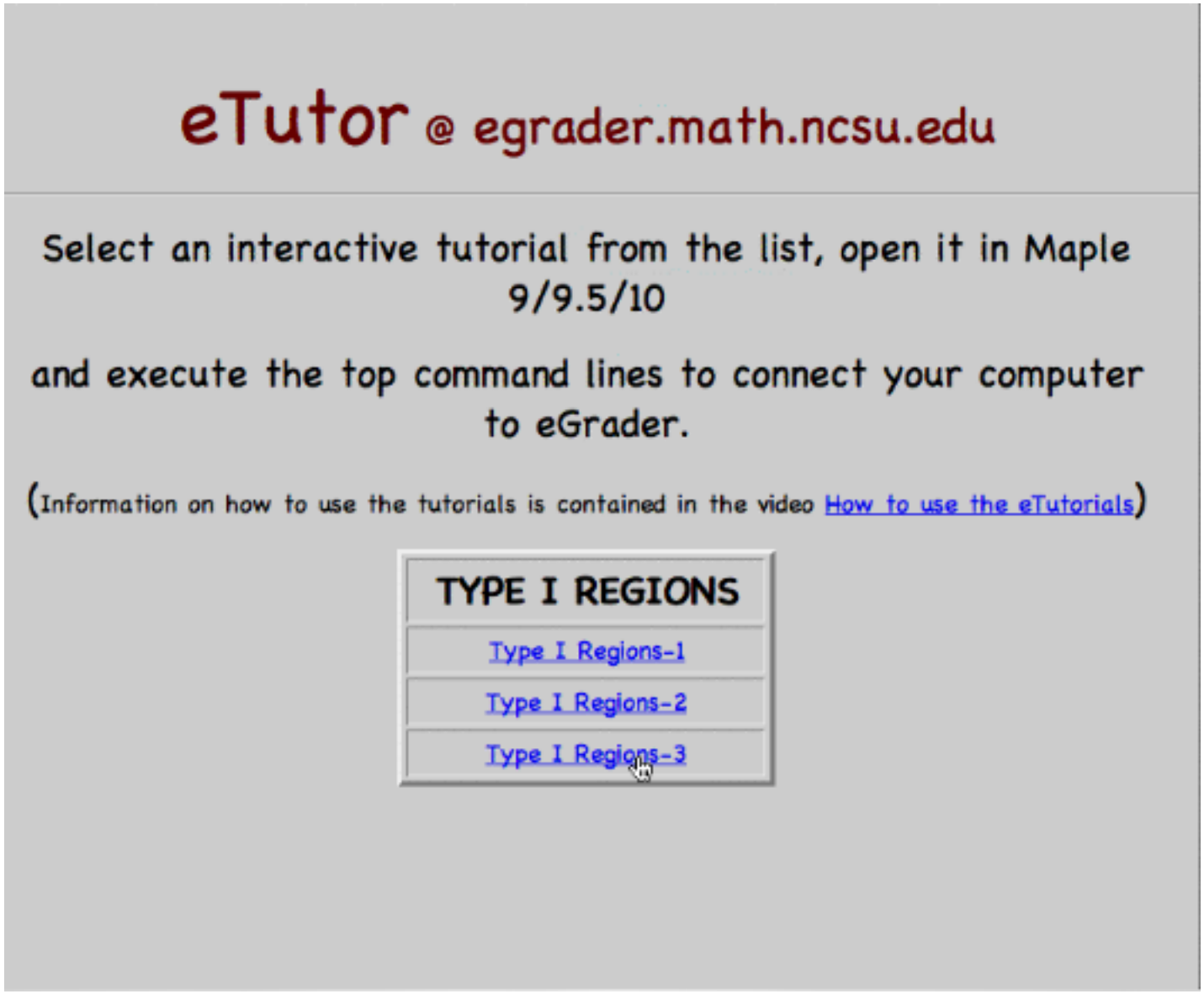


Figure #5: Beginning of a Maple worksheet eTutorial

```
> restart;
```

Initialization

```
> #Client side of the tutor
  sid := Sockets:-Open("egrader.math.ncsu.edu", 4100):
  #Open the connection to the server
  Sockets:-Write(sid, "TYPE_I_SIMPLE_10_03.mws"):
  #Send the worksheet Id
  parse(Sockets:-Read(sid), statement):
  set_sid(sid):
```

The Problem

A. The region D shown is a type I region.

blue curve is y = 25*x^3+9*x^2+40*x+61

red curve is y=4*x^3-59*x^2+62*x-55

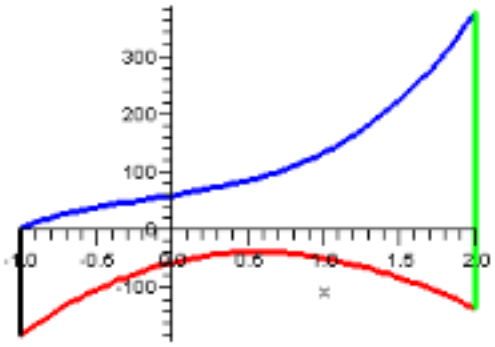
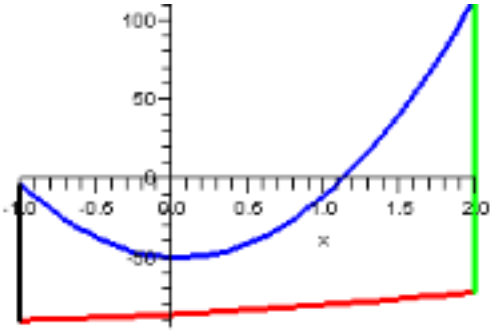


Figure #6: End of a Maple worksheet eTutorial



Describe the type I region according to the following template.

$$D = \{(x,y) \mid x = \text{ans3} .. \text{ans4} , y = \text{ans5} .. \text{ans6} \}$$

Assign your answer to the name **TheListOfRanges** in the form of a LIST as **TheListOfRanges := [x = ans3 .. ans4, y= ans5..ans6]**. For example, **TheListOfRanges:= [x=-42..55, y = -x .. x^3].**

```
>
> TheListOfRanges := [x=-1..2 , y = x^2+5*x-86 .. 43*x^2-4*x
  -50];
  printf(grade(eval(TheListOfRanges), 1, 2));
```

$$TheListOfRanges := [-1..2, y = x^2 + 5x - 86..43x^2 - 4x - 50]$$

```
Your score was 0.00 percent
Summary of deductions:
  Lost 100.00 percent: You have not given the first entry in
TheListOfRanges as an EQUATION inside of a list.  Please redo your
answer for TheListOfRanges and be certain that your list CONTAINS AN
EQUATION of the form x = ans3.. ans4 in the first slot.
```