2003-2004 Faculty Learning Community Portfolio

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Contents

Part 1

My Statement of Teaching Philosophy

It is my experience that students learn first by example. I find it most effective to present the main thrust of a theorem, discuss an example and then let the students guide me to exceptions and needed assumptions. When they point out that the Rolle's Theorem I just presented might not work if the function in question is not differentiable then I know (and they know) they understand the theorem. Of course, the complete theorems are presented by the end of lecture but mathematics should be learned like a language, at first don't dwell on the exceptions. And like a language, mathematics is best learned through practice and use. The Confucius quote "I hear, I forget; I see, I remember; I do, I understand." supports my belief that math is not a spectator sport.

In courses where the majority of the class is not pursuing a mathematics major, the question "Why do we have to learn this, what good is it to us in zoology?" must be pro-actively addressed. After the concept is grasped in the pure realm, I show a concrete use for it in another subject area using real data and simulations. It does help to know what the students are learning in their other core courses.

I feel it is important that a lecturer impart enthusiasm for mathematics and take every opportunity to reveal how elegant mathematics, even at an introductory level, can appear. I remember being a student and noticing the professor that seemed to view his teaching as a distraction from more important research. That professor missed an opportunity to leave the classroom energized. We students missed the opportunity to absorb some of his enthusiasm. Ideally, both student and professor benefit from class time.

In summary, my teaching is effective because it is enthusiastic and complete with examples, both pure and applied.

Metaphor for Teaching

My metaphor for teaching is that of an uncle. He can guide a student through the subject with advice and instruction. I hope this is illustrated in these exerts from a future work.

"Joe, what exactly is Calculus anyway", asked Lucy. "Even Mr. Kilroy's answer wasn't very clear."

"We can go ask my uncle, I said as Lucy and I stepped into the high school parking lot. It was a beautiful September afternoon that made us feel cheerful despite the fact that we had just accepted quite a challenge from our math teacher. Mr. Kilroy had convinced us to take an accelerated math course that would focus on Calculus and now we were having second thoughts. I dropped by my Uncle Rick's garage after school everyday anyway and he always seemed to know the answers to my questions. To be fair most of my questions pertained to my 1981 Fiat X/19 that Lucy and I approached in the school parking lot. She helped me take the targa roof panel off so we could enjoy this great day during our trip to my uncle's Texaco. The Fiat was a small mid-engined car, just a two-seater, but then again, I wasn't a tall girl. Lucy was tall but with the targa panel safely stowed behind the seats she had plenty of room.

"Josie Brooks, let's take the long way past DeMarco's." Lucy loved those thick shakes.

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What's a function?

Uncle Rick handed me the broom stick with a nail in the end and a garbage bag. It was my job to clean up the parking lot of all the chocolate bar wrappers and such. I considered one of the many questions that I felt he didn't have a good answer for. That is, there must be a real name for the "broom stick with a nail in the end". Uncle Rick didn't think there was.

"We talked about functions yesterday", I said as I put on my work gloves, "There were three ways of describing a function."

"I always think of a function as a machine, you give it an input and it spits out an output. What makes it a function is that you never get two different outputs for one input." Uncle Rick gestured with an old tailpipe he was putting in recycling. "What are the three ways to describe a function?" he asked.

"Verbally, algebraically and graphically; for instance for verbally we can say the dependent variable is the square of the independent variable. Algebraically we would just write $y = x^2$ and graphically we draw the graph of this parabola."

Uncle Rick held up the tailpipe in front of his face, "Whoa, slow down, independent, dependent..." I saw that Lenny, one of his mechanics had arrived. It

bothered me that Uncle Rick, who I knew was extremely smart, always dumbed himself down in front of other people. Other people besides me that is.

"The independent variable is the variable you input into the function. You choose it from the domain of the function. The dependent variable is the output; it depends on what input you choose." I explained.

Range and Domain

"I always learn by example," stated Uncle Rick. "Take for example the function $y = \sqrt{x} + 2$. The **Domain** the function means the x's that you can input into the function. In this case, since you can't take the root of a negative number, the domain of the function is all x's that are greater or equal to zero, $x \geq 0$." He took the stick with the nail on the end and drew an x-y axis in the sand. "The **Range** of a function means all the possible y's that can come out of the function. The smallest y-value of y = 2 occurs when x = 0. There is no biggest y-value. So the range is all y's greater than or equal to 2, $2 \leq y$." He drew the graph of the function $y = \sqrt{x} + 2$.

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Two Kinds of Slopes

Uncle Rick had sent me to get us some lunch at the Tim Horton's on the corner. When I returned I saw him leafing through my Calculus text. "Instantaneous rate of change, velocity, marginal cost, the derivative, tangent slope", he mumbled as I gave him his coffee. "Then we have average rate of change, secant slope, slope of the line between two points. This text has 50 different names for two things!"

"You haven't finished sandblasting my plugs?" I joked.

I don't think he even heard me. "There are only two kinds of slopes in calculus, secant slopes and tangent slopes. Any line slope that is the slope of a line between two points is a secant slope such as the average rate of change. Any slope that is the slope of the curve at one point is a tangent slope."

Part 2: The syllabus of the class

Calculus & Analytical Geometry III

1016 243 02

Spring 2003/3

Professor: Dr. Bernard Brooks
Email: bpbsma@rit.edu
Office Phone: 475 – 4717
Office: 08 3224 in the Gosnell Building
Office hours: 9 – 10:00 MRF
or by appointment or just drop by and see if the door is open.
Website: www.rit.edu/~bpbsma

Class Times		Rooms
Monday	10 -11:50	8 2305
Thursday	10 -11:50	8 2305
Friday	10 -11:50	8 2305

The Course

You must have obtained a C or better in 1016 242 to enroll in this course. See attached policy sheet. This is a One-Quarter Course with six credit hours. This calculus course includes portions of pre-calculus delivered with a "just in time" teaching methodology. That is, we will do some review topics as we go. These review topics will be needed for the proper understanding of differential calculus, with an emphasis on graphical and algebraic analysis of functions.

The Text: Calculus Early Transcendentals, 5th Edition, by James Stewart, Brooks/Cole Publishers

Calculators

Calculators will not be allowed for quizzes, midterms and exams. You don't need one for this course but you can use one quietly at home where I can't see you.

Evaluation and Grading

6 Quizzes worth a total of 24%
Minute Quizzes worth a total of 6%
3 Term Tests worth a total of 33%
Homework assignments worth a total of 11%
Participation and Attendance worth a total of 6%
Final Comprehensive exam worth 20%

The numeric grade will be converted to letter grades as follows:
90 – 100 **A**

80 – 89	**B**
70 – 79	**C**
60 – 69	**D**
0 – 59	**F**

A **W** means that you have officially withdrawn, not just stopped going to class.

Homework Policy

Completing the assigned homework is obviously a good thing. Besides the 11% allotted to it those people that do your homework do better on the tests and quizzes. Math is not a spectator sport, to quote Confucius,

"I hear, I forget; I see, I remember; I do, I understand."

I expect that you will help each other out with the homework. This is a portion of the grade that you have complete control over. Fill your boots here. Also, get a stapler. Don't hand stuff in with corners folded over; that never works.

MinuteQuiz

Almost every Monday or Friday class begins with a quick and simple quiz of one question that mirrors the last class or homework assignment. Only the first five minutes of class will be devoted to this quiz. If you come late, you have less time. More than five minutes late means a zero on that MinuteQuiz.

Make up Quizzes, tests, etc.

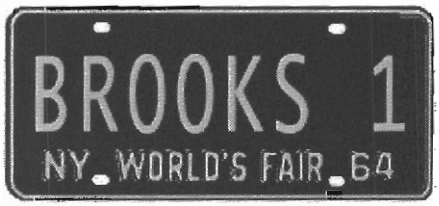
The bigger in-class evaluations occur every Thursday. If you miss a quiz, I will drop the lowest quiz anyway so you don't have to make that up. Missed homework cannot be made up. Missed MinuteQuizzes cannot be made up.

Attendance & Participation

I expect students to attend almost every class. I do keep track of who's there. This is another portion of the grade that you have complete control over. As far as participation goes, ask questions in class or during office hours to help yourself learn the material. Also, be on time for class, out of respect for the other students and to write the MinuteQuiz.

Special Math Paper

I will be giving out different styles of paper to that you must use for notes and homework etc. You will be surveyed on the effectiveness of the different styles of paper. I will use your ideas to develop a better layout of paper that will make math easier to study.



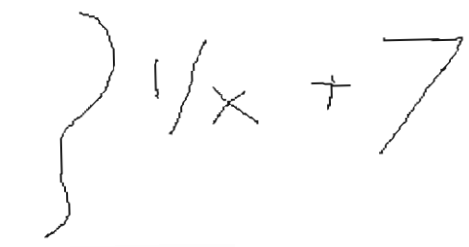
Part 3: The Problem to be addressed

I have over ten years experience teaching mathematics and year after year students express similar exasperations.

"It makes so much sense when you do it!"
"Why does my math get all confused and muddled up when I write it?"
"I don't seem to have time to review all my homework problems before the test."

These are just a few of my calculus students' issues I meant to address with this project. Why does it make so much sense when I write out a calculus problem? I look over their work and I have trouble deciphering the meandering path of their solution. Often as not it turns out to be correct but it remains very difficult to read; difficult for them to review, difficult for my grader to mark and difficult for anyone to observe the beautiful patterns of the algebra that correct mathematics creates. I saw the problem in three parts.

1) The Dominating Horizontal Line



Notice how the oppressive lines of regular note paper squeeze my student's integral. The answer is ambiguous. The correct answer could be lnx+7x+C or ln(x+7)+C. Of course the integral

could have been made clearer with brackets but we would still have the problem of trying to fit our mathematics between lines meant for prose. The horizontal lines are even more troublesome in abstract algebra where

 could mean one half or 1 divides 2.

These ambiguities in their mathematical notes were requiring that they redo problems entirely as they studied so they could understand what they wrote. This is of course not the most efficient method of studying and efficiency is needed in the quarter system. Thus, the horizontal lines of regular ruled notebook paper were making calculus more difficult than it had to be.

2) Recreating the wheel

I have had the opportunity to observe my freshman students study for their calculus exams, problem by problem. Those that are overly ambitious or very unsure of their mathematical abilities will attempt to redo every homework question and in-class example again as review. They painstakingly repeat each algebra step and fail to complete the intended review of the entire course material. Because most of them start at the temporal beginning of the course material the most important concepts, the ideas to which the whole course builds, and the bulk of the topics covered on the exam are given too little attention. They need the review a précis of a problem, perhaps carefully replicating one example per topic. This leads to their last stumbling block I hope to remove.

3) Poor Archiving

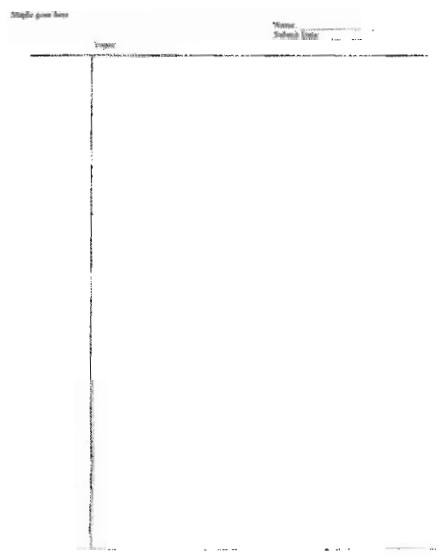
It is difficult to group the examples and homework questions into topics if the topics aren't labelled and course notes are poorly organized. Their notes

aren't properly grouped together, homework is submitted without staples, they can't remember the proper name of the topics or what goes with what.

Part 4: Proposed solution

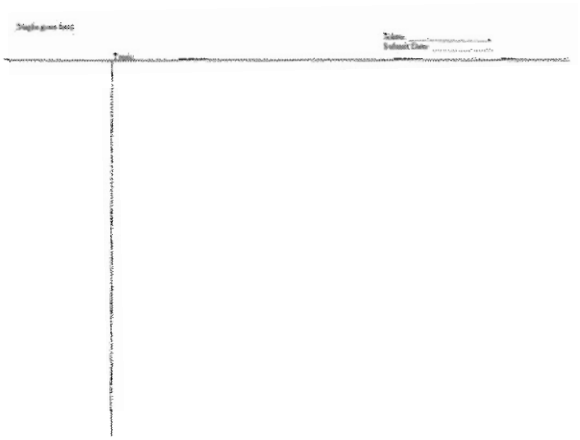
In the 2003-3 quarter I began this project with my Calculus and Analytical Geometry III (1016-243-02) class. The first step, I knew, was to get rid of those dominating horizontal lines. In fact even before the start of the project I would suggest that proper mathematics be done on non-lined paper. Most of my colleagues pursue their research without the aid of horizontal lined notepaper. At the suggestion of my Learning Community and taking a lead from the way we mathematicians write out our solutions to our research questions, I have insisted that students write only on one side of the paper. I write on only one side so that I can lay out all the sheets in a row and see the whole problem at once. I knew this would help my students be able to see their calculus problem from start to finish. Calculus looks easier in class because I can spread it out over the whole white board. Only using one side of the sheet will also make the homework questions easier to grade. The first class survey showed students favoured the non-lined paper 24 to 8.

I was inspired by George A. Heyman's presentation at the 2003 Lilly Conference, *How to Study Outside the Box*. He introduced me to the idea of wide margin note paper and its positive effect of the student's retention of material in non-technical courses. I felt it would work in my class as well. The wide margin is to be used to make notes and summarize the material. This way, instead of reviewing a problem by recreating every algebra step, they could quickly study the main idea and practice completely only a few problems from each section.

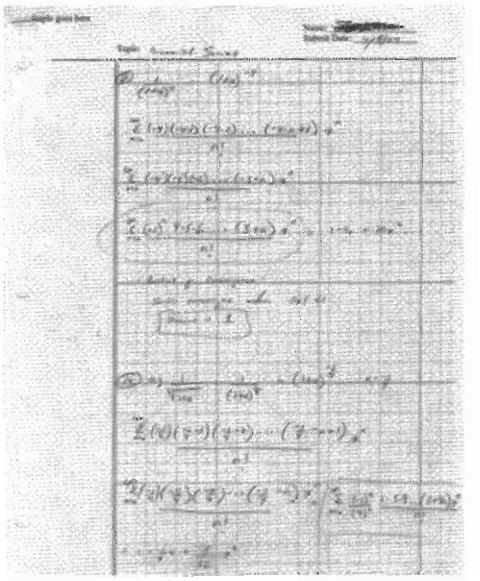


I included a reminder to staple and to label the section, topic and date. The first iteration of Mathematics Paper is pictured at

the left. Because I write my research landscape instead of portrait I also had my calculus students try the version shown at the right. The first class survey clearly indicated a preference of 19 to 9 for the portrait layout. The students also expressed the fact that without the lines their math had too much freedom. Solutions tended to droop. As well, I was hoping to include an axis on which to graph quick sketches. Mathematics is a very visual science and I encourage my students to include pictures in their solutions.



This produced the final version of Mathematics Paper that includes a faint grid similar to that found in engineering paper. The grid was favourably received by many of my students.

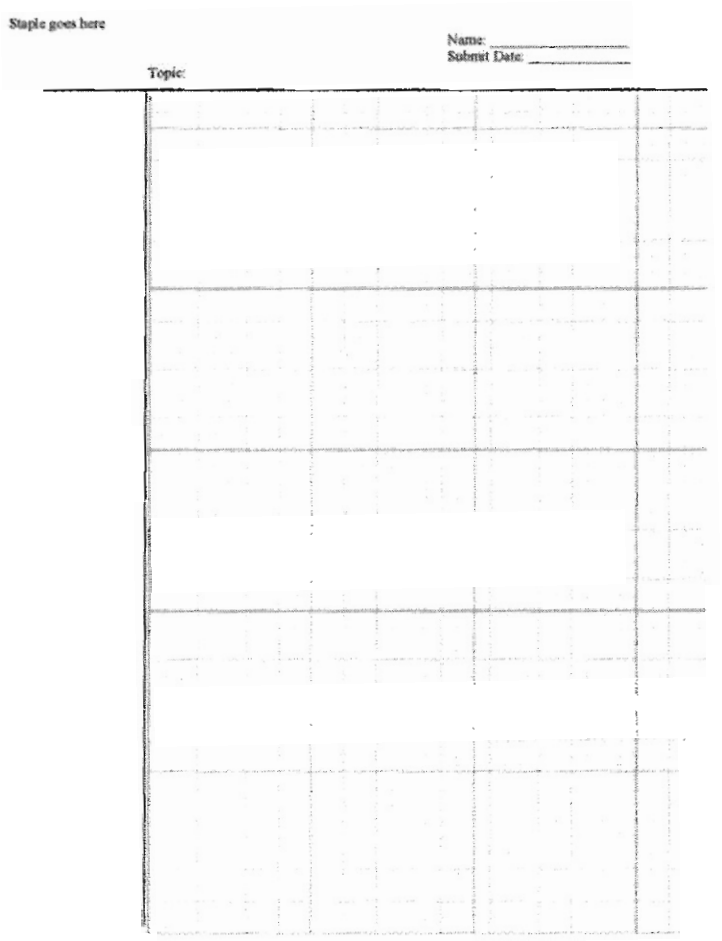


Part 5: The Results

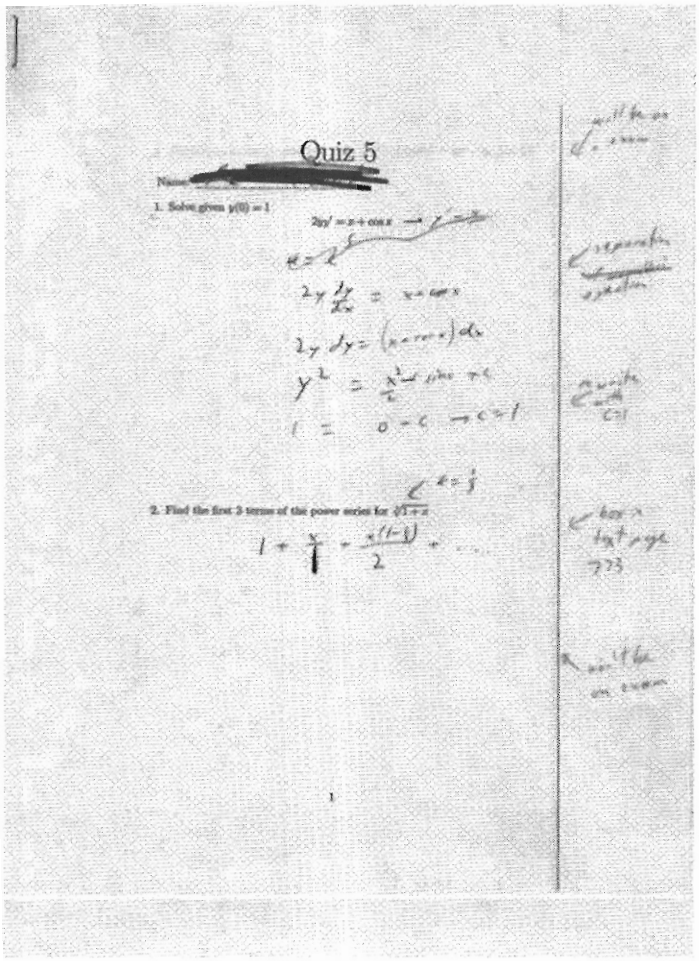
"The special math paper makes grading homework an easier task."

"Students seem to respond to the structure of the paper by completing their assignments in a more neat, concise fashion."

The final iteration in the design of the Mathematics Paper is shown below.



In addition to the paper design and at the suggestion of one of my students, I now include a wide margin on my quizzes and tests. The students can then use the margin space to make notes when we review the test in the same spirit as they do with the Mathematics Paper.



My TA has expressed "It is easier for me as a grader to follow their work as opposed to normal notebook paper when they seem to write work in random areas."

The fact that students also use only the front of the paper as opposed to normally both sides makes it easier to grade."

Part 6: Faulty and student partners

The student partner for the project was Neil Burkell. He was my teaching assistant for the calculus course and his responsibilities included assisting with the twice weekly workshops and grading the homework assignments. Neil stated that the special math paper seemed to improve the organization of the student's homework assignments. He also felt that the wide margin allowed him to make notes and comments for the students. His comments are quoted below.

Dr. Brooks,

You asked me to write a paragraph about the special math paper so I figured you could just copy and paste it from here.

The special math paper makes grading homework an easier task. Students seem to respond to the structure of the paper by completing their assignments in a more neat, concise fashion. It is easier for me as a grader to follow their work as opposed to normal notebook paper when they seem to write work in random areas. The fact that students also use only the front of the paper as opposed to normally both sides makes it easier to grade. A reason that I appreciate the more structured format is possibly rooted in my engineering background. All of my assignments utilize engineering paper which has similar structure to the special math paper. Overall, I notice a general improvement in the ability to grade papers easier.

Thanks,

Neil

The faculty partner was my colleague Mathew Coppenbarger. He used the special mathematics paper for his 1016-253 class in the 2003-3 quarter. He agreed that the special mathematics paper improved student organization.

Part 7. A teaching goals inventory for the class

The teaching goals inventory was created using the survey given by the web site (http://www.uiowa.edu/~centeach/tgi/).

Teaching Goals Inventory Results

Calculus III
7/16/2004

This table contains your results. The third column contains the percentage of items within each cluster that you rated "essential." The fourth column contains the average rating you assigned to items within each cluster.

Cluster	Goals Included in Cluster	Percent Rated "Essential"	Mean Rating
I. Higher Order Thinking Skills	1-8	-- none --	3.13
II. Basic Academic Success Skills	9-17	11%	1.78
III. Discipline-Specific Knowledge and Skills	18-25	-- none --	3.38
IV. Liberal Arts and Academic Values	26-35	-- none --	1.80
V. Work and Career Preparation	36-43	-- none --	1.50
VI. Personal Development	44-52	-- none --	2.00

You identified your primary role as a teacher as "Teaching students facts and principles of the subject matter."

It may be useful to compare your results to those of a large sample of teachers. The following table provides mean cluster ratings and the average percentage of items in each cluster rated "essential." The data were collected from over 2,800 faculty members at 15 community colleges and 17 private four year colleges. The sample is clearly biased in the direction of faculty working at institutions with the education of undergraduates as their primary mission, and if your institution's mission differs, you will want to keep that in mind.

Table 10.3* Mean Cluster Ratings (M) and Percent (%) "Essential" Ratings				
	Four-Year Colleges		*Community Colleges*	
TGI Cluster	*M*	*%*	*M*	*%*
I. Higher order thinking skills	3.05	43	3.09	45
III. Discipline-specific	2.86	37	2.83	36
VI Personal development	2.28	25	2.41	28
V. Work and career	2.27	21	2.50	26
IV. Liberal Arts	2.16	21	2.02	18
II. Basic Skills	2.12	18	2.29	22

*Reproduced with permission.

The table that follows shows the three most-endorsed goals in each of nine disciplines. **If you rated any of these goals "essential" they appear in bold type.**

Table 10.2 Three Top-Priority Teaching Goals, By Discipline									
	Percent Rating Goals "Essential" (click for a key to column headings)								
Teaching goal (TGI #)	*Arts*	*Hum*	*Eng.*	*B. Sk.*	*Soc. Sci.*	*Bus.*	*Med.*	*Sci.*	*Math*
Apply principles (1)				59	57	69	73	61	
Math skills (17)						61		60	84
Terms and facts (18)						61		60	
Wise decisions (52)							70		
Analytic Skills (2)			66						73
Self-esteem				63					

(45)									
Think for self (51)	66	59	75	65	50				
Responsible for self (44)							68		
Value of subject (21)		56			52				
Concepts and theories (19)								71	
Creativity (7)	69								
Writing skills (15)			84						
Aesthetic appreciation (31)	78								
Openness to ideas (27)		56							
Problem solving (3)						57			84

*Reproduced with permission.

The rest of this report lists the goals you rated sorted into groups according to the rating you assigned.

1.1.1 Goals You Rated "Essential"

17. Improve mathematical skills

2.1.1 Goals You Rated "Very Important"

1. Develop ability to apply principles and generalizations already learned to new problems and situations
6. Develop ability to think holistically: to see the whole as well as the parts
18. Learn terms and facts of this subject
19. Learn concepts and theories in this subject
20. Develop skill in using materials, tools, and/or technology central to this subject
24. Learn to evaluate methods and materials in this subject

3.1.1 Goals You Rated "Important"

2. Develop analytic skills
3. Develop problem-solving skills
4. Develop ability to draw reasonable inferences from observations
5. Develop ability to synthesize and integrate information and ideas
7. Develop ability to think creatively
21. Learn to understand perspectives and values of this subject
23. Learn techniques and methods used to gain new knowledge in this subject
25. Learn to appreciate important contributions to this subject
30. Develop a lifelong love of learning
31. Develop aesthetic appreciation
46. Develop a commitment to one's own values
51. Develop capacity to think for oneself
52. Develop capacity to make wise decisions

4.1.1 Goals You Rated "Unimportant"

8. Develop ability to distinguish between fact and opinion
9. Improve skill at paying attention
10. Develop ability to concentrate
16. Develop appropriate study skills, strategies, and habits
22. Prepare for transfer or graduate study
26. Develop an appreciation of the liberal arts and sciences
27. Develop an openness to new ideas
32. Develop an informed historical perspective
33. Develop an informed understanding of the role of science and technology
36. Develop ability to work productively with others
39. Develop a commitment to accurate work
41. Improve ability to organize and use time effectively
43. Develop ability to perform skillfully
44. Cultivate a sense of responsibility for one's own behavior
45. Improve self-esteem/self-confidence
47. Develop respect for one's own values

5.1.1 Goals You Rated "Not Applicable"

11. Improve memory skills
12. Improve listening skills
13. Improve speaking skills

28. Develop an informed concern about contemporary social issues
29. Develop a commitment to exercise the rights and responsibilities of citizenship
34. Develop an informed appreciation of other cultures
35. Develop capacity to make informed ethical choices
37. Develop management skills
38. Develop leadership skills
40. Improve ability to follow directions, instructions, and plans
42. Develop a commitment to personal achievement
48. Cultivate emotional health and well-being
49. Cultivate physical health and well being
50. Cultivate an active commitment to honesty

Part 8. Reflections

My participation in the Faculty Learning Community has provided many benefits and has improved my teaching. The first few meetings laid the foundation, introducing us to the terminology and the idea of scholarly teaching. The discussion and research papers concerning the various theories of physical development were particularly helpful. Some of the responsibilities I wish my students would take on were shown to be limited, not by their attitude, but by their physiological development.

The levels of understanding that students climb was something I was casually aware of but their discussion helped to clarify our goals.

Probable the most overt change that I experienced was the idea that I should approach the act of teaching in a scientific and experimental manner. I have since tried many of the teaching techniques mentioned in the literature and discussed with my Faculty Learning Community colleagues.