FACULTY LEARNING COMMUNITY 7

PORTFOLIO

Promoting Peer-to-Peer Coursework Support through Small Teams

by

Manuel Lopez

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I. Philosophical Considerations

Teaching Philosophy and Teaching Metaphor

I believe an essential ingredient of education is communication of what you believe to be true, what you have experienced and what you are struggling to learn. This point of view has a philosophical side based on modern current on education that emphasize experiential learning and learning as a kind of communal effort. My belief also has a practical side based on empirical observation of the learning dividends that presenting material brings to the presenter.

In modern instruction hands-on, learn-by-doing methods are widely accepted. It is also quite widespread to have participatory learning in which the learning experience is shared with peers. In such settings inevitably one asks, what does the individual get out of it? The answer I am looking for is better phrased in terms of the notion of 'perceived benefit' by the individual. In the settings described above, being able to communicate effectively the learning experience is strongly linked to the value of the education.

The questions 'what is this good for?' and 'will I ever need this?' are ever-present in a mathematics course. For many students the answer to this question is pivotal to how beneficial the course is perceived to be. This 'perceived benefit' feeds back into active engagement and motivation in class. Some will champion 'natural ability', the ease with which a student learns the mathematical content, as the key to success. However, active engagement and motivation are more basic qualities of successful students. These two qualities are, in mathematical parlance, necessary even though they might not be sufficient. Consequently, the two ever-present questions listed above should not be left unanswered as they often are. Almost as unproductive is to answer these two questions with generic answers backed by the authority of the instructor. Indeed, there should be a reason for taking a course that makes sense to the individual student. The teacher could not be expected to figure this out for each individual student. Having avenues through which students can articulate their beliefs, experiences and personal issues while learning the material is the best way to arrive at all the individual answers to these two questions.

On the practical side, I have often encountered, teachers (myself included) who openly admit having to teach a subject enhances the teacher's understanding. The effect is based on the contrast between spectator and performer in a traditional classroom. The difference between the two is that the onus to communicate effectively only lies with the performer. Which brings us to discuss a metaphor for teaching: "Teaching is like a seal balancing a ball." The following reasons make the metaphor work:

- There are guidelines but there is no algorithm for doing it right
- It requires constantly having a sense of the 'ball' and it's easy to drop it
- It's done for the benefit of the students/audience; not the seal
- Audience participation a plus

For the present discussion I want to emphasize the fourth and last reason listed above. Traditional thinking is that a perfectly silent audience is best for the performing seal just as a quiet class allows the teacher to get on with the task of teaching. If the seal or the teacher

are indifferent to a discontented segment of the audience or the class then this is fine. However, this could not possibly be fine in view of the third reason for the metaphor above. To prevent having students who quietly and passively fail they must be brought in to be part of a class discussion at some level. All students, but in particular those struggling, should have a way to let it be known where the stand in the learning process and rehearse presenting material to get the enhanced understanding this brings. This requires the instructor have a sense of the class, just as the seal needs a sense of the ball. Key to having such a sense of the class is the basic set of assumptions about the students – as listed below. Finally, there are very practical guidelines but no step-by-step recipe for good teaching because of the myriad variables involved: class size, service vs. advanced course, part-time students vs. full-time students. Corrections and adjustments to an on-going course can be made to keep serving struggling students if there is a continuous exchange taking place.

Assumptions about Students

- Not all come equally prepared
- Some will overestimate their background knowledge
- Those who know they lack preparation are often reluctant to say so
- Most are more likely to confide apprehension to a peer than to the instructor
- Not all have the same degree of mathematical maturity
- Not all are self-motivated to take my class or even attend college
- The most universal way to get students to participate is to have a grade associated with an assignment or project

II. FLC Project

This FLC project I designed, I tried in four courses over the winter and spring quarters of the academic year 2007 – 08. The only repetition in my teaching assignments from the winter to the spring quarter was the Linear Algebra course (which was renamed Linear Algebra II in the spring quarter but whose content and requirements remained the same as in winter quarter). Since I made slight changes to winter quarter implementation of this FLC project when I implemented it for the spring quarter, I am only focusing on Linear Algebra/Linear Algebra II when assessing the results of this teaching experiment. Here is the sample syllabus,

Linear Algebra
Spring Quarter 2007 – 08

Instructor: Dr. Manuel Lopez, malsma@rit.edu
Office: 08-3118 (third floor of the Gosnell Bldg.)
Phone #: 5-4382
Class Times: Tuesdays and Thursdays 2:00 – 3:50 pm in room 76-1235
Office Hours: Mondays & Wednesdays 10:00 – 10:50 am
Tuesdays & Thursdays 1:00 – 1:50 pm
Also by appointment

Textbook: ***Linear Algebra*** by David Poole, published by Thompson Brooks/Cole.

Welcome to our class!
Our goal is to learn more comprehensively about vector spaces and the algebra to compute with these structures. This will require we focus on the theoretical side of the subject as well as computation. View this course as an opportunity to gain experience in crafting 'proofs'.
I encourage you to work with peers while studying and doing assignments.
Your final assessment will weight each type of grade as follows:

Final Exam 25%
Each of three in-class tests 15% each
All Quizzes 15%
Homework 15%
Bonus Homework Average for Collaborating teams 5%

Attendance will also have an impact on your grade since there will be **no** make-up quizzes and **no** late homework will be accepted. Only in circumstances where I deem it warranted will a make-up test be given. In

fact, the only officially warranted reasons include medical ***emergencies.*** For example, if you have to miss an in-class test due to a scheduled doctor's appointment, you need to make arrangements to take the test **before** the rest of the class, because in this situation a make-up test at a later date is not warranted. Also any approved make-up must be done promptly after the official in-class test.

Calculators: Calculators will not be used during quizzes or tests unless I approve their use for a particular quiz or test. In cases where I allow the use of a calculator only a simple (non-scientific and non-graphing calculator) will be allowed for you to check your arithmetic. This is actually a helpful policy since you will only get credit for the steps of a particular computation shown on paper, even if you can do it all in your calculator.

Homework: You may work with your peers but the submitted draft must be your own wording of the answers. Homework assignments will be due every Tuesday at the beginning of class (except week #1, of course).
For those of you willing to participate in collaborative homework teams of three students there will be the possibility of a 5% bonus for the course grade. This means it is in your best interest to work closely with your teammates to ensure the highest possible team average.
Each third of the quarter a different person will be the representative of the group. Every Tuesday at the beginning of class the team's representative will turn the team's homework assignment in one folder (starting week #2).

Quizzes: Tentative dates for quizzes are Thursday of weeks ***1, 2, 4, 5, 7,*** and ***8***

Tests: Tentative dates for in-class tests are Thursday of weeks ***3, 6*** and ***9***. No in-class test score will be dropped from the computation of the final grade.

Final Exam: The final exam will be cumulative with questions coming from any of the following list of topics:

List of Topics for our Course:

Eigenvalues and Eigenvectors
- 4.1 Introduction to Eigenvalues and Eigenvectors
- 4.2 Determinants
- 4.3 Eigenvalues and Eigenvectors of nxn Matrices
- 4.4 Similarity and Diagonalization
- 4.6 Applications and the Perron-Frobenious Theorem

Orthogonality
5.1 Orthogonality in $\mathbb{R}^n$
5.2 Orthogonal Complements and Ortogonal Projections
5.3 The Gram-Schmidt process and the *QR*-factorization
5.4 Orthogonal Diagonalization of Symmetric Matrices
5.5 Applications

Vector spaces
6.1 Vector Spaces and Subspaces
6.2 Linear Independence, Basis, and Dimension
6.3 Change of Basis
6.4 Linear Transformations
6.5 The Kernel and Range of a Linear Transformation
6.6 The Matrix of a Linear Transformation

Distance and Approximation
7.3 Least Squares Approximation
7.4 The Singular value Decomposition

Problem Addressed by my FLC Project

There is evidence that lack of success in the classroom often is due to lack of social connections with peers in the class. In the 1970s Uri Treisman looked for the reasons behind marked differences for introductory calculus success of different groups of Berkeley students.[1] After showing the common explanations of previous preparation and socioeconomic factors could not account for the discrepancy, the importance of social interaction between students which integrated their academic work was put forth as essential contributor to successful groups. Working under the assumption that this situation is still a key factor in the DWF grades (W stand for withdrawal from class) it follows that successfully addressing the academic isolation of mathematics students will reduce the rate of DWF grades.

Proposed Solution and Later Refinement

Fostering small groups of students who would help each other succeed. They could work together in homework and if they do so there would be a grade incentive in the form of a bonus. The hope is that this cooperation will spill over into other types of cooperation; for example preparing together for tests and sharing information about what is going on in class. The groups were formed using the following well established principles:[2]
Three Principles for Implementing Solution:

- Make small teams of similar size
- Don't allow team self-selection

[1] http://www.math.uiuc.edu/MeritWorkshop/uriModel.html
[2] Brent, Elhajj, Felder, Oakley, "Turning Student Groups into Effective Teams", New Forum Press vol. 2, No. 1, 2004

- Trust randomness to create teams with mixed skill levels (this principle I modified since I could not afford waiting to be better acquainted with the students)

In the winter quarter I put students into groups of roughly three students at the beginning of the quarter and did not interfere afterwards. In the spring quarter I also put student into groups of roughly three students. However in the spring I did schedule two class activities to promote team cooperation. One activity was giving a problem per team whose solution they presented in class. The second group activity was 'stomp-another-team'. Here each team posed a question and chose another team that must attempt it. For the reasons and results of this change please see the section below entitled 'Reflections'.

Goals of the FLC Project

- To prepare students for their next mathematics/science/engineering course with increased confidence in their knowledge
- To increase the student's perception of the course as having been beneficial to their education
- To increase students' willingness to reach out to peers to form study groups and collaborations

Ways of Assessing FLC Project's Results

A robust way of measuring the success of my plan would be by counting the DWF rate with and without fostering these collaborative groups. This would require larger samples of data which cannot be collected over two quarters by a single instructor.

A softer metric of success is based on the anonymous questionnaires filled out by students three times during the quarter. They allow gauging how many are willing to participate and how they feel about it. These were given three times during the quarter; one questionnaire before each of the three in-class tests. Each time ten minutes were allotted to the questionnaire followed by a ten minute break and then sixty minutes for the test. The comments gave an indication of how well the teams were working. Also a count of 'apathy' to the anonymous questionnaire gave me an estimate of how many teams remained active.

In the following page is one sample of such an anonymous questionnaire.

Mid-Quarter Questionnaire (*Week #6*)
Linear Algebra II
Spring Quarter 2007 – 08

Are you working together on (at least some) of the homework problems? *Remark: Remember I encouraged you to do so but it was not required.*

If you have at least occasionally worked our Homework problems with others, how has it has helped (or hindered) the way you …

Analyze the material:

Apply the knowledge to new problems:

Understand the material:

Remember the material:

Future Implementations of FLC Project

As can be seen in the section 'Reflections' below, the results from the spring quarter indicate that the benefits are well worth the bonus of up to 5% of the course grade and also worth the class time set aside for the two class activities. Therefore I expect to implement a version of this project in my future teaching assignments.

III. Reflections

My original idea was to create these collaborative groups and step aside for the rest of the quarter. I was counting on the bonus to be incentive enough to keep the students participating in their group. Furthermore, I believed the collaboration between students would be more spontaneous if they somehow forgot that I had randomly placed them together in a group. However, the feedback I received from the questionnaires and some emails in winter quarter left me no doubt that left alone a majority of these groups would for all purposes dissolve. When we started the winter quarter slightly better than two thirds of respondents gave some indication that they would give collaborating with their assigned partners a chance. By the end of the quarter fewer than half showed any interest.

In the spring quarter the initial rate of interest in participating was roughly three-quarters. Perhaps the spring quarter class as a whole was more upbeat. However, I'm inclined to think that the reason the stated interest in participating remained roughly constant throughout the quarter was that the class activities gave students a concrete and public reason to collaborate – they did not want embarrassment in front of the rest of the class.

This leads me to conclude that, although humans are naturally social, cultural norms might not extend the socializing to working relationships. The idea that even though most grades are based on individual effort, there is much to be gained by collaboration needs to be constantly reintroduced. When done properly I find students tend to agree they get more out of their classroom experience.