# Running Head: ACADEMIC EMOTIONS IN UNDERGRADUATE MATHEMATICS

The Yin and Yang of Academic Emotions in Undergraduate Mathematics

by

Janet Thiel, PhD

University of Maryland, College Park

As Presented at the

11<sup>th</sup> Conference on Research on Undergraduate Mathematics

SIGMAA on RUME

February 28 – March 3, 2008

## Abstract

How do students feel when they are made to think? My curiosity about academic emotions was peaked by Pekrun's work, and as a scholar-practitioner, I too believed that there was more emotion to mathematics than the often-studied anxiety. To do further research in this area, for three semesters at the end of the course I asked my students to complete a survey on the emotions they associated with the activities and assignments of the course. These students were generally first-year undergraduates taking a required math class, and they were not math-majors. The assignments included collaborative and individual options, class presentations, on-line and computer assisted practice and assessments, as well as unit assignments of modeling, graphing, and writing. The results showed that positive and negative emotions were often paired by these students, with positive emotions taking predominance.

### Introduction

How do students feel when they are made to think? My curiosity about academic emotions was peaked by Pekrun's (Pekrun, Goetz, Titz, & Perry, 2002) work, and as a scholar-practitioner, I too believed that there was more emotion to mathematics than the often-studied anxiety. To do further research in this area, at the end of the semester, I asked my students to complete a survey on the emotions they associated with the activities and assignments of the course. The results showed that positive and negative emotions were often paired by these students.

## Purpose of the Study

The purpose of the study was to investigate the range of academic emotions students associate with the activities and assignments of a precalculus course when these are used as non-traditional assessments. The study sought to identify the predominate emotions associated with the varied assessments used in the course as well as to determine if there was a differentiation of emotions associated with assignments that were collaborative, computer-oriented, or individual in design.

### **Research Questions**

The questions of this research were:

- What emotions do students associate with the assignments and activities of a precalculus course when these are non-traditional assessments in the course?
- 2. Is there a differentiation of emotional response to activities and assignments that are collaborative, individual, or computer based in design?

### **Research Design**

Conducted as classroom action research, a survey on emotions and the assignments/assessments for first year undergraduate math courses was administered in class to the students enrolled in these courses taught by the researcher over three semesters in academic years 2005-2007. (See Appendix A). The classes were taught in a rural 4-year liberal arts college near a large metropolitan area. In all, 93 students returned the surveys, 34 in the fall 2005 semester, 10 in the spring 2006 semester, and 49 in the fall 2006 semester. The students were enrolled in either a Precalculus (Math 112) or College Algebra (Math 111) course.

From a grid listing the assignments of the course, students chose among 21 statements that completed the phrase "This assignment made me ....." Students could select more than one response for each assignment. The completing statements contained both positive and negative expressions. Among the academic emotions embedded in the phrases were satisfaction, frustration, pride, joy, anticipation (both positive and negative), determination, and confidence. These were the emotions studied by Pekrun (Pekrun et al., 2002) within student's self-regulated learning and achievement. This fit the parameters of this study, since the majority of the assignments listed were completed outside of class, and included both required and optional assignments.

The survey contained a second grid. In this chart, emotions were named explicitly and students were to choose at most three that they associated with each of the course's assignments. Students then selected the strongest emotion for each assignment, including the option of selecting no emotion. Student demographic information completed the survey. Students were identified as male/female, asked their anticipated course grade, the hours per week they spent on coursework, whether they liked math courses, and their anticipation of taking additional math courses. The students themselves were not identified on the survey.

The students completed the survey in class, and the researcher was present. A student collected the completed surveys. Participation was dependent upon class attendance; the survey was administered within the last two weeks of the course. While the numbers of students taking the survey in spring 2006 may be less than statistically valid, their responses were included to compare responses from the fall to spring semester. For the fall 2005 and spring 2006 semesters the courses and assignments followed the same format; all of these students were enrolled in a four-credit Precalculus course. For fall 2006, two classes were enrolled in a three-credit College Algebra course and one class was enrolled in the four-credit Precalculus class.

The assignments for these courses included those that were collaborative, individual, online, required, and optional. Testing-type assignments included a practice test and an online quiz included in both queries, and the in class testing added to the second query. These assignments were repeated for each of the five units of study during the semester, although due to options, the student did not need to complete each assignment for each unit. Student assignments were graded using a rubric, and points earned for each were accumulated over the semester. In fall 2006 the students were given the option of doing their practice problems online or submitting them hand-written along with a learning log of practice, whereas in the previous two semesters students only had to submit a log of practice, not the actual problems.

### **Student Demographics**

Of the 34 students who completed the survey in the fall 2005 semester, 25 were female. These students projected their final course grade to be A (41.2%), B (35.3%), or C (23.5%). The mean time spent per week on the course was 5.9 hours. Almost half (47.1%) indicated that they liked taking math courses, and 64.7% indicated that they would take additional math courses, although only 26.5% would take math courses that were elective.

In the spring 2006 semester, 4 male and 6 female students completed the survey. These students projected their final course grade to be A (30%), B (50%), or C (20%). The mean time spent per week on the course was 5.8 hours. More than half (60%) indicated that they liked taking math courses, and 80% indicated that they would take additional math courses, although only 10% would take math courses that were elective.

For the fall 2006 semester, 49 students completed the survey. Of these, 6 were male and 43 female. The mean time spent per week on the course was 5.3 hours. More than half (66%) indicated that they liked taking math courses, and 82% indicated that they would take additional math courses, with 48% of responders stating that they would take elective math courses.

## Survey Results

#### Student Description of Assignments

In the fall 2005 semester, the dyad presentation (13.4%), group assignment (12.69%), and the learning log of practice (11.05%) generated the most responses in Grid 1. In the spring 2006 semester, the dyad presentation (15.17%), the modeling assignment (13%), and the writing assignment (12.69%) generated the most responses. In the fall

2006 semester, the learning log of practice (15.9%), online quiz (11.7%), and the online practice (11.5%) generated the most responses in Grid 1. This shows the strongest emotional response associated with a collaborative assignment, followed by other assignments which may or may not be done collaboratively for the first two semesters, while the third semester's strongest emotional responses were related to individual or computer assisted learning. While the learning log of practice was an assignment to be done individually, students could collaborate with the unit assignments of writing and modeling before submitting an individual work product. Online assignments were done individually.

The phrases chosen to describe the assignments in the first grid yielded the following results. In the fall 2005 semester, the students chose to complete the statement *This assignment*... with the most frequent responses of: *made me think* (8.7%), and *challenged me* (7.2%). In spring 2006 the top responses were *I did only because I had to* (11.6%), as well as *made me think*, and *challenged me* (both 9.7%). In fall 2006, the primary responses were *made me think* (10%), *helped me learn math* (9.7%) and *challenged me* (9.5%). The response chosen the least was *made me cheat* (0.5%, 0.3%, and 0.6%). Among the other low yielding responses were *interested me* (3.1%, 0.6%, and 1.6%), and *was fun to do* (2.7%, 1.5%, and 2.4%). Table 1 gives the positive response rates, while Table 2 gives the negative response rates. A description of each follows.



Table 1. Positive Emotion Response Rates



Table 2. Negative Emotion Response Rates.

The assignment associated with the most positive responses in the first chart was that of the dyad presentation. For this assignment, in fall 2005, 66.5% of the responses were positive, whereas in the spring 2006, 65.3% were positive. In fall 2006, positive and negative responses were almost equally divided. High-ranking remarks for this assignment in fall 2005 included: made me think, and made me ask for help. Highranking remarks for this assignment in spring 2006 included: made me proud of my accomplishments and increased my confidence, I liked doing, helped me learn math, and interested me. However, for this assignment in fall 2006, high ranking remarks included I did only because I had to and bored me. Nothing was changed about this assignment during each of the three semesters for those in Precalculus. However, the majority of fall 2006 students were enrolled in a College Algebra class and their dyad assignments differed. The Precalculus students worked as dyads to present word problems to the class and used a prepared PowerPoint format. The College Algebra students worked their unit assignments as dyads, and this work was handed in to the instructor, not presented to the class.

The assignment associated with the most negative responses in the first chart was that of the learning log. For this assignment, in fall 2005 58.7% of the responses were negative, in spring 2006, 91.9% were negative, whereas in fall 2006 only 16.6% of the responses were negative. High-ranking remarks for this assignment in fall 2005 included: *I did only because I had to, was more time consuming than I planned, helped me learn math,* and *increased my confidence*. High-ranking remarks for this assignment in the spring 2006 included: *I did only because I had to, frustrated me, and was a waste of time.* In fall 2006, when the assignment was changed, the high ranking remarks were: *made me* 

*think, helped me learn math,* and *was more time consuming than I thought.* This change in response confirmed for the researcher that having students hand in actual problem sets was more beneficial to learning from the perspective of the student. Table 3 gives the most frequent response per assignment.

Most Frequent	Fall 05	Spring 06	Fall 06		
Response per	n=34 response >13	n=10 r>3	n=49 r>10		
Assignment					
learning log	I did only because I had to.	I did only because I had	made me think* (*format		
		to.	changed)		
online practice	I avoided.	No significant response.	helped me learn math.*		
online quiz	made me think.	made me proud of my accomplishments; made me think; helped me learn math	made me proud of my accomplishments; I liked doing		
iClass	I avoided.	made me proud of my	I avoided.		
discussions		accomplishments.			
dyad	made me think; made me	I liked doing.	bored me; I did only		
presentation	ask for help		because I had to		
group	made me think.	I did only because I had	made me think		
assignment		to.			
writing	was more time consuming	made me think	I liked doing.		
assignment	than I planned.				
modeling	challenged me; made me	made me think	challenged me.		
assignment	think; was more time				
	consuming than I planned				
graphing	frustrated me.	I did only because I had	helped me learn math.		
assignment		to; made me think			
practice test	made me ask for help.	challenged me.	challenged me.		

Table 3. Most Frequent Response per Assignment.

Overall, the response rates for each assignment are listed in Table 4. It is interesting to note that for fall 2005 and spring 2006, the collaborative assignment (dyad) was the highest ranked, while in fall 2006, the individual assignment (learning log) was the highest ranked in overall responses. These rankings reflected the highest emotional response to an assignment, be it a positive or negative response. For fall 2006 the assignments associated with online learning had the highest emotional impact, while group assignments were significantly lower in ranking.

Grid 1 Responses	Fall 05	n=34	Spring 06	n=10	Fall 06	n=49
Assignment	Rank	% Response	Rank	% Response	Rank	% Response
learning log	3	11.0%	5	11.2%	1	15.9%
online practice	9	6.5%	9	3.3%	3	11.5%
online quiz	7	10.0%	8	9.1%	2	11.7%
iClass discussions	10	5.4%	10	3.0%	10	4.7%
dyad presentation	1	13.4%	1	14.9%	9	7.5%
group assignment	2	12.7%	5	11.2%	8	7.6%
writing assignment	4	10.8%	3	12.5%	5	10.9%
modeling assignment	6	10.5%	2	13.1%	6	10.0%
graphing assignment	4	10.8%	4	11.6%	7	9.2%
practice test	8	9.0%	7	10.0%	4	11.1%

Table 4. Response Rate per Assignment (Grid 1).

Grid 1 Results					
Assignment generating the			Assignment generating the		
most responses		0/ CD	least responses		0/ CD
Term	Assignment	% of Responses	Term	Assignment	% of Responses
Fall 2005	dyad	13.4%	Fall 2005	iClass discussion	5.4%
	group assgn	12.7%		online practice	6.5%
	learning log	11.1%		practice test	9.0%
Spring 06	dyad	15.1%	Spring 06	iClass discussion	3.0%
	modeling	13.0%		online practice	3.3%
	writing	12.7%		online quiz	9.1%
Fall 2006	learning log	15.9%	Fall 2006	iClass discussion	4.7%
	online quiz	11.7%		dyad	7.5%
	online practice	11.5%		group	7.6%
Phrases chosen most often			Phrases chosen least often		
Term	Phrase	% of Responses	Term	Phrase	% of Responses
Fall 2005	made me think	8.7%	Fall 2005	made me cheat	0.5%
	challenged me	7.2%		was fun to do	2.7%
	0			interested me	3.1%
Spring 06	I did only because I had to	11.6%	Spring 06	made me cheat	0.3%
1 0	challenged me	9.7%	1 0	interested me	0.6%
	made me think	9.6%		was fun to do	1.5%
				decreased my confidence	1.5%
Fall 2006	made me think	10%	Fall 2006	made me cheat	0.6%
	helped me learn math	9.7%		interested me	1.6%
	challenged me	9.5%		was a waste of time	1.8%
Assignments with the most			Assignments with the most		
positive responses			negative responses		
F		% Positive			% Negative
Term	Assignment	Responses	Term	Assignment	Responses
Fall 2005	practice test	67.5%	Fall 2005	writing	60.3%
un 2000	dvad	66.5%	1 un 2000	graphing	60.3%
	iClass discussion	63.2%		modeling	58.5%
	ienss discussion	05.270		learning log	58.5%
Spring 06	online quiz	66.7%	Spring 06	learning log	91.9%
opring ou	dvad	65.3%	Spring 00	writing	56.1%
	uyau prostigo tost	62 60/		aronhina	57.00/
Eall 2004	practice test	03.0%	E-11 2006	graphing	51.9%
raii 2000	omne quiz	81.4% 72.20/	raii 2000	uyau iClass discussion	31.0%
	grapning	/3.2%		iClass discussion	47.3%
	online practice	69.5%		practice test	45.5%

Table 5. Comparative Results of Grid 1.

### Strongest Emotions Associated with Assignments

The second grid had the students define at most three emotions with each assignment, choosing the strongest of the three emotions. With the second grid, the dyad presentations had the strongest emotional response from both semesters in academic year 2005-2006, generating response rates of 12.9% and 13.7%. In fall 2006, the group assignment had the highest response rate, 12.5%. Both of these assignments were collaborative assignments.

The response rate and ranking of the emotions selected by the students in the second grid demonstrated the pairing of positive and negative emotions. For the fall 2005 semester, the primary emotion selected most frequently was frustration (20.0%), followed by confidence (13.5%). Next in ranking was dread (12.9%) followed by satisfaction (10.6%). Confusion (10.0%) was followed by determination (8.8%), while panic (8.2%), was followed by relief (6.5%). The lowest ranking was for enthusiasm (5.9%) and pride (3.5%). Overall, for the fall semester, the negative emotions were selected more often than the positive emotions in a ratio of 7: 5.83.

In the spring 2006 semester, the primary emotion selected most frequently was a tie between frustration and dread (19.6%). These were followed by satisfaction (17.6%) and both determination and panic (9.8%). Confidence (7.8%) and enthusiasm (5.9%) were selected next. The lowest ranking was for pride and confusion (3.9%), and relief (2.0%). Overall, for the spring semester, the negative emotions were also selected more often than the positive emotions in a ratio of 5.75:4.

In the fall 2006 semester, the primary emotion selected most frequently was satisfaction (21.1%). This was followed by determination (18.1%). Next in ranking were frustration (13.4%) and confidence (12.5%), dread (11.3%) and pride (6.5%), followed by enthusiasm (5.3%) and confusion (5.3%). Lastly, panic (4.5%) and relief (2.1%) were responses of the lowest rank. Overall, for the fall 2006 semester, the positive emotions were also selected more often than the negative emotions in a ratio of 4.37:2.5.

When given the choice to specifically designate *no emotion* to an assignment (grid 2), students in fall 2005 chose this response at a rate of 10.5% of total responses, students in spring 2006 chose this response at a rate of 37.0% of total responses, and students in fall 2006 chose this response at a rate of 21.6% of total responses. The most frequently chosen assignments with the response of *no emotion* were online practice, iClass discussions (online), and the learning log of practice.

Table 6 gives a summary of the results of Grid 2 responses to computer assisted learning. While these assignments generally had a low level of emotional response, their benefit was seen by students. The online practice was chosen to enhance learning in fall 2005 and spring 2006, but was deemed more of a requirement in fall 2006. The online quiz not only prepared the student for in class testing, but its results could augment the student's grade in testing, earning additional points in this category. Of the computer assisted assignments, only the online quiz was required as it was part of the department's assessment program for these courses.

						Number of		
	Percent of	Number of	Number of			No		Rank by
	Total	Positive	Negative			emotion	Total	emotion
Assignment	Responses	Responses	Responses	Percent +	Percent -	response	Responses	response
	Fall 05							
online practice	5.9%	8	2	80.0%	20.0%	5	15	7
online quiz	10.6%	8	10	44.4%	55.6%	2	20	7
iClass discussions	7.6%	7	6	53.8%	46.2%	5	18	6
	Spring 06							
online practice	3.9%	2	0	100.0%	0.0%	6	8	11
online quiz	13.7%	6	1	85.7%	14.3%	0	7	1
iClass discussions	5.9%	1	2	33.3%	66.7%	6	9	10
	Fall 06							
online practice	9.20%	22	9	51.20%	20.90%	12	43	7
online quiz	11.60%	32	7	69.60%	15.20%	7	46	3
iClass discussions	4.50%	10	5	25.00%	12.50%	25	40	10

Table 6. Summary of Student Responses to Computer Assisted Learning (Grid 2).

Table 7 gives a summary of student responses to the strongest emotions associated with learning, as found by responses on Grid 2. Within this table the pairing of positive and negative emotions can be seen.

The students also displayed a balance in the range of positive and negative responses. The fall 2005 results showed a range of 71.0% among students' positive responses, with a minimum of 13.2 % and a maximum of 84.2%. The range among the negative responses was also 71.0%, with a minimum of 15.8% and a maximum of 86.8%. The mean of positive responses was 49.9% while the mean of negative responses was 50.1%. The fall 2006 results showed a range of 44% among students' positive responses, with a minimum of 25 % and a maximum of 69.6%. The range among the negative responses was 54%, with a minimum of 12.5% and a maximum of 66.7%. The mean of positive responses was 49% while the mean of negative responses was 28%.

Term Fall 2005Assignment dyad% of Responses 12.9%Term Fall 2005Assignment online practice (Class discussion (Class discussion) (Class discussion)	Grid 2 Results Assignments generating the most responses			Assignments generati the least responses	ng	
Fall 2005dyad12.9% modeling graphingFall 2005online practice (Class discussion (Class discussion (Class discussion) (Class discussion) (Class discussion)5.9% (Class discussion)Spring 06dyad13.7% in class testing11.8%Spring 06online practice 	Term	Assignment	% of Responses	Term	Assignment	% of Responses
modeling graphing11.2% 11.0%iClass discussion writing asgn7.6% 9.4%Spring 06dyad online quiz in class testing13.7% 13.7%Spring 06online practice iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussion4.5% dyadFall 2006group assgn practice problems10.7% 10.7%Fall 2006iClass discussion dyad4.5% dyad7.4% individual assgn9.2% 0.2%Emotions cited most in responsesTerm frustration confidence dread7.4% 12.9%Fall 2006Fenotion responses% of ResponsesFall 2005frustration frustration confidence dread atsisfaction20.0% 12.9%Fall 2005relief pride3.9% 3.9% 2.9%Fall 2006gratisfaction frustration atsisfaction21.1% 19.6%Fall 2006enthusiasm confusion 13.4% 2.1%5.3% 2.0%Fall 2006satisfaction determination frustration frustration confidence2.1% 2.1%Fall 2006enthusiasm confusion 5.3% confusion 5.3% confusion 5.3%5.3% 68.4%Fall 2006confusion frustration frustration frustration frustration confidence confusion 13.4%Fall 2006enthusiasm confusion 5.3% confusion frustration frustration frustration frustration frustration frustration frustration frustration frustr	Fall 2005	dyad	12.9%	Fall 2005	online practice	5.9%
graphing11.0%writing assgn9.4%Spring 06dyad online quiz in class testing13.7% 13.7% in class testingSpring 06online practice iclass discussion3.9% iclass discussion3.9% iclass discussion3.9% iclass discussionFall 2006group assgn practice test12.5% 10.7%Fall 2006iclass discussion dyad individual asgn online practice 9.2%2.2% online practice 9.2%Emotions cited most in responsesEmotion frustration confidence dread2.0% 12.9%Fall 2005Famotion responses% of Responses Fall 2005Fall 2005frustration frustration tread2.0% 12.9%Fall 2005Fellef entread6.5% enthusiasm confisionSpring 06frustration frustration tread19.6% 13.4%Spring 06pride confusion confusion statisfaction2.1,1% treadFall 2006Fall 2006satisfaction determination frustration confidence2.1,1% treadFall 2006enthusiasm confusion statisfaction5.3% treifefFall 2006satisfaction determination frustration group assignment% of Responses Rom to determination frustration frustration to fall 8.1%Satisfaction frustration <br< td=""><td></td><td>modeling</td><td>11.2%</td><td></td><td>iClass discussion</td><td>7.6%</td></br<>		modeling	11.2%		iClass discussion	7.6%
Spring 06dyad online quiz in class testing13.7% 11.8%Spring 06online practice iclass discussion3.9% 5.9%Fall 2006group assign practice problems practice test12.5% 10.7%Fall 2006iclass discussion dyad individual assgn online practice 9.2%7.4% dyad individual assgn 9.2% online practice responses7.4% dyad individual assgn 9.2% online practice responsesEmotions cited most in responsesEmotion response Term frustration confidence infered teread satisfaction% of Responses 12.9% Fall 2005Emotion response response frustration 10.6% teread 12.9%Emotion response relief confusion infered confusion 3.9% confusion 3.9% confusion infered teread satisfaction2.1.1% fall 2006Fall 2005 relief confusion 3.9% confusion 3.9% confusion satisfactionFall 2006gatisfaction determination frustration confidence inclass2.1.1% fall 2006Fall 2006 enthusiasm confusion satisfaction2.1.1% fall 2006Fall 2006 enthusiasm confusion satisfaction2.1.1% fall 2006Fall 2006 enthusiasm fall 2005Assignment fall 2006% of Responses frust fall 2005Assignment fall 2006Assignment fall 2005Assignment fall 2006Main fall 2006Assignment fall 2005Main fall 2006Assignment fall 2005Assignment fall 2005Assignment fall 2005Assignment fall 2005Assignment fall 2005Assignment fall 2005Assignment fall 2005<		graphing	11.0%		writing assgn	9.4%
online quiz in class testing13.7% 11.8%iClass discussion5.9%Fall 2006group asgn practice problems10.7%Fall 2006iClass discussion (dyad)4.5%practice problems10.7%individual asgn practice test9.2%individual asgn practice9.2%Emotions cited most in responsesEmotionVoltase of the sponsesEmotion% of ResponsesTermEmotion frustration20.0%Fall 2005relief pride6.5%Fall 2005frustration dread10.6%Spring 06pride3.9%Spring 06frustration dread19.6%Spring 06pride3.9%Fall 2006satisfaction dread12.1%Fall 2006enthusiasm confusion5.3%Spring 06frustration frustration13.4%confusion statisfaction5.3%Fall 2006satisfaction determination trustration13.4%confusion statisfaction statisfaction5.3%Fall 2006satisfaction determination frustration confidence13.5%Fall 2006enthusiasm confusion statisfaction statisfaction5.3%Fall 2005satisfaction determination frustration group assignment7.6%Fall 2006enthusiasm confusion statisfaction statisfaction21.1%Fall 2005satisfaction determination frustration group assignment7.6%Fall 2006enthusiasm confusion statisfaction statisfaction21.1%Fall 2005online quiz group assignm	Spring 06	dyad	13.7%	Spring 06	online practice	3.9%
Fall 2006group assgn practice problems practice test12.5% 10.7%Fall 2006iClass discussion dyad4.5% 7.4% individual assgn 9.2% online practiceEmotions cited most in responsesEmotions cited least in responsesEmotions cited least in responsesFall 2005iClass discussion dyad4.5% 7.4% individual assgn 9.2%Emotions cited most in responsesEmotion responsesCentre responsesEmotion responses% of Responses responsesTerm Fall 2005Emotion frustration attisfaction% of Responses 12.5%Term Fall 2005Emotion relief% of Responses 6.5% confidence attisfaction10.6% 10.6%Spring 06pride confusion 3.9% confusion3.9% 3.5%Fall 2006satisfaction determination response21.1% 18.1% reliefFall 2006enthusiasm confusion 5.3% relief5.3% confusion 2.1%Assignments with the majority positive emotion responseAssignment 9.0% relief% of Responses remotion responseTerm responseAssignment 8.1% relief% of Responses attisfaction 13.4% reliefAssignment 8.4% relief% of Responses 8.4% confusion attisfaction responseSpring 06enthusiasm attisfaction attisfaction attisfaction2.1% attisfaction attisfaction responseAssignment response% of Responses rem responseFall 2006satisfaction response21.1% reliefAssignment attisfaction attisfaction% of Responses remotion res		online quiz	13.7%		iClass discussion	5.9%
Fall 2006group assgn practice problems practice test12.5% 10.7%Fall 2006iClass discussion dyad individual assgn online practice4.5% result y 2.2%Emotions cited most in responsesEmotions cited least in responsesEmotions cited least in responsesEmotion responsesEmotion responsesEmotion responsesEmotion responsesMain responses9.2% online practiceTerm Fall 2005Emotion frustration (confidence dread trustration 10.6%% of Responses reliefEmotion responses6.5% relief6.5% online pride5.9% online y 60 (Responses prideSpring 06frustration frustration trustration confidence trustration 11.6%21.1% Spring 06Spring 06enthusiasm confusion satisfaction5.3% confusion satisfaction trustration 13.4%5.3% confusion satisfactionFall 2006satisfaction frustration confidence confidence21.1% 12.5%Fall 2006enthusiasm confusion satisfaction5.3% confusion satisfactionFall 2006satisfaction frustration confidence21.1% 12.5%Fall 2006enthusiasm confusion satisfaction5.3% confusion satisfactionFall 2006satisfaction frustration confidence12.5%Fall 2006enthusiasm confusion satisfaction5.3% confusion satisfactionFall 2005satisfaction frustration confidence12.5%Fall 2005Segment for desponses for desponsesFarm response res		in class testing	11.8%			
practice problems practice test10.7%dyad7.4% individual assgn online practice7.4% individual assgn o.2%Emotions cited most in responsesEmotion% of ResponsesTerm responsesEmotion% of ResponsesTerm Fall 2005Emotion% of ResponsesTerm responsesEmotion% of ResponsesFall 2005frustration dread20.0% 12.9%Fall 2005relief online practice6.5% 6.5% 6.5%Spring 06frustration frustration atsisfaction19.6% 17.6%Spring 06pride confusion 3.9% 6 confusion 3.9% 6 confusion 5.3% frustration frustration 17.6%Fall 2006enthusiasm confusion 5.3% confusion 5.3% confusion 5.3% frustration frustration 13.4%Assignment with the majority negative emotion response TermAssignment % of Responses frustration 13.4%Assignment with the majority negative group assignment% of Responses 80.0%Term Fall 2005Assignment graphing assgn 68.4%Spring 06online practice group assignment100.0% 85.7%Spring 06in class testing graphing assgn 80.0%Spring 06online practice group assignment100.0% 85.7%Spring 06in class testing graphing assgn 80.0%Spring 06online practice group assignment100.0% 85.7%Spring 06in class testing graphing assgn 80.0%Spring 06online quiz69.6% 85.7%Fall 2006in class testing graphing assgn 80.0% <td>Fall 2006</td> <td>group assgn</td> <td>12.5%</td> <td>Fall 2006</td> <td>iClass discussion</td> <td>4.5%</td>	Fall 2006	group assgn	12.5%	Fall 2006	iClass discussion	4.5%
practice test10.7%individual assgn online practice9.2% 9.2%Emotions cited most in responsesEmotion% of ResponsesEmotion% of ResponsesTermEmotion% of ResponsesTermEmotion% of ResponsesFall 2005frustration dread20.0%Fall 2005relief6.5% confidenceSpring 06frustration frustration19.6%Spring 06pride3.9% confusionFall 2005astisfaction frustration19.6%Spring 06pride3.9% confusionFall 2006astisfaction determination frustration determination21.1% 13.4%Fall 2006enthusiasm confusion5.3% confusionFall 2006astisfaction determination response21.1% confusionFall 2006enthusiasm confusion5.3% confusionAssignments with the majority positive emotion responseAssignment 70.6%Spring 06Assignment majority negative emotion response% of Responses Fall 2005Assignment majority negative emotion responseAssignment majority negative emotion response% of Responses fall 2006Assignment majority negative emotion response% of Responses fall 2005Assignment majority negative emotion response% of Responses fall 2005Assignment majority negative emotion responseAssignment majority negative emotion response% of Responses fall 2005Assignment majority negative emotion response% of Responses fall 2005Assignment majority negative emotion		practice problems	10.7%		dyad	7.4%
Emotions cited most in responsesEmotions cited least in responsesEmotions cited least in responsesEmotions cited least in responsesTermEmotion% of ResponsesTermEmotion% of ResponsesFall 2005frustration20.0%Fall 2005relief6.5%frustration20.0%Fall 2005relief6.5%dread12.9%pride3.5%Spring 06frustration10.6%relief2.0%dread19.6%Spring 06pride3.9%dread19.6%satisfaction3.9%dread19.6%satisfaction3.9%frustration17.6%confusion3.9%Fall 2006enthusiasm5.3%determination18.1%confusion5.3%frustration13.4%panic4.5%confidence12.5%relief2.1%Assignments with the majority positive emotion responseAssignment% of Responses 80.0%Fall 2005graphing assgn in class testing% of Responses 68.4%Spring 06online practice group assignment100.0% 85.7%Spring 06in class testing graphing assgn in class testing% of Responses 68.4%Fall 2006online quiz69.6%Spring 06in class testing graphing assgn68.4% 68.4%Spring 06online quiz85.7%Spring 06in class testing graphing assgn68.4% 68.4%Spring 06online quiz69.6%Spring 06 <t< td=""><td></td><td>practice test</td><td>10.7%</td><td></td><td>individual assgn</td><td>9.2%</td></t<>		practice test	10.7%		individual assgn	9.2%
Emotions cited most in responsesEmotions cited least in responsesEmotion responsesMod ResponsesTerm Fall 2005Function (confidence dread satisfaction frustration dread satisfaction frustration frustration satisfaction dread tread satisfaction frustration tread satisfaction frustration tread satisfaction frustration tread satisfaction tread <b< td=""><td></td><td></td><td></td><td></td><td>online practice</td><td>9.2%</td></b<>					online practice	9.2%
TermEmotion% of ResponsesTermEmotion% of ResponsesFall 2005frustration20.0%Fall 2005relief6.5%confidence13.5%enthusiasm5.9%dread12.9%pride3.5%satisfaction10.6%pride3.9%dread19.6%confusion3.9%dread19.6%confusion3.9%satisfaction17.6%Fall 2006enthusiasm5.3%Fall 2006satisfaction21.1%Fall 2006enthusiasm5.3%furstration18.1%confusion5.3%furstration12.5%relief2.1%Assignments with the majority positive emotion2.1%Assignments with the majority negative emotion response% of ResponsesTermAssignment% of ResponsesTermAssignment% of ResponsesFall 2005online practice group assignment% of ResponsesTermAssignment% of ResponsesFall 2006online practice group assignment10.0%Spring 06in class testing graphing assgn68.4%Spring 06online quiz69.6%Fall 2006in class testing graphing assgn83.3% 80.0%Fall 2006online quiz69.6%Fall 2006in class testing graphing assgn66.7% 33.3%	Emotions cited most in responses			Emotions cited least i responses	n	
Fall 2005frustration confidence dread satisfaction20.0% 10.6%Fall 2005relief6.5% enthusiasm5.9% prideSpring 06frustration frustration adread satisfaction19.6% 19.6%Spring 06pride confusion 3.9% confusion3.9% confusionFall 2006satisfaction determination frustration frustration frustration terstration determination frustration frustration terstration <td>Term</td> <td>Emotion</td> <td>% of Responses</td> <td>Term</td> <td>Emotion</td> <td>% of Responses</td>	Term	Emotion	% of Responses	Term	Emotion	% of Responses
confidence13.5% dreadenthusiasm5.9% prideSpring 06frustration10.6% frustration19.6% 	Fall 2005	frustration	20.0%	Fall 2005	relief	6.5%
dread satisfaction12.9% 10.6%pride3.5%Spring 06frustration dread adisfaction19.6% 19.6%Spring 06pride confusion 3.9% confusion stisfaction3.9% 3.9% confusion 3.9%Fall 2006satisfaction determination frustration confidence21.1% 18.1% frustration 13.4%Fall 2006enthusiasm confusion 5.3% confusion panic entitient5.3% confusion 5.3% confusion 2.1%Assignments with the majority positive emotion response Fall 2005Ssignment online practice group assignmentAssignments with the majority negative emotion responseAssignment % of Responses Response TermAssignment Assignment % of Responses frust frust and responseMassignment % of Responses frust frust and response frust frust and responseAssignment % of Responses frust frust frust frust frust frustSpring 06in class testing graphing assgn 68.4% 68.4%Spring 06online practice online quiz group assignment100.0% 69.6%Spring 06in class testing graphing assgn graphing assgn graphing assgn 80.0%Fall 2006online quiz group assignment69.6% 63.8%Fall 2006in class testing graphing assgn graphing assgn 66.7% 33.3%		confidence	13.5%		enthusiasm	5.9%
Spring 06satisfaction10.6% frustrationSpring 06pride confusion3.9% confusionSpring 06frustration19.6% dreadSpring 06pride confusion3.9% confusion3.9% confusionFall 2006satisfaction21.1% determinationFall 2006enthusiasm confusion5.3% confusionFall 2006satisfaction21.1% determinationFall 2006enthusiasm confusion5.3% confusionAssignments with the majority positive emotion response		dread	12.9%		pride	3.5%
Spring 06frustration dread satisfaction19.6% 19.6%Spring 06pride confusion relief3.9% confusion 3.9% reliefFall 2006satisfaction determination frustration confidence21.1% 18.1% frustration 13.4%Fall 2006enthusiasm confusion 5.3% panic relief5.3% confusion 5.3% panic reliefAssignments with the majority positive emotion response Term Fall 2005Satisfaction determination 18.1% frustration confidence21.1% 18.1% frustration 13.4% confidenceAssignments with the majority negative emotion response TermSystem Assignment signment% of Responses 80.0% 70.6%Term Fall 2005Assignment graphing assgn in class testing graphing assgn 83.3%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn assgn 80.0%83.3% 83.3%Fall 2006online quiz group assignment69.6% 63.8%Fall 2006in class testing graphing assgn graphing assgn 33.3%		satisfaction	10.6%		•	
dread satisfaction19.6% 17.6%confusion relief3.9% 2.0%Fall 2006satisfaction determination frustration confidence21.1% 18.1% frustration 13.4% confidenceFall 2006enthusiasm confusion 5.3% panic5.3% 5.3% confusionAssignments with the majority positive emotion response	Spring 06	frustration	19.6%	Spring 06	pride	3.9%
satisfaction17.6%relief2.0%Fall 2006satisfaction determination frustration confidence21.1% 18.1% frustration confidenceFall 2006enthusiasm confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion 5.3% panic relief5.3% confusion panic relief5.3% confusion panic relief5.3% confusion panic relief5.3% confusion panic relief5.3% confusion panic relief5.3% confusion panic relief5.3% confusion response5.3% confusion response5.3% confusion response5.3% confusion response68.4% sin class testing graphing assgn68.4% sin class testing sing sing sing sing68.4% sin sing sing68.4% sin sing sing sing sing sing sing83.3% sing sing sing sing51%51% sing sing sing sing sing sing sing sing83.3% sing sing sing sing sing sing66.7% sing sing sing sing sing66.7% sing singFall 2006online quiz group assig		dread	19.6%		confusion	3.9%
Fall 2006satisfaction determination frustration confidence21.1% 18.1% 13.4% 12.5%Fall 2006enthusiasm confusion panic relief5.3% confusion 5.3% panic reliefAssignments with the majority positive emotion responseKasignment majority negative emotion responseAssignment majority negative emotion responseAssignment majority negative emotion responseMassignment majority negative emotion respons		satisfaction	17.6%		relief	2.0%
determination18.1%confusion5.3%frustration13.4%panic4.5%confidence12.5%relief2.1%Assignments with the majority positive emotion responseAssignmentMassignments with the majority negative emotion responseAssignment% of ResponsesTermAssignment% of Responses 80.0%TermAssignment% of ResponsesFall 2005online practice group assignment80.0% 70.6%Fall 2005graphing assgn68.4%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn83.3% 80.0%Fall 2006online quiz69.6% group assignmentFall 2006in class testing graphing assgn66.7% 33.3%	Fall 2006	satisfaction	21.1%	Fall 2006	enthusiasm	5.3%
frustration13.4%panic4.5%confidence12.5%relief2.1%Assignments with the majority positive emotion responseAssignmentAssignments with the majority negative emotion responseAssignment% of ResponsesTermAssignment online practice group assignment% of Responses 80.0%TermAssignment graphing assgn% of Responses 68.4%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn83.3% 80.0%Fall 2006online quiz69.6% 63.8%Fall 2006in class testing graphing assgn66.7% 33.3%		determination	18.1%		confusion	5.3%
confidence12.5%relief2.1%Assignments with the majority positive emotion responseAssignments with the majority negative emotion responseAssignments with the majority negative emotion responseAssignment M of ResponsesAssignment M of ResponsesTerm Fall 2005Assignment online practice group assignment% of Responses 80.0%Term Fall 2005Assignment graphing assgn in class testing% of Responses 68.4%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn 80.0%83.3% 80.0%Fall 2006online quiz69.6% 63.8%Fall 2006in class testing graphing assgn 33.3%66.7% 33.3%		frustration	13.4%		panic	4.5%
Assignments with the majority positive emotion responseAssignments with the majority negative emotion responseAssignments with the majority negative emotion responseAssignment% of Responses (80.0%)Term Fall 2005Assignment online practice group assignment% of Responses (80.0%)Term Fall 2005Assignment (70.6%)% of Responses (70.6%)Spring 06online practice online quiz100.0% (85.7%)Spring 06in class testing (83.3%) (80.0%)Fall 2006online quiz69.6% (63.8%)Fall 2006in class testing (70.6%)		confidence	12.5%		relief	2.1%
TermAssignment% of ResponsesTermAssignment% of ResponsesFall 2005online practice80.0%Fall 2005graphing assgn68.4%Spring 06online practice100.0%Spring 06in class testing83.3%Spring 06online quiz85.7%Spring 06in class testing83.3%Fall 2006online quiz69.6%Fall 2006in class testing66.7%group assignment63.8%SameSameSameSame	Assignments with the majority positive emotion response	ı		Assignments with the majority negative emotion response		
Fall 2005online practice group assignment80.0% 70.6%Fall 2005graphing assgn in class testing68.4%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn83.3% 	Term	Assignment	% of Responses	Term	Assignment	% of Responses
group assignment70.6%in class testing68.4%Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn83.3% 80.0%Fall 2006online quiz group assignment69.6% 63.8%Fall 2006in class testing practice problems66.7% 33.3%	Fall 2005	online practice	80.0%	Fall 2005	graphing assgn	68.4%
Spring 06online practice online quiz100.0% 85.7%Spring 06in class testing graphing assgn83.3% 80.0%Fall 2006online quiz group assignment69.6% 63.8%Fall 2006in class testing practice problems66.7% 33.3%		group assignment	70.6%		in class testing	68.4%
online quiz85.7%graphing assgn80.0%Fall 2006online quiz69.6%Fall 2006in class testing66.7%group assignment63.8%practice problems33.3%	Spring 06	online practice	100.0%	Spring 06	in class testing	83.3%
Fall 2006online quiz69.6%Fall 2006in class testing66.7%group assignment63.8%practice problems33.3%		online quiz	85.7%		graphing assgn	80.0%
group assignment 63.8% practice problems 33.3%	Fall 2006	online quiz	69.6%	Fall 2006	in class testing	66.7%
		group assignment	63.8%		practice problems	33.3%

Table 7. Summary of Responses to Strongest Emotions (Grid 2).

## Conclusions

While it is expected that mostly first-year undergraduate students who are not

math majors would have negative emotions about a required Precalculus math course,

these survey results also show a variety of positive emotions associated with the course

assignments. Interesting is the pairing of positive and negative emotions, and the student balance in reporting such. Moreover, the positive emotions were generally predominant.

How do students feel when they are made to think? First, they acknowledge that they are made to think and are challenged by the work of these Precalculus math courses. They also acknowledge that they do the assignments because they are required to do so. They recognize the importance of the assignment in helping them learn math, while they underestimate the amount of time it will take to complete an assignment. These behaviors seem typical of those students who are beginning their college career and are in the process of becoming adult learners (Chickering & Gamson, 1999; Cross, 1999; Eberly Center for Teaching Excellence, 2002).

A common assessment taken by the students during the semester showed comparable performance in each unit each semester even though the students taking the course in the spring are usually considered weaker in math skills. This may explain the inclusion of dread as a primary emotion for the spring students. The ranking of confidence was higher in the fall semester than in the spring semester, also giving credence to the perception of the spring semester students having weaker math skills.

While the students showed high emotional responses to collaboration, they did not consider that they cheated on assignments. Working together with classmates and others on math assignments was not considered cheating by these students. It should be noted that the students were trained in collaboration by the researcher (Bruffee, 1999; Johnson & Johnson, 1999).

In both semesters, a surprisingly low response was given to the emotion of pride (fall 2005: 3.5%; spring 2006: 3.9%; fall 2006: 5.7%). Students were more likely to

indicate satisfaction as their predominate positive emotion (fall 2005: 17.6%; spring 2006: 10.6%; fall 2006: 21.1%). In all semesters frustration was higher than dread (fall 2005: 5.1% vs. 4.9%; spring 2006: 8.2% vs. 4.9%; fall 2006: 13.4% vs. 11.3%). The students also gave a high response of determination, especially in fall 2006 (fall 2005: 8.8%; spring 2006 9.8%; fall 2006: 18.1%).

While these millennium students were expected to have a high level of familiarity with computer-assisted instruction, this was not always the case. Interestingly, these students gave a mixed response to the assignments done on the computer. All assignments except for their practice problems were to be computer generated. This contributed to the response that the work of the assignments took longer than they expected.

Connected to each other by text and instant messaging of cell phone use, this technology preference did not transfer into the chat room option (iClass discussion) among the assignments given. Often these were done at the last minute to gain some extra points prior to the in class testing date, rather than viewed as a way to gain understanding of the course content as it was being taught.

As a math instructor, it was gratifying to know that the course and its assignments made the students think and learn math. Beyond the thinking and learning math, these students indicated that they felt good about the learning process be it by determination or satisfaction with results. Only the in class testing was dreaded, an emotion heavily engrained by their experience. Hopefully, for these students, their memories of undergraduate math will reflect their positive emotions, as time goes by.

## References

- Bruffee, K. A. (1999). *Collaborative learning: Higher education, interdependence, and the authority of knowledge* (2nd ed.). Baltimore: The Johns Hopkins University Press.
- Chickering, A. W., & Gamson, Z. F. (1999). Development and Adaptations of the Seven Principles for Good Practice in Undergraduate Education. *New Directions for Teaching & Learning*(80), 75-81.
- Cross, K. P. (1999). What do we know about students' learning, and how do we know it? *Innovative Higher Education*, 23(4), 255-270.
- Eberly Center for Teaching Excellence. (2002). *Best practices for teaching first year undergraduates*. Retrieved October 26, 2004, from http://www.cmu.edu/teaching/documents/bestpractices.htm#Engaging
- Johnson, D. W., & Johnson, R. T. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning* (5th ed.). Boston: Allyn and Bacon.
- Pekrun, R., Goetz, T., Titz, W., & Perry, R. (2002). Academic emotions in students' selfregulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist*, 37(2), 91-105.

## Appendix A.

Directions: Consider each of the class assignments for this course. The statement: This assignment ..., is completed on the chart below in the first column. If the statement applies to how you felt about the particular assignment, mark the corresponding box with a check ( $\sqrt{}$ ). If the statement does not describe how you feel about the assignment, then leave the area blank.

This assignment	learni ng log	online practi ce	online quiz	iClass discussi ons	dyad presenta -	group assign- ment	writing assign- ment	modeling assign- ment	graphing assign- ment	practi ce test
		00		0113	tion	ment	ment	ment	ment	1031
made me proud of my accomplishm ents.										
I liked doing.										
I avoided.										
bored me.										
frustrated me.										
required me to be patient.										
increased my confidence.										
decreased my confidence.										
challenged me.										
made me anxious.										
I did only because I had to.										
interested me.										
was fun to do.										
made me cheat.										
made me think.										
made me ask for help.										
helped me learn math.										
helped me learn more than math.										
was more time consuming than I										
was a waste of time.										
l dreaded doing.										

Now, describe the emotions you associate <u>most strongly</u> with each assignment. Choose <u>no more than three</u> emotions, and <u>circle</u> the one that you would consider the emotion you are <u>most likely</u> to associate with this assignment.

Assignment/ Emotion	pride	frustration	satisfaction	determination	enthusiasm	panic	confidence	confusion	relief	dread	no emotion
learning log											
online practice											
online quiz											
iClass discussions											
dyad presentation											
group assignment											
writing assignment											
modeling assignment											
graphing assignment											
practice test											
in class testing											

Please answer the following.

Are you \_\_\_\_ male or \_\_\_\_ female?

What is your anticipated grade for this course? \_\_\_\_\_

How many hours a week do you spend on doing work for this course? \_\_\_\_\_

Do you generally like math classes? \_\_\_\_ Yes \_\_\_\_ No

Are you planning on taking additional collegiate math classes? \_\_\_\_ Yes \_\_\_\_ No

Would you take a math class that was not required? \_\_\_\_ Yes \_\_\_\_ No

Thank you for your time in answering this survey.