

Running Head: ACADEMIC EMOTIONS IN UNDERGRADUATE MATHEMATICS

The Yin and Yang of Academic Emotions in Undergraduate Mathematics

by

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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:

1. 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.

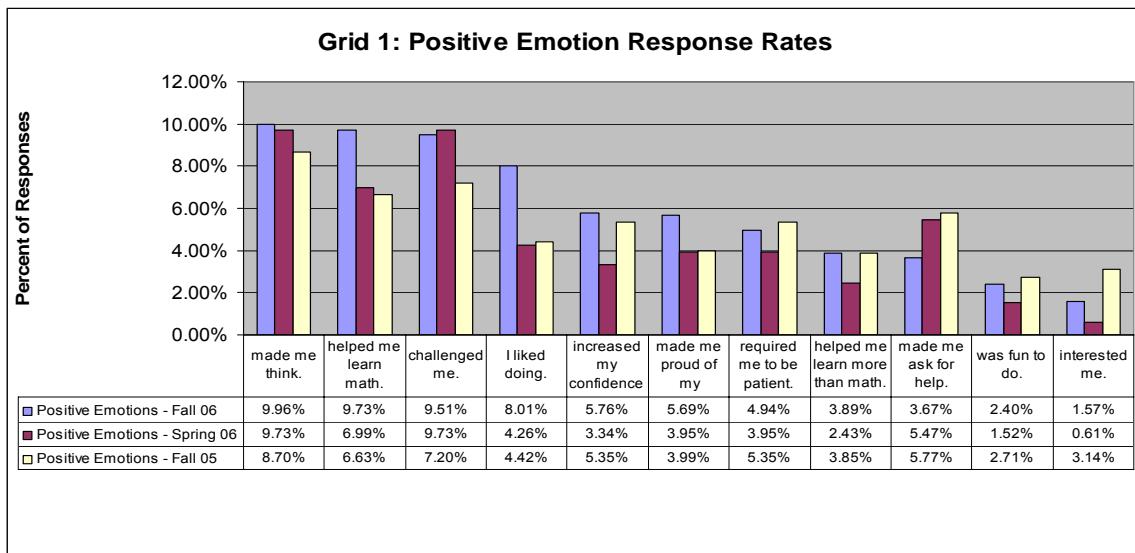


Table 1. Positive Emotion Response Rates

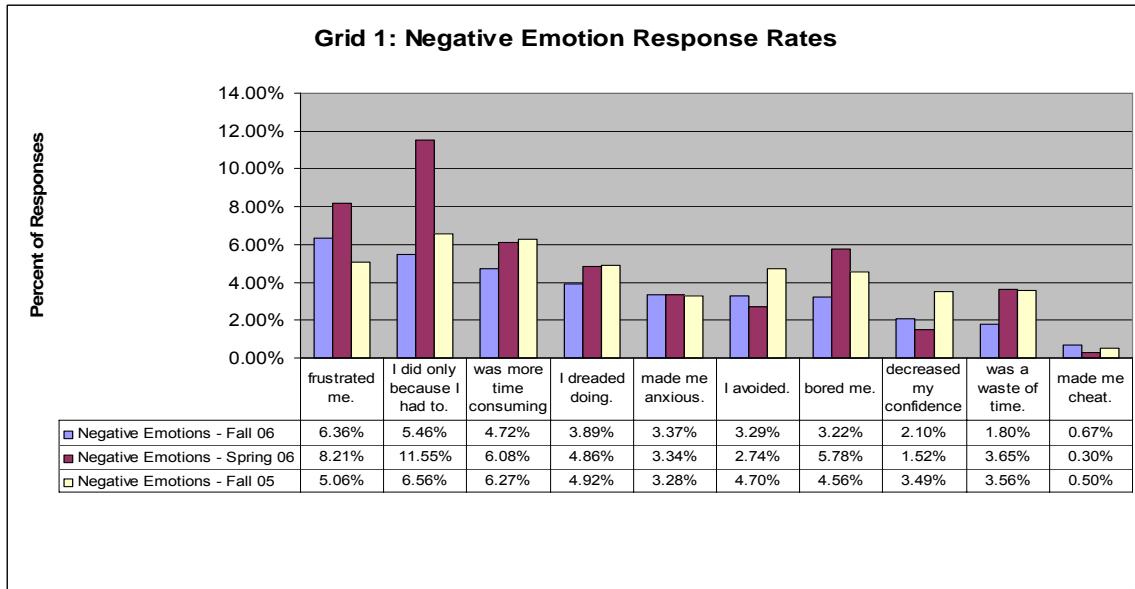


Table 2. Negative Emotion Response Rates.

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*. High-ranking 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 Response per Assignment	Fall 05 n=34 response >13	Spring 06 n=10 r> 3	Fall 06 n=49 r>10
learning log	I did only because I had to.	I did only because I had to. No significant response.	made me think* (*format changed) helped me learn math.*
online practice	I avoided.	made me proud of my accomplishments; made me think; helped me learn math	made me proud of my accomplishments; I liked doing
online quiz	made me think.	made me proud of my accomplishments.	
iClass discussions	I avoided.	I liked doing.	I avoided.
dyad presentation	made me think; made me ask for help	I did only because I had to.	bored me; I did only because I had to
group assignment	made me think.	made me think	made me think
writing assignment	was more time consuming than I planned.	made me think	I liked doing.
modeling assignment	challenged me; made me think; was more time consuming than I planned	made me think	challenged me.
graphing assignment	frustrated me.	I did only because I had to; made me think	helped me learn math.
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 least responses		
Assignment generating the most responses			Assignment generating the least responses		
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%
Spring 06	I did only because I had to	11.6%	Spring 06	interested me	3.1%
	challenged me	9.7%		made me cheat	0.3%
	made me think	9.6%		interested me	0.6%
Fall 2006	made me think	10%	Fall 2006	was fun to do	1.5%
	helped me learn math	9.7%		decreased my confidence	1.5%
	challenged me	9.5%		made me cheat	0.6%
				interested me	1.6%
				was a waste of time	1.8%
Assignments with the most positive responses			Assignments with the most negative responses		
Term	Assignment	% Positive Responses	Term	Assignment	% Negative Responses
Fall 2005	practice test	67.5%	Fall 2005	writing	60.3%
	dyad	66.5%		graphing	60.3%
	iClass discussion	63.2%		modeling	58.5%
Spring 06	online quiz	66.7%	Spring 06	learning log	58.5%
	dyad	65.3%		learning log	91.9%
	practice test	63.6%		writing	56.1%
Fall 2006	online quiz	81.4%	Fall 2006	graphing	57.9%
	graphing	73.2%		dyad	51.0%
	online practice	69.5%		iClass discussion	47.3%
				practice test	45.3%

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.

Assignment	Percent of Total Responses	Number of Positive Responses	Number of Negative Responses	Percent +	Percent -	Number of No emotion response	Total Responses	Rank by emotion 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%.

Grid 2 Results					
Assignments generating the most responses			Assignments generating the least responses		
Term	Assignment	% of Responses	Term	Assignment	% of Responses
Fall 2005	dyad	12.9%	Fall 2005	online practice	5.9%
	modeling	11.2%		iClass discussion	7.6%
	graphing	11.0%		writing assgn	9.4%
Spring 06	dyad	13.7%	Spring 06	online practice	3.9%
	online quiz	13.7%		iClass discussion	5.9%
	in class testing	11.8%			
Fall 2006	group assgn	12.5%	Fall 2006	iClass discussion	4.5%
	practice problems	10.7%		dyad	7.4%
	practice test	10.7%		individual assgn	9.2%
				online practice	9.2%
Emotions cited most in responses			Emotions cited least in responses		
Term	Emotion	% of Responses	Term	Emotion	% of Responses
Fall 2005	frustration	20.0%	Fall 2005	relief	6.5%
	confidence	13.5%		enthusiasm	5.9%
	dread	12.9%		pride	3.5%
Spring 06	satisfaction	10.6%	Spring 06	pride	3.9%
	frustration	19.6%		confusion	3.9%
	dread	19.6%		relief	2.0%
Fall 2006	satisfaction	21.1%	Fall 2006	enthusiasm	5.3%
	determination	18.1%		confusion	5.3%
	frustration	13.4%		panic	4.5%
	confidence	12.5%		relief	2.1%
Assignments with the majority positive emotion response			Assignments with the majority negative emotion response		
Term	Assignment	% of Responses	Term	Assignment	% of Responses
Fall 2005	online practice	80.0%	Fall 2005	graphing assgn	68.4%
	group assignment	70.6%		in class testing	68.4%
Spring 06	online practice	100.0%	Spring 06	in class testing	83.3%
	online quiz	85.7%		graphing assgn	80.0%
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.

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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 (✓). If the statement does not describe how you feel about the assignment, then leave the area blank.

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