2010

Dealing with large classes: a real challenge

Pauline Carolyne Fortes
University of Wollongong, pfortes@uow.edu.au

Abdellatif Tchantchane
University of Wollongong in Dubai, tchantch@uow.edu.au

Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 8 (2010) 272–280

Procedia
Social and Behavioral Sciences

International Conference on Mathematics Education Research 2010 (ICMER 2010)

Dealing with Large Classes: A Real Challenge

Pauline Carolyne Fortes[a,]*, Abdellatif Tchantchane[b]

[a,b]*Faculty of Computer Science and Engineering, University of Wollongong, Dubai*

Abstract

Dealing with large classes constitutes a real challenge to every teacher: diversity of students, lack of flexibility, class climate management, difficulty of setting and enforcing classroom behaviour (crowd control), minimum attention to students, limited monitoring of students' learning and difficulty in engaging students to activities. The major hypothesis is that effective teaching and producing learning is critically constrained by the large size of classes and the students' perception about large classes being negative. This research is to engage in a study of the effectiveness of teaching foundation Math for very large classes (150-200 students). The baseline of our study is based on data that has been collected from students' survey. Two surveys were conducted throughout the semester to monitor students' expectations, motivation, own perception on performance, views and preferences about the delivery of the lecture and the learning. We designed the surveys to detect accurately as much as possible students' attitude towards learning. Each student's responses such as the students own perception has been correlated to real performance through out the semester as measured by two midterms, weekly class work, quizzes, tutorials and the final. Our study will highlight other solutions to the above critical obstacles to conducting an effective learning environment. Both the lecturing time and the mode of teaching are investigated and reviewed as a potential solution to the problems encountered during the lecture delivery. We compare our findings to the existing literature and other teachers' experiences. Studying students' experience is quite challenging and can be used as a quality indicator in addition to the standard quality in higher education. Evaluating or assessing students' experience, need and expectations can lead to improvements in teaching performance and achieving learning outcomes. Since most studies on students' achievements and class size effects are done in a western context, this study is timely and relevant for United Arab Emirates.

***Keywords*:** Students' expectations; Class size; Factor analysis; Analysis of variance student performance; Mathematics in higher education

1. Introduction

The Faculty of Computer Science at the University of Wollongong in Dubai has a growing concern on the failure rate of students in the Foundation of Mathematics. The subject is conducted in two hour lecture and 1 hour tutorial per week. Initially, tutorials only have a class size of 25 students, while lecture used to have 50-60 students but

* Corresponding author.
E-mail address: PaulineFortes@uowdubai.ac.ae

1877-0428 © 2010 Published by Elsevier Ltd.
doi:10.1016/j.sbspro.2010.12.037

recently, there was a dramatic increase in the class size in the lecture and tutorial classes. Each tutorial has 30-40 students while lecture class size increased to more than 150 students. Attendance is not compulsory in the lecture; however, students should not miss more than 25% of the tutorial classes. Students who are enrolled in the mathematics foundation subject are undergraduate freshman, or new in the higher education, or students who did not apply or pass the mathematics challenge test. Students enrolled in the university come from diverse cultural background, and in fact, the university has more than 100 different nationalities. Diverse backgrounds, different teaching assessments and strategies in high school, different expectations, different levels of English competency, and conducting large classes in Mathematics in UOWD are some of the challenges faced.

1.1 Review of Literature

Majority of the undergraduate students find difficulty in mathematics and statistics foundation subjects. Students' attitude towards mathematics varies: i.e., the time devoted to studying mathematics, the inability to adapt to the teaching methodologies in higher education as compared to the high school environment. Students' expectations are not solely the basis for driving educational planning but such expectations can create dilemmas or problems for the part of the academic staff as noted by James (2002). On the other hand, aside from being concerned with the teaching strategies or lecture delivering, teaching staff are also concerned on how to deal with student's expectations, perceptions, motivations to improve their academic performance. Hence, student preferences and expectations, and the relationships of these to the institutional expectations and priorities are exceedingly complex issues of analysis (James, 2002). Cook and Leckey (1999) noted that transition of the students from secondary to a higher education will cause problems if not acknowledged and resolved properly. Lowe and Cook (2003) stated that some students enter the university environment unprepared and have minimal idea of what to expect and little understanding of how university environment would affect their lives. According to James (2002), students' expectations can be relative to "the value money" and importance of the subject. Coaldrake (2002) mentioned that students' experience satisfaction on daily based experiences such as library services, sports activities, interaction with other students and access to the teachers.

Base on our review of literature, we set the following hypotheses:
Hypothesis 1: *There exists a high correlation between student's attitudes and performance in Mathematics*.

In general, attitude towards learning affects individual performance. These includes students' attitude towards specific subjects would have either a positive or a negative impact on their academic performance as confirmed recently by Goodykoontz (2008). His studies suggested that students' positive attitude toward a subject leads to successful academic performance. Based on students' survey, Goodkoontz (2008) and Hannula (2002) asserted that the teachers' attitude and their teaching style, type of assessments are among the factors influencing students' attitude towards mathematics.

Hypothesis 2: *The students perceive that Math subject is difficult*.

Mathematics is a subject that students perceived to be difficult. This is the reason why number of students ended by withdrawing from Math related subjects and considers a non-math related career. This has motivated Math educators to investigate how seriously the student's attitude towards Mathematics would affect performance. Norton & Irvin (2007) found that the dramatic decrease in students' enrolment in Mathematics is due to the increasing proportion of students finding Algebra being difficult. Shen & Talavera (2003) conducted a research study in 38 countries on student's perception towards Mathematics. They found that those students who think that Mathematics is easy do well in Mathematics. Further study conducted by Hembree (1990) found that a Math anxiety is related to poor performance on achievement tests.

Hypothesis 3: *Students with positive attitude have more chances of obtaining good grades.*

Many empirical studies tested the belief that students' positive attitude towards learning and positive self perception of their competence have a strong effect on their motivation and enhances their academic performance. Shen & Talavera (2003) assert that students with positive attitude are more likely to spend more time on studies, solving problems and seek help from lecturer when they have doubt or need more clarifications.

Hypothesis 4*: Students with negative attitudes are more likely to fail*

According to Hannula (2002), student's attitude towards Mathematics tends to degrade as student move from grade school to secondary school. Because of this negative attitude, students show poor classroom participation, hence, ending by withdrawing from Mathematic subjects (Goodykoontz (2008), Norton & Irvin (2007), Ma & Kishor (1997), and Farooq & Shah (2008)).

Hypothesis 5: *Students prefer smaller class size*

Large classes are very common for many foundation subjects in higher education in Europe, USA and Canada, wherein they conducted first-year classes ranges from 300 to 1,000 and sometimes even larger (Gibbs & Jenkins 1992). With a large class, students would experience less interaction with their teachers, leading to a drop-out and failure as asserted by Gibbs & Jenkins (1992). Students' preference of small class size is not a surprise, especially for the freshman. A comparative analysis conducted by Stanne & Donovan (1999) revealed that small-group learning are more effective in promoting greater academic achievement, and enhances favourable attitudes toward learning. Based on our interactions with the students enrolled in our Foundation Mathematics subject, they expressed their dissatisfaction towards large classes. They often get distracted with noise, and do not get opportunity to approach the lecturers for help. According to Goodykoontz (2008), though some students felt accustomed to large classes, they still prefer smaller classes would be more effective.

2. Methodology and Survey Design

This study conducted two surveys throughout the semester to monitor students' expectations, motivation, difficulties, own perception on performance, views and preferences about the delivery of the lecture and the learning. The first survey was conducted before the midterm exam to determine the students' expectation in the subject and performance, while the second survey was conducted before the final examination. We conducted same set of questionnaires in the second survey in order to determine if the student's perception and expectations changed.

The survey was designed to detect students' attitude towards learning and try to spot students weaknesses and their attitude towards learning. Each student's responses such as the students own perception will be correlated to real performance through out the semester as measured by two midterms, weekly class work, quizzes, tutorials and the final. A statistical analysis is carried out to test the hypotheses of this research.

3. Findings

3.1 Empirical Analysis of the results

Students were asked to respond to each question on a 5-point scale; the response scale for all questions (X_1 to X_{28}) was 1=strongly agree and 5 strongly disagree. The frequencies for each question corresponding to both survey I and survey II are reported in **Table 1**. The frequencies of students' response corresponding to questions related to the class size and class duration preferences are summarized in **Table 2**. Accordingly, 63% of the students preferred class size of less than 80 for lectures and 88% preferred class size of less than 30 for tutorials. This confirms our hypothesis (H6) that students prefer smaller class size. Further, 53 % of the students preferred 1.5 hours of lecture while only 19% preferred 2 hours of lectures. 69% preferred only one hour of tutorial while only 9% prefer tutorials of two hours or more.

The eight variables X_1, X_2, X_4, X_5, X_8, X_9, X_{10} and X_{11} were phrased so that agreement indicates a positive perception towards Mathematics in general whereas the five variables X_3, X_6, X_7, X_{12} and X_{13} were phrased so that agreement indicates a negative perception towards Mathematics. Together the cited variables are supposed to measure a single factor representing the level of perception towards Math. In order to confirm this, we conducted correlation technique based on factor analysis. To start the analysis, we issued the following SPSS commands: Analyze->Dimension Reduction->Factor. We selected Principal Axis Factoring as the extraction method. In order to make the output easier to scan and since factor loading less than 0.5 are considered too small to be considered, we

suppressed the low absolute loadings. Analysis results revealed that the first factor explains 44.21% of the variance. The second factor added only 9.8% to the accumulated variance. **Table 3** shows that after rotation, the first factor contains most cited variables except for X_4 and X_7. Therefore the 11 variables together hang in a single factor saved as a new variable named *perception-towards-math_survey_1*. The original variables with negative loadings suggest a negative correlation with the major factor as expected. In order to be consistent with the scale, we have negated the new variable and scaled it between 0 and 1 so that high values refer to positive perception. A further reliability analysis test confirmed a Cronbach's alpha=0.886 for the 13 original variables and a slightly smaller Cronbach's value of .878 when only the 11 variables contributing to the major factor were included. Further correlation analysis revealed that students seem to respond similarly to the questions X_{17} and X_{18} related respectively to the specific place and time to study; X_{14} and X_{15} related respectively to preferring class work and being motivated by quizzes, and X_{16} with X_{19} related respectively to the lack of study skills and to the pace of the lecture.

Table1 Frequency distribution: Students' responses

	Survey I					Survey I I				
Variable / Response scale	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
X_1 - I particularly like the Math subject	44	58	53	27	11	48	56	44	17	7
X_2 – Math has been my best subject	25	34	64	48	23	35	41	44	36	17
X_3 – Math has been my worst subject	17	22	49	53	50	17	21	39	45	47
X_4 - I find the Math subject relevant to my degree	34	63	53	31	11	32	70	49	14	5
X_5 - I believe that I can succeed in Math subject	66	92	27	3	0	55	91	23	3	1
X_6 - I never expect to do well in Mathematics	7	21	35	71	58	10	30	35	57	39
X_7 – I just want to pass the Mathematics course	34	37	27	62	29	25	34	33	51	28
X_8 - I expect to get a good grade in Mathematics	70	75	29	16	1	58	76	34	4	0
X_9 – I can solve mathematical problems with minimal supervision	25	73	60	26	6	34	68	58	11	1
X_{10} - I am currently doing well in Mathematics	32	78	54	22	7	33	83	37	15	4
X_{11} – I can solve mathematical problems with confidence	23	72	53	36	8	31	72	48	19	3
X_{12} – I usually struggle in my Mathematics assignments and class work	9	33	47	82	22	11	28	47	70	13
X_{13} - I always need help when I solve Math problems	12	26	59	75	17	15	21	50	66	18
X_{14} - I prefer class work during Mathematics lecture	30	75	50	20	17	32	64	52	15	9
X_{15} - Quizzes motivate me to constantly do my Math assignments	42	77	44	24	7	32	81	40	14	5
X_{16} - I have a lack of study skills	8	28	45	71	33	10	29	40	63	28
X_{17} - I have specific place to study Math	9	40	62	59	22	13	38	52	50	16
X_{18} - I have specific time to study Math	12	46	51	57	25	14	45	47	47	18
X_{19} – The pace of the lectures is too fast	13	40	65	51	14	15	29	63	54	10
X_{20} – The subject has a helpful teaching staff	42	99	32	10	2	44	96	27	4	1
X_{21} – The teaching staff gives regular feedback	30	98	46	9	0	34	94	37	5	1
X_{22} – The teaching style is relaxed and informal	17	76	63	19	8	29	75	54	10	4
X_{23} – The lecturer gives helpful presentation for examination	40	89	41	10	3	42	98	24	6	1
X_{24} – The subject is not too different from high school.	39	76	43	18	7	39	70	42	14	5
X_{25} – The lecturer encourages me to think on my own	31	77	62	14	1	26	84	51	10	1
X_{26} – The teaching staff are approachable when I need help	36	90	42	10	3	30	88	42	7	3
X_{27} – The teaching staff have been interested in my progress in Mathematics	32	57	77	12	6	32	71	56	9	3
X_{28} – The teaching staff gives me extra help in the areas in which I need help	36	55	72	15	6	24	70	62	16	0

1-Strongly Agree; 2-Agree; 3- Neutral; 4-Disagree; 5-Strongly Disagree

Table 2 Frequency distribution of the survey corresponding to class size and class duration

	Student Preference in the lecture				Student Preference in the tutorial			
	1	2	3	4	*1*	2	3	4
Class Size	65	41	42	19	100	39	26	2
Hours	40	90	32	5	116	32	16	3

Table 3 Rotated Factor Matrix (Survey I)

	Factors		
Variable	1	2	3
X1_1	.763		-.528
X2_1	.795		
X3_1	-.617		
X4_1			
X5_1	.630		
X6_1	-.570		
X7_1			
X8_1	.642		
X9_1	.701		
X10_1	.778		
X11_1	.734		
X12_1	-.504	.680	
X13_1	-.538		

Extraction Method: Principal Axis Factoring, Rotation Method: Quartimax

The second stage of our analysis is to assess the degree of association between the new construct *perception-towards-math_survey_1* and students' performance. Students' performances are measured by the final grade obtained in the course. Final grades in the course are scaled between 0 and 5 where 0=fail (F) 1= Pass conceded (PC), 2= Pass (P), 3=Credit(C), 4=Distinction (D), and 5=highly distinction (HD). The distribution of the grades is given in the last column of Table 4. One-Way ANOVA was conducted; Students' performance was used as a factor with 6 levels from failing group to the high distinction group. The results of the analyses are shown in **Table 4** below.

Table 4 One way ANOVA Analysis
Dependent variable: perception-towards-math survey 1

Dependent variable*: Perception_Math_survey_1*			
Factor Levels (Final grade)	***Perception Mean****	***Std.***	***Number of students***
F	*.3577*	*.160*	*30*
PC	*.3923*	*.256*	*6*
P	*.4867*	*.218*	*26*
C	*.5802*	*.165*	*23*
D	*.6273*	*.220*	*39*
HD	*.7326*	*.163*	*33*

*$F(5,151)=14.6$, $p=0.000$, $\eta^2=.326$, * Homogeneity test of equal variance $p=0.086$*

The test is significant, F(5,151)=14.6, p=0.000, η^2=.326 reflecting a large effect size. In the range of 0 and 1, the perception average among the failing students is about .358 to an average of .734 for the high distinction students. **Figure 1** shows the relationship students' perception towards Math among the 6 various levels of performance.

Similarly the Eight questions X_{20}, X_{21}, X_{22}, X_{23}, X_{25}, X_{26}, X_{27} and X_{28} are grouped into one cluster named *perception_towards_teaching_survey_1*. The internal consistency of the new cluster indicated a reliability test of Cronbach's alpha = 0.865. Questions X_{24} and X_{19} do not string up to the cluster; a dimension reduction analysis show that these two questions cluster together to a second factor with loading -.512 and .806 respectively. The scores of the *perception_towards_teaching_survey_1* were obtained by adding the scores on the eight questions; then scaled so that the overall score of the new variable would vary between 0 and 1. The lowest scores correspond to a low perception towards teaching approach and the highest scores correspond to those students being happy towards the teaching approach. Next we investigated the association between students' performance measured by the final grade and the degree of happiness towards the teaching approach. To assess such an association the means of the degree of happiness were compared across the six levels of students' performance (fail to highest distinguished). The analysis results are summarized in **Table 5**; the means of the various levels of performance are all close to the overall mean.

Figure 1. Perception towards math for various performance groups

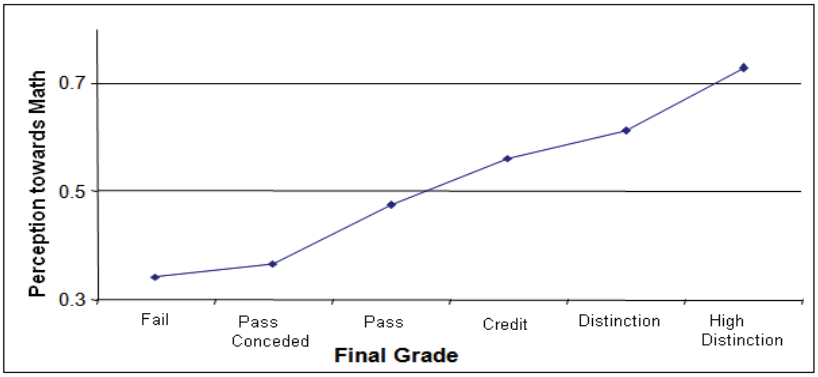

Table 5 One way ANOVA Analysis
Dependent variable: perception-teaching_survey_1

Factor Levels (Final grade)	*Perception Mean**	*Std.*
Fail	*.640*	*.028*
Pass Conceded	*.475*	*.067*
Pass	*.665*	*.028*
Credit	*.746*	*.033*
Distinction	*.667*	*.024*
High Distinction	*.696*	*.025*

*F(5,144)=3.19, p=0.009, η^2=.09, * perception is scaled between 0 and 1*

Though the ANOVA results for the perception towards teaching indicates an overall significance (F value=3.19, p=0.09) among the final grade performance groups but with only with a moderate effect size η^2=0.09. Post Hoc multiple comparisons were performed to control for type I error. As shown in Table 6, tests revealed no significance between the means except between students who obtained a PC and C (p =0.005) and also between students who obtained a PC and HD (p=0.028). **Figure 2** plots the means of the *perception-toward_teaching* for each group as a function of the factor variable *final grade* for both surveys.

Figure 2. Perception towards teaching approach for various performance groups

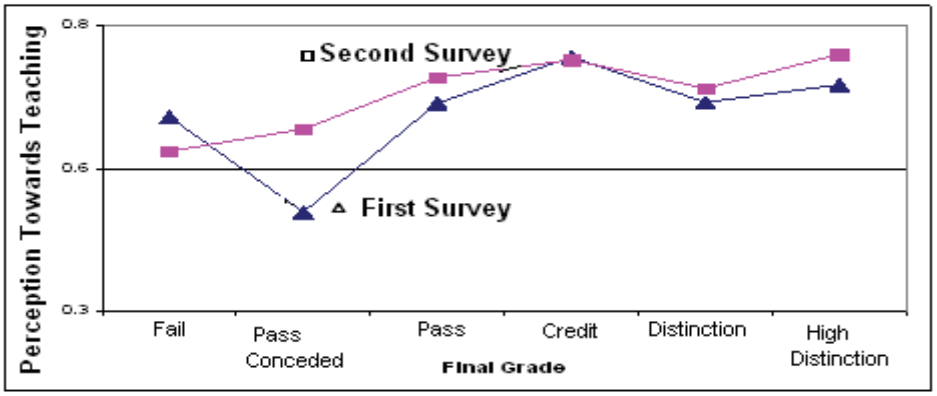

Table 6 Multiple Comparison for Post Hoc Analysis

Factor Levels (Final grade)	*Grade*	*Difference In perception towards math*	*Sig*
Fail (F)	*PC*	*0.17*	*.213*
	P	*-0.02*	*.989*
	C	*-0.11*	*.146*
	D	*-0.03*	*.979*
	HD	*-0.06*	*.669*
Pass Conceded (PC)	*P*	*-0.19*	*.101*
	C	***-0.27****	*.005*
	D	*-0.19*	*.084*
	HD	***-0.22****	*.028*
Pass (P)	*C*	*-0.08*	*.422*
	D	*0.00*	*1.000*
	HD	*-0.03*	*.960*
Credit (C)	*D*	*0.08*	*.382*
	HD	*0.05*	*.844*
Distinction (D)	*HD*	*-0.03*	*.957*

** significant at 0.05*

3.2 Analyses of the second survey

Data reduction analysis revealed that the variables X_1, X_2, X_4, X_5, X_8, X_9, X_{10}, and X_{11}, corresponding to the second survey cluster into one single factor explaining 60 % of the variance between the variables and with reliability scale of Cronbach's alpha = 0.904 . The scores of the factor were saved as a new variable, *perception-towards-math_survey_2*, to be used in place of, the 8 original variables. The new variable was negated and scaled it between 0 and 1 so that high values refer to positive perception. The variables X_3, X_6, X_7, X_{12} and X_{13} cluster into a second factor with a reliability Cronbach' alpha=0.631. Amazingly the correlation between the two variables *perception-towards-math_survey_1* and *perception-towards-math_survey_2* is very strong (.832). To investigate the dependency of the *perception-towards-math_survey_2* on the performance levels (F, PC, P, C, D and HD), ANOVA was conducted. The results reported in Table 7 show that the means of the *perception-towards-math_survey_2* across the six levels of students performance differed significantly with F(5, 141)=20.9, p=0.000. Note that the ANOVA assumption of equal variance among the 6 levels of final grade factor could not be rejected (p=0.604) as asserted by the Levene homogeneity test of equal variance.

Table 7 One way ANOVA Analysis
Dependent variable: perception-towards-math_survey_2

Factor Levels (Final grade)	*Perception Mean**	*Std.*	*Number of students*
F	*.387*	*.187*	*20*
PC	*.468*	*.194*	*7*
P	*.614*	*.162*	*30*
C	*.659*	*.175*	*24*
D	*.686*	*.166*	*34*
HD	*.836*	*.124*	*32*

*$F(5,141)=20.9$, $p=0.000$, $\eta^2=.329$, * Homogeneity test of equal variance $p=0.604$*

Analogous to survey I, questions X_{20}, X_{21}, X_{22}, X_{23}, X_{25}, X_{26}, X_{27} and X_{28} corresponding to the second survey clustered into a single factor named *perception-teaching_survey_2*. This new variable did not suggest a significant dependency on students' performance. The means of this new variable across the various students' performance levels are plotted in **Figure 2** with the corresponding results of survey I.

4. Conclusion

Analysis of Survey I and Survey II confirm that students' performance in mathematics is highly related to their perception (H1 and H2). Students with high positive perception are likely to perform well compared to students with a low perception. Therefore Hypothesis H3 and H4 are confirmed by our research study.

Our research study shows that student positive perception towards teaching did not have a significant effect on the students' performance, even though we believe it is important. The total agreement between the two surveys, students after 6 weeks seem to respond the same to the questions conducted on the final week. Furthermore, the responses of the students showed that students preferred small class size hence this confirms Hypothesis H5.

Students' attitude and performance towards Mathematics, in large classes is a real challenge, and guidance and support would be necessary to achieve learning. Most likely, instructors may provide hand-outs and lecture slide presentation as a link to an additional resources to support learning. Weak students or those with very low perception towards Mathematics may be given additional time for consultation or extra classes as a reinforcement. Moreover, introductory subjects can be conducted into smaller classes for the students to have a smooth transition from secondary to college education at the same time they will be given more attention, less distracted and be able understand Mathematics without difficulty. Understanding and analyzing students' perception, motivation, and performance would guide the Faculty of Computer Science at our university to come up with strategic and effective management in handling classes to achieve the learning outcomes and resolve the failure rate in the mathematics foundation courses.

References

Coaldrake, P. (2002). Institutional Responses to Changing Student Expectations: Project Overview *Responding to Student Expectations*: Organization for Economic Co-operation and Development. 7-17.

Cook, A., & Leckey, J. (1999). Do Expectations Meet Reality? A survey of changes in first-year student opinion. *Journal of Further and Higher Education, 23*(2), 157-171.

Farooq, M. S. & Shah, S. Z. U. (2008). Student's Attitude Towards Mathematics. *Pakistan Social and Economic Review, 46*(1), 75-83.

Gibbs, A., & Jenkins, G. (1992). *Teaching Large Classes in Higher Education*: Kogan Page Limited.

Goodykoontz, E. (2008). *Factors that Affect College Student's Attitudes toward Mathematics.* West Virginia University.

Hannula, M. S. (2002). Attitude Towards Mathematics: Emotions, Expectations and Values. *Educational Studies in Mathematics, 49*, 25-46.

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematical Anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46.

James, R. (2002). Students' Changing Expectations of Higher Education and the Consequences of Mismatches with the Reality. *Responding to Student Expectations*. Retrieved from http://www.cshe.unimelb.edu.au/people/staff_pages/James/James-OECD_IMHE.pdf, 71-83.

Lowe, H., & Cook, A. (2003). Mind the Gap: are students prepared for higher education? *Journal of Further and Higher Education, 27*(1), 53-76.

Ma, X., & Kishor, N. (1997). Assessing the Relationship Between Attitude Toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education,* 28(1), 26-47.

Norton, S., & Irvin, J. (2007). *Developing Positive Attitude Towards Algebra*.

Shen, C., & Talavera, O. (2003). The Effects of Self Perception on Students' Mathematics and Science Achievement in 38 Countries Base on TIMSS 1999 Data. Retrieved May 25, 2010 from http://ideas.repec.org/p/boc/asug03/08.html.

Stanne, M. E., & Donovan, S. S. (1999). Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis. *Review of Educational Research, 69*(1), 21-51.