MATHEMATICS SAC CLASS SIZE RECOMMENDATION

A report prepared for the Math SAC and DOI's

Portland Community College

CONTENTS

BACKGROUND INFORMATION

According to the PCC Faculty Federation,

> ARTICLE 26 – PARTICIPATION & COLLEGE SERVICE
>
> 26.24 Class Size. The SAC will periodically review class size limits with regard to both instructional soundness and fiscal responsibility. Recommendations for changes will be stated in writing. The SAC and Administrative Supervisor(s) will then reach written consensus (see Article 1.06) regarding any revised limits. Any revisions will be established prior to schedule input deadlines.

At a Math SAC meeting on February 10th, information about class sizes at other colleges and class sizes at PCC was shared. Table 1 below shows class cap size data that was collected from department chairs across the state.

Table 1

Community College	Math 20	Math 60/65	Math 95	Math 111 or higher
Clackamas	30	35	35	35
Clark	30	30	30	35
Mt. Hood	34	34	34	34
Chemeketa	35	35	35	35
Linn-Benton	45 (see note)	35	35	35
Lane	31	31	36	36
Central Oregon	25	35	35	35
Blue Mountain	25	25	25	25
Rogue	30	30	30	30
Treasure Valley	24-30	24-30	24-30	24-30
Portland Community College	35	38	36	38

Note: Linn-Benton's MTH 20 classes have a cap of 45. For each MTH 20 class, there is one instructor, one assistant instructor, and three instructional aides.

Exceptions: A couple of colleges reported smaller caps for the 211-213 sequence (LBCC - 24, LCC - 31). LBCC also has a cap of 30 for statistics courses. LCC has a cap of 28 for their discrete math course.

Table 3 shows the average class size for PCC Math Classes at each campus from Fall 2011 along with the Week 4 Actual Class Size. The concern among faculty was not over the average Cap size, it was over the trend of increasing class sizes. In particular, some class caps were set as high as 38 students. The concern is that larger class sizes are adversely affecting the learning environment of the students. Larger class sizes make it harder to have effective group work sessions and activities in the classroom. Larger classes also make it harder for the teacher to effectively work individually with students. The different class caps at different campuses create an inequity among student learning experiences. As a SAC that values consistency in our program, we feel that as much as possible, class sizes should be consistent (at least in maximum size) so that students can get a consistent educational experience.

Table 3		
Campus	**Cap size (Average)**	**Week 4 Actual**
Sylvania	33.7	30.8
Cascade	32.1	31.4
Rock Creek	30.2	26.8
ELC	28.2	27.4
District Wide	31.5	29.1

Table 2		
Class	Cap Size	Maximum Week 4 Enrollment[1]
Math 20	35	37
Math 60/65	38	44
Math 61,62,63,91, 92	35	37
Math 70	38	38
Math 93	38	18
Math 95	36	42
Math 111/112	38	46
Math 243/244	35	35
Math 251	35	34
Math 252-254, 256, 261	38	38

[1] Highest enrollment among all sections, campus wide.

As a result of the February 10th , 2012 meeting, the SAC suggested to the DOI's lowering class caps to no more than 35 students while a committee worked to find reasonable class sizes.

> *"The SAC recommends face to face class sizes be changed to no more than 35 starting summer 2012. A committee will be formed to investigate appropriate class sizes. The committee will make their recommendations prior to the deadline for the fall 2012 schedule."*

On April 16th, 2012 we received the following administrative response:

> *Rather than make a decision for summer that may not continue after consideration of the overall review, we'll wait for the MTH SAC's complete report on this subject. Since Summer registration doesn't begin until 15 May, we have time to adjust summer enrollment limits before students begin to register. In conducting the overall review, we would appreciate consideration of how enrollment limits might be reduced, maintained, or increased to provide as close to an enrollment-neutral position as possible. For example, enrollment limits in MTH 20 might be reduced and limits in DL offerings might be increased.*

COMMITTEE RECCOMENDATIONS

A committee was formed to investigate appropriate class sizes and met on March 3rd 2012. A survey of faculty was sent out and 60 faculty members (32 part-time and 28 full-time) responded. Most faculty members were supportive of smaller class sizes in regards to how smaller class sizes would better serve students. The results from this survey can be found in the appendix.

The Mathematics SAC believes that creating class caps that are below our current maximum of 38 students per class will improve the learning environment and college experience for our students. Here are some of the reasons we (the Math SAC) recommend this:

- We believe that group work is an important part of the mathematics classroom. This is related to PCC's core outcome of **Community and Environmental Responsibility and Communication.** Large class sizes do not lend themselves to group work very well because the instructor is unable to give each group enough attention. For example, if you have 8 groups of 4, you can spend 3.75 minutes per group in a 30 minute session. If you have 10 groups of 4, you can only spend 3 minutes per group in a 30 minute session.
- We believe that feedback and assessment is an important part of the learning process. The quality and frequency of feedback can be reduced as class sizes get larger and instructors try to manage their workload. Instructors may choose to give fewer assessments and assignments in a larger class because of the increased workload.
- Quality feedback on things like format and notation cannot be automated. We believe that quality feedback can be useful to improving student work. This is related to PCC's core outcome of **Communication.**

- Timely feedback—if a student is to learn from and correct their mistakes, they need to get their work back in a timely manner. Increasing class sizes could decrease the likelihood that students will receive their work back promptly.
- We believe that questions are an important part of the learning process. In larger classes, students tend to feel they are unable to get all of their questions answered. This was a trend that we noticed in our student survey. Further results will be discussed in our program review.
- Students expect consistency among their classes. Class sizes fluctuate from campus to campus and from class to class at the same campus. We know that not a lot can be done about small class sizes or small classrooms, but we can do something about large class sizes.
- Students have noticed the increase in class sizes (see Responses from Student Survey)
- Students expect lower class sizes at a community college than at a university. While our class sizes/caps are lower in some cases, they are higher in many others. In particular, we have higher class caps in Math 70 and Math 105. Our class caps are very similar to PSU's for Math 111, 112, and 252-256. See Table 4 in the appendix.
- Both the MAA and AMATYC recommend class sizes of no more than 30 students (see Reccomendations from National Mathematics Associations later in this document).

The Math SAC also believes that creating class caps are important for the faculty. High class sizes diminish our ability to serve students and the college effectively. Here is why we think class caps are important for faculty.

- Work load equity. Class sizes for the same class range from 24 students to 38 students. For a full time faculty member, it would be possible to have anywhere from 100-152 students per term. We know that variation is expected. For faculty who are on the higher side of student contact hours, we find it harder to manage group work in class, difficult to complete our student work (such as grading) outside of the class, and manage our many committee responsibilities.

After discussing the results of the Math SAC survey and having follow-up conversations with faculty, the class size subcommittee came up with the following recommendations. In most cases, the class size was set at 32, but in some cases it was set lower (reasons given below).

- Math 20 is a fast paced course with a lot of curriculum. Although it is intended as a review course, many students enter without the necessary pre-requisite skills or have gaps in their knowledge. There needs to be adequate time for student questions. In addition, smaller class sizes allow for more group work and more individual attention.
- Math 61-63 is a slower version of the Math 60/65 sequence. Anxiety and behavioral issues are frequent in this class. A smaller class size allows for the instructor to deal with these issues more effectively.
- Math 93 is the calculator instruction class. Questions are frequent and nearly always require individual attention with the instructor physically going to the student and looking at their calculator entry.
- Math 211-213 employs frequent group work. Class sizes were chosen so that there are no more than 7 groups of 4.
- Math 251 has a lab component where students are working in groups for 3 hours per week. Although a lab assistant is usually hired for classes with more than 25 students, it can still be hard to get to all groups with a lab assistant. The lab assistant should remain a part of the course. There is also a very high grading load with the lab component of this course. The labs are critical to developing student's mathematical communication and timely feedback is crucial to this development.
- Both the MAA and AAMATYC recommend class sizes of no more than 30 students.

Math Class	Recommended Class Size
30	32
20	28
60/65/70	32
61-63	24
91/92	24
93	24
95	32
105	32
111/112	32
211-213	28
243-244	32
251	28
252-256 **261**	32

SUPPORTING RESEARCH/DOCUMENTATION

RESEARCH ON CLASS SIZES/PEDAGOGY

Class size research is limited and often contradictory. Class size is only one factor in a myriad of factors that affect student success. Smaller class sizes do offer more opportunities for instructors to use innovative teaching techniques, for students to participate in meaningful group work and for students to know their peers and interact with their instructor.

Effects of a Syllabus Offer of Help, Student Age, and Class Size on College Students' Willingness to Seek Support from Faculty, Perrine and Lisle, Journal of Experimental Education, Fall95, Vol. 64 Issue 1, p41

> *As class size increases, students perceive teachers to be less concerned about students and less respectful of them. Students also perceive teachers of large classes to be less available and less helpful. If students perceive teachers of large classes to be less concerned about them and less available, they would be more hesitant to seek help from an instructor in a large class than in a smaller class.*

Overview of Class Size Research, Judy Shoemaker, DUE/Research and Evaluation, November 1, 2007

> *Research has shown that the following types of students benefit most from small classes: most able, those with low motivation, those with high affiliation needs, beginners in the subject matter, students from low economic backgrounds, and those predisposed to learn facts rather than apply or synthesize.*

Cohorts and Relatedness: Self-Determination Theory as an Explanation of How Learning Communities Affect Educational Outcomes, Beachboard, M., Beachboard, J., Li, W., & Adkison, S. (2011). Research In Higher Education, 52(8), 853-874. doi:10.1007/s11162-011-9221-8

> *Measuring **student** perceptions of the contributions of their institutions, the study found increased **relatedness** to peers and faculty and increased higher order thinking assignments (a control variable included in the research model) to be substantial predictors of educational outcomes relevant to literacy, critical thinking, and, especially, job preparation. The researchers suggest that institutions will want to ensure that their learning community designs enhance **student** feelings of **relatedness**.*

Classroom Organization and Participation: College Students' Perceptions, Robert R. Weaver; Jiang Qi, The Journal of Higher Education, Vol. 76, No. 5 (Sep. - Oct., 2005), pp. 570-601

> *Students who actively participate in the learning process learn more than those who do not. "Involvement matters," as Tinto (1997) points out, and this involvement can occur both inside and outside the classroom, … Active involvement in class facilitates critical thinking (Garside, 1996) and facilitates the retention of information that might otherwise be lost (Bransford, 1979). If student participation is so central to the learning process, why is participation in the college classroom frequently so low? What constrains the more active involvement of students? Scholars have identified a host of factors ranging from, for instance, class size, faculty authority, gender, age, student preparation, or student emotions such as confidence or fear.*

RECCOMENDATIONS FROM NATIONAL MATHEMATICS ASSOCIATIONS

The American Mathematical Association of Two-Year Colleges Guidelines for Mathematics Departments at two year colleges:

> *Mathematics departments should be adequately staffed to allow for a maximum class size of thirty students. Opportunity for frequent interaction between students and instructors should be provided, both in the classroom and in office consultations.*

The Mathematical Association of Americas Guidelines for Programs and Departments in Undergraduate Mathematical Sciences:

> *Departments must be provided with the resources necessary to deliver high quality teaching that includes the opportunity for students to interact frequently and nontrivially with their instructors. Departments should facilitate these personal interactions by avoiding the use of large lecture settings that require students to become passive audiences. The best way to encourage active student-faculty interactions and to enable faculty to give students individual attention is to provide a small-class environment with fewer than thirty students in each section. Also with restricted class size, faculty members gain flexibility to adopt a teaching style that best fits both the material to be learned and their students' needs.*

RESPONSES FROM FACULTY SURVEY

- Smaller class sizes allow us to devote more energy and attention to each student. This is especially important in the developmental math classes.
- I teach 20 a lot and it's demanding both for students and teacher, as well as involving many students with poor study skills and problematic attitudes, so... smaller is better. That way also we have more time to give detailed feedback on homework.
- I taught a Math 65 this term with 39 students. One of the best groups I have ever had, but even so, there were simply too many students for me to be able to adequately answer questions and work with individuals in class.
- Math 95 has both challenging material for students (less review than previous classes) and moves at quicker pace. For this reason a smaller class size would allow for more "at the board" activities or group interaction. Also this class requires instruction for CAS so this would be ideal on a smaller class size.

RESPONSES FROM STUDENT SURVEY

As part of PCC's assessment of core outcomes, the math department conducted a survey of students to measure self-reflection and professional competence. Here are some un-edited responses from students in reference to class sizes.

Think of a time in a math class where you have NOT experienced success. What prevented you from succeeding?

- I could not understand the concepts and it was hard to get help since it was a large class.

- Time to work on in-class activities is frustrating in a large class when it is a new topic and only once instructor to walk around and help. I find myself sitting for up to fifteen minutes at a time doing absolutely nothing, waiting for an instructor to help. It would be awesome if a teacher's aid were present during this time for additional help.
- large class sizes and teachers who taught straight out of a book.
- Too large of class size. A student becomes lost in a sea of people. The larger the class size, the more intimidated a person is to ask a question when they don't understand something. Hear that PCC? Stop trying to squeeze every last penny out of a classroom!

Think of a time in a math class where you have experienced success. What lead to that success?

- an engaging teacher and smaller class sizes.
- I learn better in small groups where there is not much noise.
- I think a clear understand of what the teacher is saying and working in groups helped me to understand the subject.

INSTITUTIONAL RESEARCH

It is very difficult to isolate class size as a factor in student success. There are many other factors to consider such as instructors, campus, time of day, previous college history, etc.

Using data from Fall 2011, we found the following information (see appendix for regression analysis) with regards to class size and success rates:

- There is a significant negative relationship between class size and success rates for Math 20 at Sylvania (where class sizes for Math 20 are higher than at other campuses). See

Table 4: PCC vs PSU Cap size and enrollment

Class	PCC Cap /Actual Enrollment	PSU Cap /Actual Enrollment
70	38/34.5	30/29.5
95	36/30.1	40/33.3
105	38/28.33	35/29.5
111	38/30.3	40/37.7

112	38/30.1	40/38.75
211-213	38/18.75	35/20.6
251	35/27.9	40/35
252-256	38/25.3	40/37
261	34/24.5	50/46

- Table 5 for results. Sylvania does have significantly higher success rates for Math 20, so including their data with all campuses distorts any relationship between class size and success rates.
- There is a significant negative relationship between class size and success rates for Math 61-63 and 93 (we recommend smaller class sizes for these classes).
- There is a non-significant negative relationship between class size and success rates for Math 251.
- There is a negative relationship between class size and success rates for Math 211-213 but the sample size is too small for regression results to be valid.

FINANCIAL IMPLICATIONS

The financial implications of reduced class sizes were not thoroughly investigated by the committee or the SAC. We feel that increasing class sizes in not an appropriate response to increases in enrollment. Reducing class sizes *will* result in the need to increase the number of sections offered. Our calculations are based on dividing enrollment by the suggested cap size. Under this assumption, the fill rates for each campus will remain virtually unchanged. We do realize that there are limitations on room size and space that cannot be avoided and that this may change the number of sections needed.

We do agree that it is reasonable to ask instructors to take 1-2 students above their cap so as not to necessitate the need for an additional section. We do not agree with the administrative response to take up the excess students in our online classes. Distance education is not the best option for the vast majority of students and many of our DL classes are already at capacity. Offering more DL sections would in many cases mean taking an experienced instructor out of a classroom. **We are not recommending changing the distance learning cap sizes.**

WITHIN CAMPUS ENROLLMENT NEUTRAL

In order to remain enrollment neutral within campuses (based on actual enrollment from Fall 2011 provided by IE), the following sections would need to be added for a typical **fall term.** (Note: some of these recommendations are not based solely on a reduction of class size, but rather on a trend of high enrollment in these classes. In other words, some additional sections may have been needed regardless of a change in class size).

- Math 20: 3 sections at SY, 1 section at CA
- Math 60: 1 section at SY, 1 at CA
- Math 61/62/63: 1 section of each at either CA, SE or SY. There aren't enough students to justify a whole extra section at any one campus.
- Math 65: No additional sections needed.
- Math 70: 1 additional section needed district wide (either CA or SY)
- Math 95: 1 section at SY, 1 at CA

- Math 111: 0 at SY, 1 at CA
- Math 112: 0 at SY, 0 at CA
- Math 253: 1 section needed district wide

CONCLUSION

The mathematics SAC recommends lowering the class caps for our classes to create consistency between classes and campuses, increase the likelihood of teacher/student interaction and to create workload equity. Lower class sizes will serve our math students better because it will increase the quality of the instructional environment and learning experience. We believe our recommendations to be fair, thoughtful and justified. We look forward to your response.

APPENDIX (FIGURES, CHARTS AND DATA)

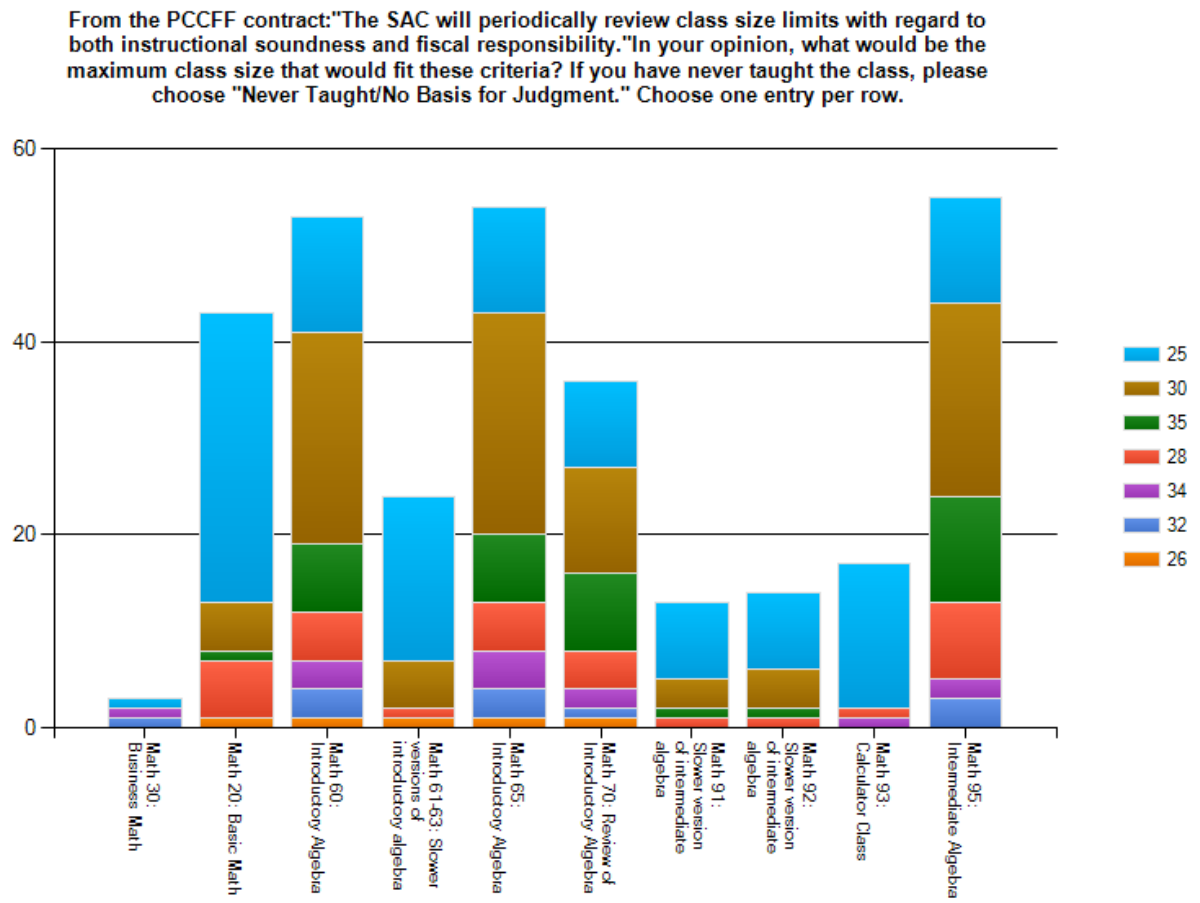

Figure 1: Faculty Class Size Responses for Pre-College Classes

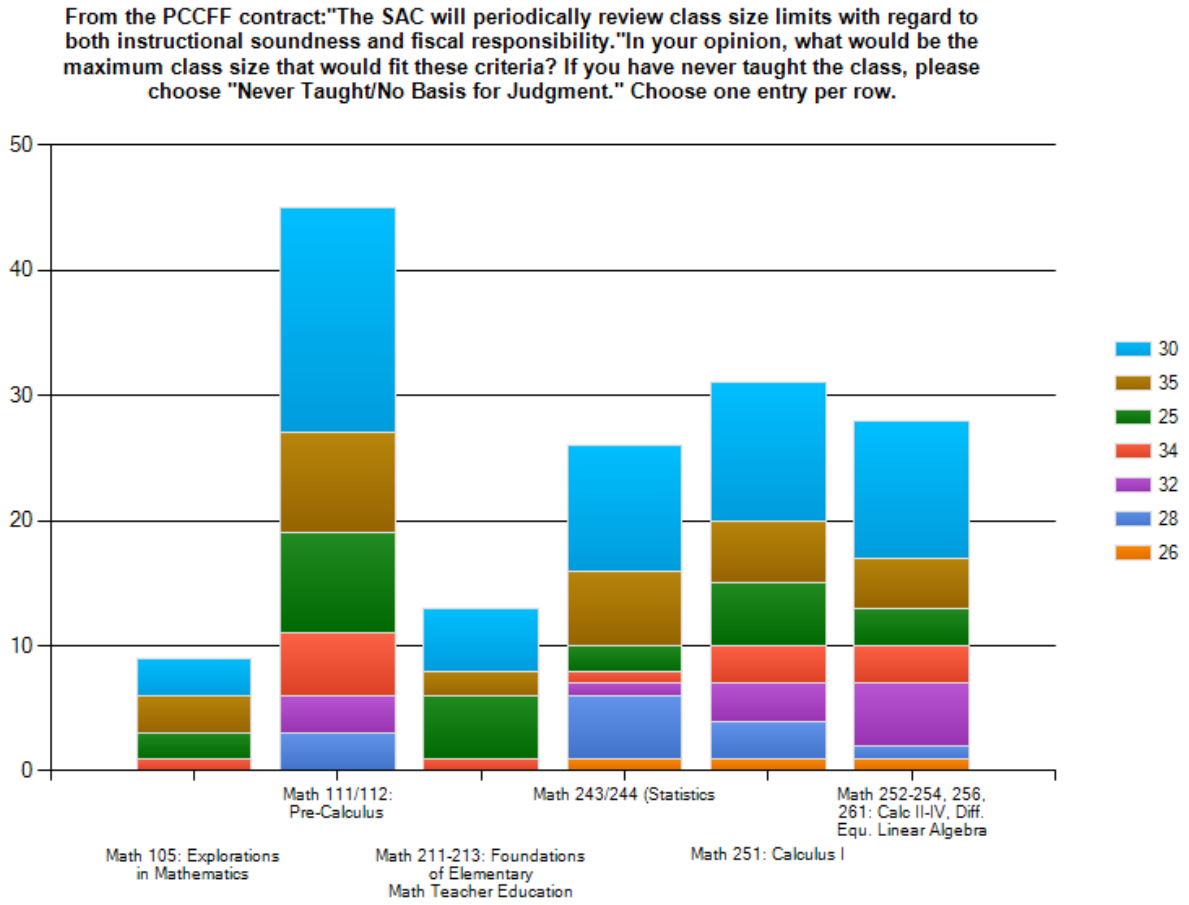

Figure 2: Faculty Class Size Responses for College Level (100+) Classes

Table 4: PCC vs PSU Cap size and enrollment		
Class	PCC Cap[2] /Actual Enrollment[3]	PSU Cap /Actual Enrollment
70	38/34.5	30/29.5
95	36/30.1	40/33.3
105	38/28.33	35/29.5
111	38/30.3	40/37.7
112	38/30.1	40/38.75
211-213	38/18.75	35/20.6
251	35/27.9	40/35
252-256	38/25.3	40/37
261	34/24.5	50[4]/46

[2] The maximum cap across all sections/campuses. Obtained from MyPCC and MyPDX

[3] The average class size across all sections/campuses (at the end of Week 4). Obtained from PCC IE and MyPDX

[4] Math 261 is a markedly different course at PSU with less content and lower pre-requisites.

Table 5: Regression Analysis for Math 20 at SY

Simple linear regression results:

Dependent Variable: Pass Rate

Independent Variable: Math20ClassSize@SY

Pass Rate = 136.29749 - 1.9686614 Math20ClassSize@SY

Sample size: 19

R (correlation coefficient) = -0.5495

R-sq = 0.30199733

Estimate of error standard deviation: 10.279198

Parameter estimates:

Parameter	Estimate	Std. Err.	Alternative	DF	T-Stat	P-Value
Intercept	136.29749	23.462055	≠ 0	17	5.809273	<0.0001
Slope	-1.9686614	0.7258946	≠ 0	17	-2.7120488	0.0148

Analysis of variance table for regression model:

Source	DF	SS	MS	F-stat	P-value
Model	1	777.16534	777.16534	7.355208	0.0148
Error	17	1796.2526	105.66191		
Total	18	2573.418			

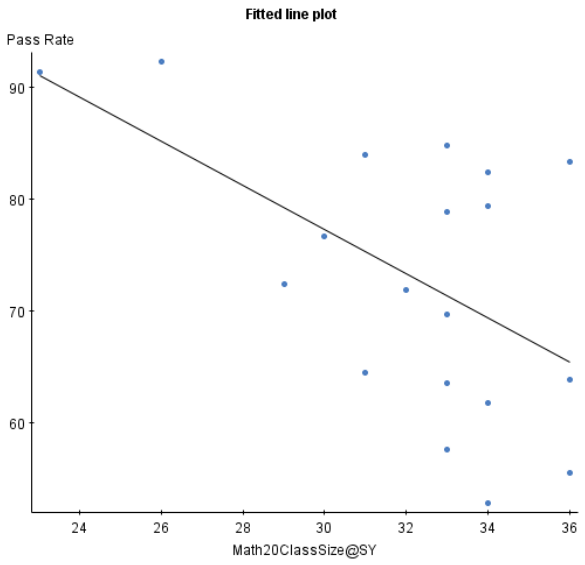

Table 6: Regression Analysis for Math 61-63, 93

Simple linear regression results:
Dependent Variable: Pass Rate
Independent Variable: Math61-63,93 Class Size
Pass Rate = 95.61773 - 1.2053437 Math61-63,93 Class Size
Sample size: 14
R (correlation coefficient) = -0.5199
R-sq = 0.27031055
Estimate of error standard deviation: 14.08319

Parameter estimates:

Parameter	Estimate	Std. Err.	Alternative	DF	T-Stat	P-Value
Intercept	95.61773	16.841545	≠ 0	12	5.6774917	0.0001
Slope	-1.2053437	0.5716863	≠ 0	12	-2.1084003	0.0567

Analysis of variance table for regression model:

Source	DF	SS	MS	F-stat	P-value
Model	1	881.6745	881.6745	4.4453526	0.0567
Error	12	2380.035	198.33623		
Total	13	3261.7092			

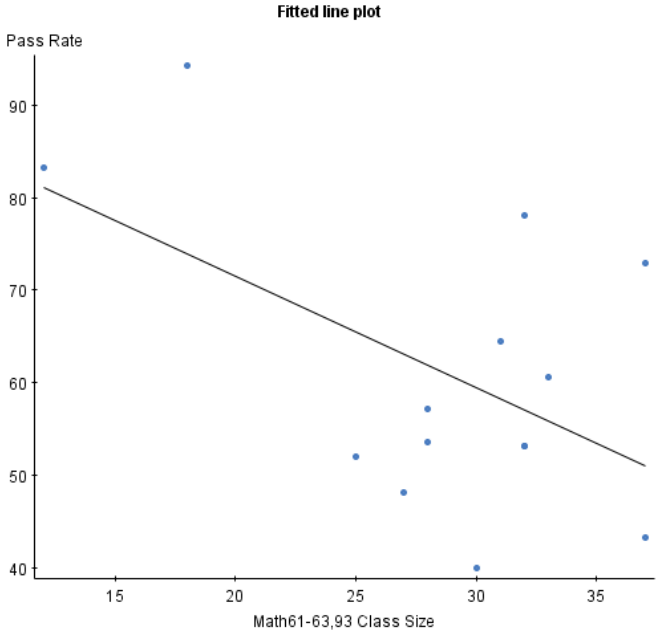

Table 7: Regression Analysis for Math 251

Simple linear regression results:
Dependent Variable: Success Rate
Independent Variable: Math 251 Class Size
Success Rate = 106.12736 - 1.2180774 Math 251 Class Size
Sample size: 12
R (correlation coefficient) = -0.4172
R-sq = 0.17406653
Estimate of error standard deviation: 11.075829

Parameter estimates:

Parameter	Estimate	Std. Err.	Alternative	DF	T-Stat	P-Value
Intercept	106.12736	23.91794	≠ 0	10	4.4371443	0.0013
Slope	-1.2180774	0.8390538	≠ 0	10	-1.4517275	0.1772

Analysis of variance table for regression model:

Source	DF	SS	MS	F-stat	P-value
Model	1	258.53696	258.53696	2.1075127	0.1772
Error	10	1226.7397	122.67397		
Total	11	1485.2766			

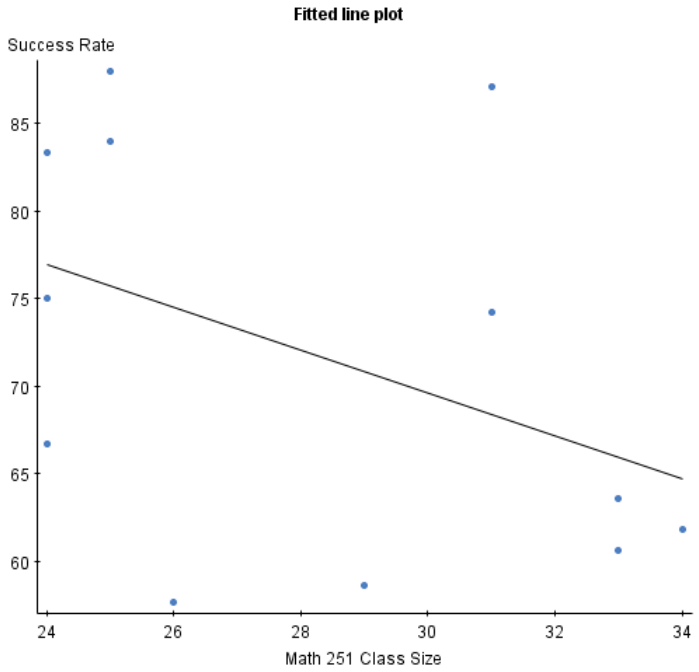

Table 8: Regression Analysis for Math 211-213

Simple linear regression results:
Dependent Variable: Pass Rate
Independent Variable: Math211-213 Size
Pass Rate = 117.78565 - 1.6295081 Math211-213 Size
Sample size: 4
R (correlation coefficient) = -0.9114
R-sq = 0.8307006
Estimate of error standard deviation: 5.745488

Parameter estimates:

Parameter	Estimate	Std. Err.	Alternative	DF	T-Stat	P-Value
Intercept	117.78565	10.292311	≠ 0	2	11.444043	0.0075
Slope	-1.6295081	0.52017206	≠ 0	2	-3.132633	0.0886

Analysis of variance table for regression model:

Source	DF	SS	MS	F-stat	P-value
Model	1	323.94623	323.94623	9.81339	0.0886
Error	2	66.02127	33.010635		
Total	3	389.9675