Student Teaching Practicum at Doherty Memorial High School

An Interactive Qualify Project
submitted to the faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the
requirements for the Degree of
Bachelor of Science

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ABSTRACT

This paper summarizes the experience of a mathematics student teaching practicum at Doherty Memorial High School in Worcester, Massachusetts. Its intended purpose is to fulfill the requirements of the Interactive Qualifying Project at Worcester Polytechnic Institute and to present a case for the completion of the standards set by the Massachusetts Department of Elementary and Secondary Education.

The paper begins by looking at the legal and historical aspects of education in Massachusetts, the demographics of Doherty Memorial High School and then delineates the five professional teaching standards and their satisfaction through the student teaching practicum. Finally, the classes taught are explored in greater detail to give the reader insight into the experience of teaching high school mathematics in an urban classroom.

ACKNOWLEDGEMENTS

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CHAPTER 1

Background

Introduction

In Massachusetts, education reform introduced in 1993 still drives curriculum changes, education standards, and goals for student progress throughout their school career. State-wide learning objectives, standardized testing, and increased accountability for schools shifted the focus of teaching in classrooms across Massachusetts, but these changes certainly encountered resistance from administrators, parents, and teachers alike. Although the debate raged over whether the Education Reform Act of 1993 would sufficiently aid students, the National Assessment of Educational Process (NAEP) testing results show that Massachusetts now ranks within the top three states in the nation for mathematics and reading.[1] The modest gains that standardized curriculum has brought about influenced the creation of the Common Core State Standards Initiative, a nationwide attempt to create uniform educational benchmarks that will challenge students to master even more than before. As forty-five states begin implementing the Common Core Standards, much remains to be seen with regards to the efficacy in closing achievement gaps across the nation.

Over twenty years after its enactment, the initial Massachusetts Education Reform Act has produced substantial benefits for many students, but Massachusetts must continue to push for reforms that reach all students, including minorities, those from lower-income families, and non-native English speakers. Schools such as Doherty Memorial High School in Worcester, Massachusetts display an achievement gap on standardized tests between white students and

[1] NAEP, "State Performance," http://nationsreportcard.gov/reading_math_2013/#/state-performance.

their African American, Hispanic, and English language learning peers.[2] Furthermore, Massachusetts must set the bar higher for all students; while the Education Reform Act set a target for content mastery to be achieved prior to high school graduation, Massachusetts is in a position to assist students even more, by teaching content area material as well as universal problem solving skills to be used in college and beyond.

Massachusetts Education Reform Act of 1993

The Massachusetts Education Reform Act of 1993 was a landmark shift in education objectives, performance accountability, and standardized testing. The Act took a three-pronged approach to reforming schools in Massachusetts, as legislators realized that simply shifting educational goals to objective, measurable standards that could be tested would not aid students unless teachers were also given adequate resources and motivation to perform their duties.[3]

The first prong was a reorganization of curriculum standards and graduation requirements for students in high school, driven primarily by the need to better prepare students for the academic rigor of college.[4] In order to ensure that students would be prepared for either college or a career after high school graduation, the Reform Act implemented both state-wide learning objectives for all students and a new, standardized test known as the Massachusetts Comprehensive Assessment System (MCAS) to quantitatively measure students' mastery of those objectives. Students would take the mathematics, science, and reading portions of the MCAS several times in their academic career, but would be required to pass the exam in order to

[2] Massachusetts DESE, "2013 MCAS Results by Subgroup by Grade and Subject," http://profiles.doe.mass.edu/mcas/subgroups2.aspx?linkid=25&orgcode=03480512&fycode=2013&orgtypecode=6&.
[3] Patricia G. Anthony and Gretchen B. Rossman, "The Massachusetts Education Reform Act: What Is It and Will It Work?," (1994)., pg. 2
[4] Mass Insight Education, "Education Reform in Massachusetts," http://www.massinsight.com/publications/ACSC/226/file/3/pubs/2013/05/10/EdReformReport.pdf., pg. 3

graduate high school with a "Certificate of Mastery" or "Certificate of Occupational Proficiency" degree.

In addition to holding students to higher standards for graduation, the second prong of the Act also made organizational changes to schools and school districts to increase school and teacher accountability with regards to student success. With the creation of a school council for every Massachusetts public school and the granting of power to the state to step in to reform "underperforming" schools, teachers and principals needed to make concrete strides in improving students' mastery of content-area education objectives, or risk losing their jobs.[5] If students repeatedly performed poorly on the MCAS, the implication was that teachers were not adequately helping students master the curriculum standards, and thus not preparing them for a successful future.

Furthermore, school districts needed to assist in preparing students by making sure that schools were fully funded and able to accommodate all students, including English language learners and students with disabilities. The third prong of the Reform Act mandated that towns and cities raise part, if not all, of the funding for schools, and required that Massachusetts step in to pay for the remainder of the amount.[6] The Act laid out a clear plan and formula for how school districts would procure the minimum of $5,500 per student, making it clear that cities and towns needed to work to increase the amount they were contributing so that the state's contribution could decrease. The financial plan was the final major piece of the Reform Act, and it sent the message that subpar standards and resources in schools would no longer be tolerated;

[5] Anthony and Rossman, "The Massachusetts Education Reform Act: What Is It and Will It Work?.", pg. 4-6
[6] Ibid., pg. 7

students need ample materials and assistance to learn effectively, and the Act sought to promote exactly that.

The results of the Reform Act have already begun to show after twenty years of implementation. Higher expectations for high school graduation and core curriculum standards have reshaped the educational experience for students throughout Massachusetts. Prior to the Reform Act, the only uniform standard to graduate from high school was four years of physical education classes and American History; starting with the graduating class of 2003, however, students must have passed the MCAS and demonstrated mastery of the new common educational objectives.[7] This change puts increased pressure on students and teachers to perform well on the MCAS, lest students fail to graduate or schools be deemed "underperforming". Critics of the MCAS and a common curriculum focused on central objectives argue that the fear of low test scores may drive some teachers to "teach to the test", and only teach material that they believe will appear on the MCAS. Thus, in the worst case scenario, subjects such as art or music could be pushed aside in favor of mathematics, reading, and science, which are the key portions of the MCAS.

While the concept of statewide testing is not new, Massachusetts had not administered a high-stakes test such as the MCAS prior to 1993. Although Massachusetts used the Massachusetts Educational Assessment Program (MEAP) to evaluate students, poor performance on the test did not stop students from graduating or lead to any action holding low-scoring schools accountable.[8] The increased observation of schools to ensure that they are adequately teaching students the core curriculum has led to schools either being shut down or forced to

[7] Education, "Education Reform in Massachusetts.", pg. 6
[8] Ibid, pg. 6

follow a timeline of improvements to keep their doors open.[9] While the pressure to teach students well has increased the quality of the education received, the stress to produce high test scores can be overwhelming for school districts with students that may have trouble taking standardized tests.

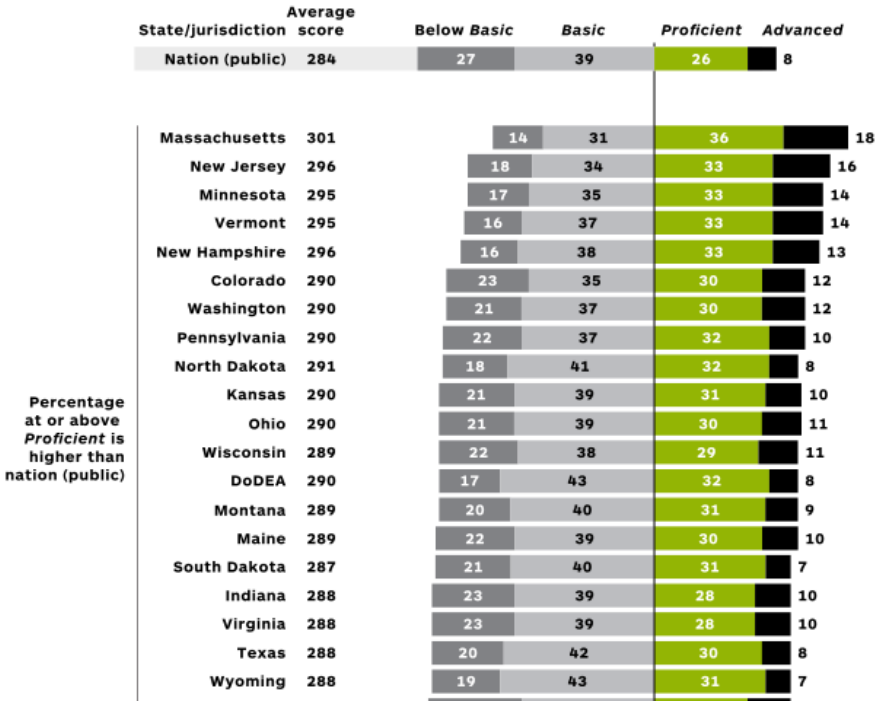
Overall, this struggle to find the balance between delivering high quality, objective-driven instruction and placing undue burden on teachers and students to perform well on assessments characterizes the post-Education Reform Act era. Seeing quantitative results of the Act's changes may be the best way to truly measure its success in reforming education in Massachusetts.

NAEP and TIMMS

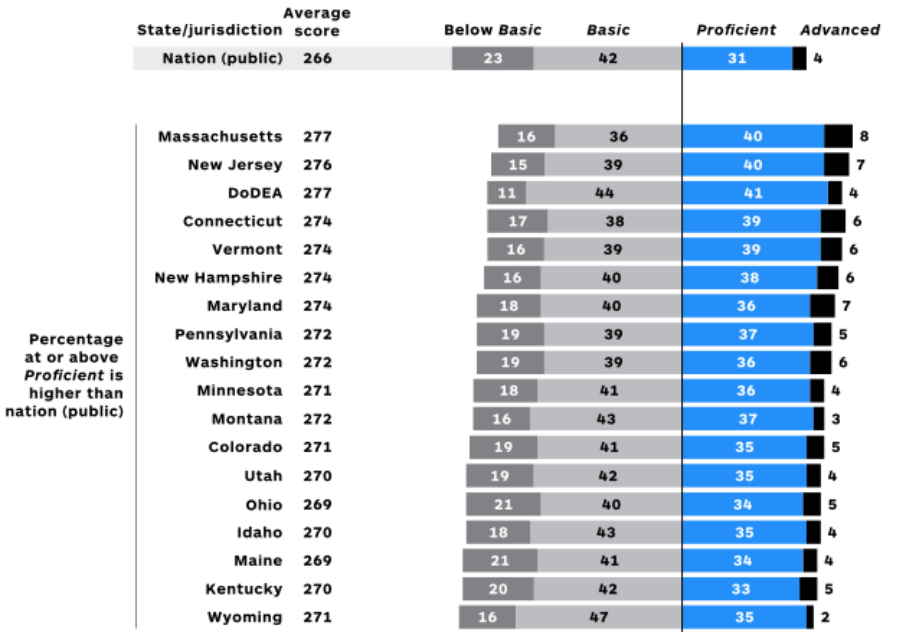
The results of the Massachusetts Education Reform Act can be measured quantitatively by comparing Massachusetts' students' standardized test scores to those of students from around the country. The National Assessment of Educational Progress (NAEP), often referred to as the "nation's report card", gathers the results of mathematics and reading tests administered to fourth and eighth grade students throughout the country.[10] After a national public average is calculated, each state can be compared to determine how well students have mastered certain key curriculum objectives, which are similar to the common standards instituted in the Reform Act.

Overall, students from Massachusetts have done quite well on the NAEP, placing Massachusetts in the top three states for every test. The average score for Massachusetts' students is statistically significantly higher than the nation's average, and Massachusetts also has more students performing at the Proficient and Advanced level than any other state.

[9] Massachusetts DESE, "State Upgrades 40 Percent of Schools Named Underperforming in 2010 as Schools Meet their Three-Year Turnaround Goals," http://www.doe.mass.edu/news/news.aspx?id=7700.
[10] NAEP, "About the 2013 Assessments," http://nationsreportcard.gov/reading_math_2013/#/about#naep_samples.



8th Grade Mathematics Results[11]



8th Grade Reading Results[12]

[11] NAEP, "State Performance."
[12] Ibid.

In addition to comparing students from Massachusetts to other students in America, the Trends in International Mathematics and Science Study (TIMSS) tracks scores for fourth and eighth grade math and science scores for numerous countries around the world.[13] The TIMSS was last administered in 2011, and the results were mixed for the United States as a whole. The U.S. ranked eighth out of all countries tested, but had a far smaller percentage of students reaching the international benchmark of mathematics performance than the top scoring countries.[14] However, when Massachusetts students' scores were examined, their results were statistically significantly higher than the rest of America.[15] Internationally, Massachusetts ranks fifth in mathematics and second in science scores, with an average score very close to the countries placed above it.[16]

While these results certainly look promising, they do not break down the scores by subgroups, such as by race, economic situation, or English language proficiency. The MCAS was designed with individual student progress monitoring in mind, making it an important tool to analyze the relationship between standardized test score (and therefore content mastery) and a student's background. Once broken into subgroups, the results offer a more startling picture; African American and Hispanic students tend to do worse on the MCAS than their white peers, creating a performance gap that has yet to be closed, despite efforts to better prepare all students for the test. Additionally, English Language Learning students and students from low income families have trouble scoring in the Proficient and Advanced levels.[17] Clearly, state educations

[13] International Study Center, "About TIMSS and PIRLS," International Study Center, http://timssandpirls.bc.edu/home/pdf/TP_About.pdf.
[14] International Study Center, "Performance at the TIMSS 2011 International Benchmarks," International Study Center, http://timssandpirls.bc.edu/timss2011/downloads/T11_IR_M_Chapter2.pdf.
[15] Massachusetts DESE, "Trends in International Mathematics and Science Study (TIMSS), 2011:Summary of Massachusetts Results," http://www.doe.mass.edu/mcas/2011timssSummary.pdf., pg. v
[16] Ibid., pg. v-vi
[17] DESE, "2013 MCAS Results by Subgroup by Grade and Subject."

and teachers need to address this problem, and give special assistance to subgroups that have difficulty mastering the common core of educational objectives.

Curriculum Frameworks

In order to address shortcomings of the initial Massachusetts common curriculum standards set up after the Reform Act in 1993, educators and researchers across the state have compiled more comprehensive standards for students in kindergarten through grade twelve. Known as the Curriculum Frameworks, they outline specific objectives that should guide teachers' lessons and students' learning. There are also conceptual categories that group topics together to present a high-level design of what students should be aiming to achieve. Below is a sample of the Curriculum Frameworks for high school algebra.

CONCEPTUAL CATEGORY: Algebra [A]

Content Standards

Seeing Structure in Expressions **A-SSE**

Interpret the structure of expressions.

1. Interpret expressions that represent a quantity in terms of its context. *
   a. Interpret parts of an expression, such as terms, factors, and coefficients.
   b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)^n$ *as the product of P and a factor not depending on P.*
2. Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems.

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
   a. Factor a quadratic expression to reveal the zeros of the function it defines.
   b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
   c. Use the properties of exponents to transform expressions for exponential functions. *For example, the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*
4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. *For example, calculate mortgage payments.* ¶

Curriculum Frameworks for Algebra[18]

[18] Massachusetts DESE, "MA Curriculum Framework for Mathematics," http://www.doe.mass.edu/frameworks/math/0311.pdf., pg. 82

Massachusetts has based many of its Curriculum Frameworks objectives off of the Common Core State Standards, the national effort to standardize curriculum and promote educational success. In addition to implementing the Common Core State Standards, Massachusetts added additional standards to push students above and beyond their peers throughout the country.

Common Core

The Common Core is very similar to Massachusetts' Curriculum Frameworks, in that it provides a general outline of educational objectives that should be mastered by students in order to progress in school. The mission statement of the Common Core proposes that "[t]he standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers," promoting the idea that all students should be capable of success after graduation from high school.[19]

Schools in Massachusetts have adopted the Common Core, and added on additional standards in the Curriculum Frameworks. At Doherty Memorial High School in Worcester, for example, teachers are already using the Common Core learning objectives in mathematics and English classrooms. While some content material can still be delivered similarly to how it was taught in the past, other courses, such as Geometry and Algebra I, have had to be completely revamped to match the Common Core standards. To prepare for the switch, department heads from throughout Doherty were brought together to align their course objectives with the Common Core, and also rewrote many assessments to measure students' mastery of the new frameworks. While shifting the curriculum presented a big challenge to teachers not familiar

[19] Common Core State Standards Initiative, "Common Core State Standards Initiative | Home," http://www.corestandards.org/.

with the Common Core, the school is eager to see if these new changes can help students from all backgrounds succeed in their academic classes.

Doherty Memorial High School Demographic Breakdown

Doherty Memorial High School will be an interesting benchmark for the success of the Common Core State Standards, as it is a very diverse school with a high population of minority students. The percentage of African American, Asian, and Hispanic students at Doherty is much higher than the state averages.

Enrollment by Race/Ethnicity (2012-13)			
Race	**% of School**	**% of District**	**% of State**
African American	14.0	14.2	8.6
Asian	9.7	8.1	5.9
Hispanic	29.5	38.1	16.4
Native American	0.7	0.3	0.2
White	43.7	35.8	66.0
Native Hawaiian, Pacific Islander	0.0	0.0	0.1
Multi-Race, Non-Hispanic	2.5	3.5	2.7

Doherty High School Enrollment Statistics[20]

In addition, Doherty serves more English language learners than average, with 25.8% of students are Doherty being English language learners, as compared to the state average of 7.7%.[21] The high rate of English language learners, minorities, and students from low-income families (Doherty 59.3% vs MA 37%) stems from the location of Doherty; the area immediately surrounding Doherty is urban city, although some parts of the city contain upper middle-class families.

The diversity of students at Doherty presents an excellent microcosm in which to study the performance of many subgroups of students. The most recent data from MCAS testing shows

[20] Massachusetts DESE, "Student Data," http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=03480512&orgtypecode=6&.
[21] Ibid.

that minority groups do not have the same percentage of students scoring at the Advanced or Proficient levels as white students.[22] Students from low-income families also have trouble matching the scores of their peers from higher income homes.

GRADE LEVEL 10 - MATHEMATICS																									
	School									District									State						
	Stud. Incl	Part. Rate	% at Each Level				CPI	SGP	Incl. in SGP (#)	Stud. Incl	Part. Rate	% at Each Level				CPI	SGP	Incl. in SGP (#)	Stud. Incl	Part. Rate	% at Each Level				CPI	SGP	Incl. in SGP (#)
Student Group	#	%	A	P	NI	F				#	%	A	P	NI	F				#	%	A	P	NI	F			
Accountability Subgroups																											
Students w/disabilities	41	98	10	20	34	37	61.0	43.0	34	342	92	4	14	36	46	55.0	39.5	220	11,188	95	14	26	30	30	70.0	42.0	8,871
ELL and Former ELL	76	99	29	17	22	32	68.1	35.5	46	515	97	17	23	31	28	66.5	45.0	330	4,097	96	17	22	29	32	64.4	45.0	2,350
Low income	158	96	38	21	23	18	77.5	47.5	114	1,143	96	30	26	25	19	76.5	49.0	810	23,120	97	33	30	22	15	81.2	45.0	18,819
High needs	183	97	38	21	22	19	77.5	47.5	134	1,262	96	29	26	25	20	76.0	50.0	897	29,807	97	30	31	23	16	80.3	45.0	24,202
Afr. Amer./Black	38	100	29	26	24	21	73.7	31.0	27	254	98	27	26	26	21	73.9	46.5	174	5,819	97	28	32	24	17	79.0	44.0	4,507
Amer. Ind. or Alaska Nat.	4	-	-	-	-	-	-	-	-	12	100	50	25	17	8	87.5	N/A	11	180	95	46	32	13	9	89.3	54.5	158
Asian	28	100	64	7	11	18	80.4	N/A	18	154	100	58	18	13	12	85.9	51.5	114	3,831	99	74	15	7	4	95.1	59.0	3,255
Hispanic/Latino	73	95	18	30	30	22	72.9	40.0	57	586	95	21	28	30	22	72.7	44.5	422	9,318	96	27	30	24	19	76.9	42.0	7,258
Multi-race, Non-Hisp./Lat.	5	-	-	-	-	-	-	-	-	28	97	50	14	21	14	81.3	57.5	22	1,467	97	54	25	13	7	89.5	49.0	1,291
Nat. Haw. or Pacif. Isl.		-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	76	97	53	18	16	13	84.9	48.0	61
White	135	99	75	16	7	3	95.6	41.5	116	555	97	51	26	14	9	89.1	52.0	439	48,128	98	62	24	10	4	93.7	52.0	43,740
Other Subgroups																											
Male	139	98	53	22	12	14	85.1	45.5	110	814	96	36	25	22	17	79.2	50.0	577	34,803	98	55	24	13	8	89.7	53.0	30,097
Female	144	97	51	17	20	12	83.5	37.5	114	775	98	37	26	22	15	81.1	49.0	605	34,018	98	55	26	13	7	90.7	49.0	30,173
Title1		-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	14,102	97	34	30	22	14	81.2	46.0	11,268
Non-Title1	283	98	52	19	16	13	84.3	42.5	224	1,588	97	37	25	22	16	80.1	49.0	1,182	54,717	98	60	24	10	6	92.5	52.0	49,002
Non-Low Income	125	100	69	18	8	6	92.8	39.0	110	446	98	54	24	13	8	89.5	49.0	372	45,699	99	65	23	8	4	94.7	54.0	41,451
ELL	46	100	11	13	30	46	56.0	33.0	20	315	97	4	15	39	42	53.2	40.0	161	2,678	96	10	17	30	43	55.2	41.0	1,159
Former ELL	30	97	57	23	10	10	86.7	35.5	26	200	97	37	37	20	7	87.4	50.0	169	1,419	98	30	32	27	12	81.6	50.0	1,191
1st Year ELL	8	-	-	-	-	-	-	-	-	45	100	-	-	-	-	-	N/A	N/A	584	98	-	-	-	-	-	N/A	N/A
Ever ELL	116	99	39	18	19	24	74.4	39.5	82	744	98	29	23	26	22	73.3	48.0	521	9,449	97	34	26	22	19	77.7	47.0	7,183
All Students																											
2013	283	98	52	19	16	13	84.3	42.5	224	1,589	97	37	25	22	16	80.1	49.0	1,182	68,821	98	55	25	13	7	90.2	51.0	60,270
2012	269	94	48	24	18	10	86.1	51.5	208	1,517	96	35	27	23	14	81.1	53.0	1,066	69,015	98	50	28	15	7	90.0	50.0	59,816

10th Grade Math MCAS Score Report for Doherty High School[23]

Compared to the rest of the Worcester school district and the state, Doherty high school's scores are about the same when broken down by subgroup. English language learning students in particular seem to do as well, if not better, at Doherty than the rest of the state and district. The only difference seems to be lower than average test scores for Hispanic students at Doherty; for some reason, Doherty's success is not mirrored within the Hispanic and Latino subgroup. This

[22] DESE, "2013 MCAS Results by Subgroup by Grade and Subject."
[23] Ibid.

finding should be looked into further, in order to assist Hispanic and Latino students in their success at the MCAS and mastering the Curriculum Frameworks and Common Core objectives.

English Language Learners and Sheltered English Immersion

One of the most prominent subgroups at Doherty High School is the group of English language learners, which contains students for whom English is not their native language. These students may be at varying levels of English proficiency, ranging from no fluency in English up through advanced levels of oral and written fluency. A student who is new to a school or just entering public school for the first time will be evaluated on a standardized test to measure their English language skills. If their score indicates that they are struggling with English fluency, or if they do not speak English as a native language, they will be classified as an English language learner. The school must then make special accommodations to teach the student English and content area material, while making sure that the student is progressively meeting the Curriculum Frameworks and Common Core educational standards.

One program often used by schools to assist English language learners in developing English skills and content area knowledge is Sheltered English Immersion (SEI). The goal of SEI is to allow students to learn at the appropriate content level while also gaining English skills through extra English language classes and sheltered instruction by their content area teachers.[24] In a sheltered instruction setting, teachers are mindful of English language learners in their classes, and ensure that all material presented is accessible to students, no matter their level of English fluency. Teachers may choose to add vocabulary objectives to their lessons, in addition to the content standards provided by the Curriculum Frameworks. The SEI method assists English language learners by incorporating English learning into their content area classes, and

[24] Suzanne Peregoy and Owen Boyle, *Reading, Writing, and Learning in ESL*, 6th ed. (Pearson, 2013)., pg. 94

promoting the idea that all students should be able to master key objectives to enjoy success not only in school, but in life as well.

Conclusion

In the past two decades, Massachusetts has made great strides in improving the education that all students receive and better prepared its high school graduates for their college experience and future career. With the passage of the Education Reform Act in 1993, common standards and content mastery objectives set clear goals for teachers and students alike. Although the value of the standardized MCAS has been debated, its use as a diagnostic tool to evaluate school districts and various subgroups has been paramount in holding schools accountable for the education they are providing. Perhaps the drive for content mastery and high standards had vaulted Massachusetts to the top of national and international rankings in mathematics and science. Though Massachusetts has continuously pushed to be on the leading edge of education reform with its Curriculum Frameworks and Common Core Standards, its educators need to better address the achievement gap that affects students from low-income families, English language learning students, and minorities. If all students in Massachusetts could perform at the high level that is expected from them, they would certainly be ready to achieve great things in college, a career, and far beyond.

CHAPTER 2

Planning Curriculum

A large part of this teaching practicum involved learning how expert teachers plan lessons, gather varied resources for those lessons, and evaluate the results of carrying out that lesson. Planning a lesson relies on careful examination of the *Common Core* standards, gauging students' prior knowledge, and planning clear objectives that can be met by students. In addition, drawing on experience from other teachers and online resources helps immensely when it comes to developing novel and exciting lesson plans. After finishing the lesson, formal and informal assessments must be carried out to test both the effectiveness of the lesson and students' mastery of the content objectives.

Lesson Planning

Before beginning to plan any lessons, it is vital to assess the students' prior knowledge and skills, as well as general mathematical sense and intuition. The structure of the teaching practicum allowed me to observe all of the students for about seven weeks during the normal course of their class. As I watched the students and slowly began helping out during the lessons, I was able to pinpoint their strengths and weaknesses, and the ways that Renah Razzaq, my mentor, adjusted her lesson planning to meet the students' needs. For example, in the Algebra II Honors class, Renah was teaching a lesson about rational exponents and how to simplify expressions with multiple rational exponent terms. While teaching the lesson over the course of a week, she found that the students were struggling with the concept because they had trouble manipulating fractions according to the rules of exponents.

With this critical prerequisite skill missing, students performed poorly on that week's test. Renah and I had to reevaluate our strategy for teaching about rational exponents, and backtrack

to cover the material that students had either forgotten or never fully grasped when it was first introduced. Although it was time-consuming to go back and teach a lesson on manipulating fractions, that experience showed me that it is vital to always assess students' prerequisite skills before beginning a new lesson. If Renah and I had identified the missing skill before teaching an entire week's lesson on rational exponents, we would have saved ourselves and the students a great deal of frustration and confusion. The implementation of sequential standards such as the *Common Core* may help prevent situations such as this, by clearly outlining what students need to master before they are allowed to move onto the next topic; for example, if all students must demonstrate an ability to fluently manipulate fractions before arriving in Algebra II, they will be much more prepared for dealing with the complex topic of rational exponents, which rely heavily on fractions.[25]

Once I began teaching, I tried to incorporate time at the beginning of each new lesson or topic to review and assess students' prerequisite skills. I would leave space in my lesson plans to adjust based on the prior knowledge that students had; if students were already familiar with the concepts being introduced and covered, a simple refresher of the material would suffice; otherwise, more time would need to be spent reviewing the prerequisite material before moving onto the main part of the lesson. Renah tried to help me find a good balance between presenting prerequisite topics to students and saving enough time to complete a week's lesson plan; master teachers such as her have much more experience with the range of knowledge students enter their classes with and have a better sense of how much time they can allocate to reviewing prerequisite skills.

[25] "Grade 7: Ratios & Proportional Relationships," Common Core State Standards Initiative, http://www.corestandards.org/Math/Content/7/RP/.

After assessing where students fell within various skill ranges, I needed to coordinate my lesson plans with the year-long outline of topics to be covered that the Math Department at Doherty High School had created. The year-long outline drew heavily from the *Common Core* standards, in order to ensure that students were progressing at the pace set by these guidelines. Appendices I.A and I.B includes a sample of the outline, dictating which objectives match with which *Common Core* standards; the Algebra II sample actually details to which section each topic corresponds. Before I arrived at Doherty, these outlines had been put together in the beginning of the year to standardize the topics covered by each math teacher; in addition to fitting the *Common Core* framework into a year-long schedule, the mathematics teachers also aligned the materials that would be used in the textbook for each section.

This long-term planning helped me set concrete goals and objectives into a time schedule when I began writing my lesson plans. I found it helpful to look at the structure of the overall plan and then break each topic into several day- or week-long lessons. Each weekly lesson plan that I wrote had a definite goal of introducing at least one new topic from the year-long outline, allowing students to practice and hopefully master the material, and then assessing students' knowledge with a test or quiz at the end of the week. Appendix II.A shows a sample lesson plan from Pre-Calculus aimed at introducing terminology and properties of angles, matching Section V in the Pre-Calculus year-long outline (Appendix I.B). Keeping a lesson plan consistent with the *Common Core*, textbook, and overall schedule was a challenge, but it also gave me plenty of resources to draw upon when it came to write each week's goal.

Of course, planning a lesson and schedule does not guarantee that everything will go as expected. Room for adjustments needs to be built in to accommodate schedule changes, school closures, and different students' needs. A lesson that I believed would take one day to deliver

may be prolonged if students do not grasp the prerequisite concepts necessary for that topic, or are having trouble understanding the new material. For example, the lesson in Appendix II.A contains material about coterminal angles that I thought would be covered in about a day and a half. Instead, after seeing students struggle with this idea and have trouble on that week's quiz, I needed to build in more time to cover the topic in the following week. Balancing the needs of students with the year-long goals was difficult, and I frequently asked Renah for help and guidance on structuring manageable objectives for myself and the students.

Resource Gathering

In addition to working closely with Renah during lesson planning, I also learned important tips and techniques from watching her teach and asking for help when dealing with different situations. Renah and the rest of the Math Department were valuable resources, and they used their experience to suggest appropriate materials and activities for the classes that I was teaching. For example, Renah and I set up a session in a computer lab for the students to use a program called Khan Academy which allows teachers to input learning objectives and activities, and then customizes problems for each student and their learning ability.[26] I never would have found such a great resource if I hadn't collaborated with Renah and taken her suggestions into consideration. I also received a great deal of guidance from my advisor, Professor Goulet, who mentored me about the skills possessed by master teachers and tips for handling difficult academic material with the students I was teaching.

In addition to the helpful advice that I was given by teachers in the Math Department, they also lent technological resources to me so that I could use them effectively in the classroom. For any student in today's technologically-packed world, it is vital that they can utilize the tools

[26] KhanAcademy, "Khan Academy," khanacademy, http://www.khanacademy.org.

available to them to assist them in their learning, visualization of mathematical concepts, and computation. I incorporated several lessons into my planning that included working with TI-83 and TI-84 calculators so that students could become more familiar with their usages and see a different perspective on the math that they were learning (See 4/9/2014 in Appendix II.B).

Although I wanted students to practice using graphing calculators within the scope of my lesson plans, I would not have been able to do so without the cooperation and hard work of the other teachers in the Math Department. Many students in my classes could not afford to purchase their own graphing calculator, as nearly 59% of Doherty students qualify for free or reduced lunch programs.[27] With only a limited number of school calculators to use across the entire Math Department, I needed to work closely with the other teachers to coordinate days when the calculators would be available for my classes to use.

Fortunately, Renah served as a great example of collaboration and resource gathering when she applied for donations to purchase new TI-84 calculators via DonorsChoose.org.[28] The website serves as a crowdfunding forum for teachers to post projects that they need assistance funding; donors can choose to assist different projects based on the teacher's type of request, the poverty level of the teacher's school, or the relative worthiness of the request. After posting her request, Renah was able to receive enough donations to fund the purchase of a new set of graphing calculators and a carrying case for them. Renah's hard work and dedication to providing the best possible materials for her students truly showed me collaboration and resource gathering at their finest.

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[27] Massachusetts Department of Education, "Doherty Memorial High Students," Massachusetts Department of Education, http://profiles.doe.mass.edu/profiles/student.aspx?orgcode=03480512&orgtypecode=6&leftNavId=305&fycode=2014.

[28] Renah Razzaq, "Graph It Like It's Hot!," donorschoose, http://www.donorschoose.org/project/graph-it-like-its-hot/1151587/.

Formal and Informal Assessment

After planning lessons, reviewing prerequisite skills, gathering adequate resources and assistance, and delivering a lesson, formal and informal assessments need to take place. Informal assessments, such as Do Nows and review questions, can take place during the lesson so as to shape the future parts of the lesson. For example, at the start of each class, students would do a small exercise for participation credit known as a Do Now. A sample question might be:

Simplify:

$$\frac{(2\sqrt{x}y^2)^3}{\sqrt[3]{x}}$$

Based on students' answers to this informal assessment, I can predict whether I will need to spend more time reviewing that material or can safely move on without confusing anyone. Another informal assessment that students enjoy and can also give good feedback about how to shape a day's lesson is having students write their solutions to homework problems on the board at the beginning of class. Although the students may not realize it, their board work allows me to informally assess their problem solving procedure, grasp of the material, and confidence solving each type of problem. Even such simple things as circulating around the classroom while students work on in-class problems can provide feedback about what type of mistakes students may be making, and what material needs to be added to a lesson plan to correct those errors.

When writing a lesson plan, I can plan objectives for each day, a whole week, and an overarching lesson, and then use informal assessments to check students' progress towards meeting those objectives. The objectives must be designed so that they are clear, concise, and measurable; often times, they can include vocabulary terms that students should begin using in context, mathematical procedures that students should be able to fluidly perform, and techniques

for students to practice (See objective in II.C). The objectives that I have for each part of the lesson are summarized on the board in a section called "Students Will Be Able To", or SWBAT, to reinforce the overall goals that I have for each student's performance. These key points are what I use when designing formal assessments at the end of each week.

At the end of presenting a topic, students will need to be formally assessed to measure their mastery of the lesson objectives that were previously informally checked. Due to the testing schedule at Doherty, math classes can only give formal assessments such as tests or quizzes on Fridays. This means that I must create objectives and lesson plans that can be completed reasonably during class on Monday through Wednesday, provide a review of the important material and objectives on Thursday, and finally assess students on Friday. I feel that it is important to summarize and reinforce key objectives for each topic so that students have an opportunity to ask questions about and practice material that will be important to their higher understanding of a mathematical concept.

In materials such as study guides and practice quizzes (see Appendix III.A and III.B), I stress the vital skills, vocabulary, and techniques on which students will be formally assessed. The formal assessments that I then give to students are meant to draw directly on the items that I highlighted in the reviews, SWBAT statements, and informal assessments. Thus, I provide many chances for students to truly master lesson objectives before formally measuring them at the end of the week. If students study for quizzes and tests based on the homework problems they were given, the key objectives I outlined for the week, and the review material I give on Thursday, then the assessment should measure the highlighted topics and skills (see Appendix III.C for an assessment based on III.A).

CHAPTER 3

Delivers Effective Instruction

Many key components go into the delivery of an effective lesson, including lesson planning, gathering adequate resources, and constant assessment of the climate of the class. The stages of teaching an individual class can roughly be broken into several stages: beginning the lesson; carrying out the lesson; completing and reviewing the lesson; and evaluating the lesson. Each piece is crucial in the process of delivering a concise and interesting presentation to students, and must be carefully thought out prior to starting a topic. In my student teaching, I believe that I adequately met the challenges related to each portion of instruction and was able to effectively motivate students in my classes.

Beginning the Lesson

Engaging students in Algebra II and Pre-Calculus classes required careful planning of the start of each new lesson or overarching topic. A structured introduction to a new idea is vital in demonstrating to students what they are about to learn, what objectives they must meet, and what the long-term goal of that particular section is. If students have a clear picture in their mind of what they can expect to see in the next one or two weeks, they will be better prepared to receive each part of the lesson.

To introduce the theme of a new lesson, I listed objectives on the side of the board and also verbally explained the outline of what we would be learning. For example, in Algebra II, we were covering a few sections in the textbook regarding finding the zeros of a polynomial by factoring, implementing DesCartes' Rule of Signs, and using a calculator. It was useful to tell students about our goals for solving these problems at the beginning of the lesson, and then find

new ways of achieving the same objective. Later in the lesson, some students then found it easier to relate the zeros of a polynomial to its factors based on our original statement of our goals.

In addition to making a point of explaining the key objectives of a new section at the beginning of a lesson, I also tried to speak about different applications that could apply to the types of problems that we were solving. When a real-world version of the mathematics is presented, students tend to enjoy learning more than a lesson based solely on textbook theorems and definitions. The biggest success of this approach came when Renah and I began a lesson on exponential functions with chemistry, physics, and financial applications of the material. Given a new context to apply the lesson to, students were visibly more engaged and open to learning, and the project we assigned for exponential functions not only inspired students to work hard, but also gave them valuable insights into how to apply mathematics to their finances.

Carrying out the Lesson

Once a topic has been fully introduced, the actual core content of the lesson may begin. I must use a variety of teaching methods, including teacher-driven instruction, group work, and individual student practice, to effectively assist students in their learning. Typically, the bulk of new material that I introduced was presented via notes and examples that I wrote on the board. During this time, students were encouraged to take notes and ask questions; answers to student questions could then be put on the board to interactively build notes that were maximally useful for students. Using multiple colored markers was another way to make examples on the board as clear and organized as possible for students following along. During some lessons, I gave students colored pencils so that they too could color code their notes, making it easier for them to look back on their notes and understand what they had seen.

In the theme of incorporating student activity to fully immerse them in the learning process, I also relied on student input and student-driven work during each lesson. To review the previous night's homework, for example, I would call student volunteers up to the board to write up their solutions. Not only was student board work an effective form of informal assessment, it got students to stand up, be active, and take ownership of their work as well. During class, I would often write multiple problems on the board for students to work on with a seatmate as I circulated around the room. Many times, I saw that students who were still struggling with the material were able to get help from classmates without my explicit instruction; this interaction benefitted both the student who needed help and the student who was explaining the material, as they both reinforced the new concepts while working on the example. Once again, material that students worked on could be written on the board for further reinforcement and informal assessment.

In addition to students working with partners to solve example problems, I also encouraged students to participate actively in the lesson by asking students to orally answer questions. I either allowed students to volunteer to answer questions, or used a technique demonstrated by Renah called "cold calling", where a teacher picks out students who are not necessarily raising their hand to answer questions. This practice allowed me to get more students involved in answering questions, especially those that were not confident enough to volunteer to answer questions themselves. I picked students to answer questions to which I knew that they were capable of responding; even if a student didn't realize they understood the material, I could verbally step through the problem with them to allow them to gain confidence in problem-solving methods. Seeing or hearing a classmate solving a similar problem often gave students new insights into the lesson and encouraged them to further ask questions.

I hoped to foster student questions throughout each of my lessons by demonstrating a mastery of the content. If students knew that I fully understood the material, and could re-explain something for those who didn't immediately grasp it, they often felt better about expressing their confusion. Even when I was just observing Renah teaching the classes, I frequently circulated around the room to answer student questions as they arose; given a different explanation of the same material, students then were able to gain a better understanding of a concept. My mastery of the content has been built over many years of exploring mathematics, from my high school classes to my more intense studies at WPI as a mathematical sciences major. With the knowledge I've gained from my work, I was able to demonstrate a mastery of the content to my classes, ensuring that each lesson was delivered in a robust and academically rigorous manner.

Completing and Reviewing the Lesson

Once a lesson has been covered in class, students need to practice and review the material to truly cement their understanding. Homework serves exactly this purpose, allowing students to individually practice the techniques and skills learned in class so that they are ready to build off of them in the next class. The homework that I gave normally came out of the textbook section that we were working with that day in class, and ranged in amount of work from several problems up to about ten problems. I tried to match the level of difficulty of the questions with the amount of time that we had spent in class focusing on that topic; if a section was new or if we hadn't fully completed the lesson, the difficulty would be rather low. For material that we had been working on for a day or two, I expected students to be able to complete homework of medium difficulty, with a possible challenge problem at the end.

I expected students to at least try each homework problem, even if they were unsure of how to complete it. Because we would review the problems the next day, it was acceptable for

students who did not understand a problem to bring their incomplete work into class the next day to ask questions. At the beginning of each class, I would circulate around the room to check if each student did the homework, and then called students up to the board to present their solutions. For those students who did not understand a question, this review period was intended to be a time for them to observe their classmates' work, take notes, and hopefully figure out how to do that problem and ones like it. If I found that many students were not fully grasping the homework, I could revise my lesson plan for the day to include more time reviewing homework and practicing problems similar to the ones assigned. Several times, I even adjusted the following night's homework in order to give students more of the same types of practice problems; I did not want homework to deal with material further ahead in the lesson than we had covered, as I intended homework to be a productive review of concepts they had already seen.

Evaluating the Lesson

The final part of the lesson comes when the students are evaluated informally and formally to check their mastery of the material and my presentation of it. These evaluations can take many forms, such as Do Nows, quizzes, projects, and tests. I can use different types of assessment to spot common problem areas and correct them before students are formally assessed at the end of the week. For example, if many students make a similar mistake on a Do Now, I can give practice examples during class for students to work on to hopefully fix any misconceptions about the material.

The results of each assessment need to be presented to students so that they could check the progress of their learning and see where they stand grade-wise. To do this, Renah used an online gradebook program called Engrade, which allowed us to create classes, make assignments

for each class, and report grades for students for every assignment.[29] Students were given a login username and password at the beginning of the year and could check which problems were assigned for homework, their attendance record, and grades. For both teachers and students, this easily accessible tool made reporting grades and keeping track of multiple assignments less of a hassle, while providing up-to-date feedback for students about their various assessments. Engrade also allowed early error-detection if students noticed a discrepancy with a grade they received on paper and the score that I had recorded in the gradebook; by sorting out any mistakes soon after they happened, the grades at the end of a trimester would accurately reflect the sum of all of a student's assessments. Once all grades were put into Engrade, both the students and I could examine the data to determine the relative success of a lesson. The outcome of these assessments could then be used as feedback and input for the next series of lessons.

[29] "Engrade," https://engrade.com/.

CHAPTER 4

Managing Classroom Climate

While lesson planning, resource gathering, and delivery of instruction are all important parts of the learning environment, they are intangible concepts that are difficult to assess easily. In contrast, the physical setup of the classroom, daily routines, and standards of behavior are vital pieces of the environment for every teacher to manage that can quickly be checked by any observer in the room. Renah and I worked hard to ensure that each class we taught was held in a room conducive to learning, efficiency, and hard work. The physical environment and the emotional atmosphere played key roles in determining how smoothly each lesson went and what lessons a student took out of each class.

The Learning Environment

The most noticeable and easily observable part of the classroom climate is the physical setup of the desks, boards, and supplies around the room. Upon entering Renah's classroom, students in both the Pre-Calculus and Algebra II classes could immediately see pieces of information relevant to their lesson. Normally, I would stand just outside the door of the class to hand out pieces of scrap paper on which students could complete the Do Now warmup problem; the Do Now itself was displayed in large writing on the side of the front board so that students in all parts of the room could read the problem and begin working. Having the paper and problem quickly available reinforced the routine established by Renah, in which students were to sit down and begin a sample problem while attendance and homework checks were done.

In addition to the Do Now exercise, the lesson objectives for the Pre-Calculus and Algebra II classes were written on the opposite side of the front board. Whenever the lesson objectives changed, such as at the beginning of a new section in the textbook, I tried to draw

attention to them by reading the "Students Will Be Able To" goals aloud. If students paid attention to the lesson objectives throughout the course of a topic, they would be able to predict the important skills and vocabulary that I would be assessing on homework, quizzes, and tests.

The last piece of information constantly displayed on the board was that particular week's homework assignments for each class. The side board was divided into the 2 classes and 4 separate days for which I could write homework. On Monday of each week, the homework to be completed was displayed for every day, ensuring that students could plan ahead and take note of what work they could expect to complete that week; in addition to being written on the board, the homework assignments for the week were entered into the Engrade website as another resource for the students. This presentation of material, expectations, and goals for students gave students every opportunity to make the most out of their classroom surroundings.

Not only did the information relevant to students need to be arranged in a manner that supported learning, but the desks also needed to be set up to foster a rich classroom environment. Renah and I placed the desks in 6 columns facing the front board, with about a foot and a half of lateral space between each column. We found that this grid of desks allowed students to easily move around the room, focus on individual work and note-taking, and discuss ideas and problems with their neighbors if there was a time for group work. On days where I planned more involved group-based activities, I instructed students to move their desks into small clusters facing each other to facilitate discussion and partner work.

The seating plan of students in the desk arrangement needed to be carefully thought out to accommodate students with learning disabilities, vision impairments, and various behavioral needs. Throughout my time student teaching, I moved the seating assignment of three out of the

four classes I taught in an effort to make the classroom environment more conducive to learning. The biggest problem I faced was seating a large group of students in such a way that kept students with specialized needs at the front while separating students who tended to frequently disrupt class with chatter from one another. Some seating changes were made on-the-fly to fix smaller problems (a student who forgot their glasses, for example), while some needed to be planned in advance and discussed with Renah before implementing. Although students often had their own opinions of where they wanted to sit in class, I needed to ensure that, above all, the seating arrangement lent itself in a positive manner to the classroom learning environment.

Lastly, the physical classroom environment was made more positive though the displays of outstanding student work on the corkboard in the back of the room. Students enjoyed seeing their projects hung in the back of the room, and this presentation motivated students to work hard on projects to earn a spot on the wall. While working on a topic involving exponential functions in the Pre-Calculus classes, Renah and I assigned a project that student groups completed by calculating the cost of a house purchased with a mortgage, minimum payments for student loans, etc. We encouraged students to go above and beyond with their mini-posters or booklets, letting the students know that projects consisting of correct mathematics and nice visuals would be featured on the back board. We were amazed at the quality of student work produced for this project and loved how happy students were when they saw their hard work hung up for each class to see. This simple display of student work had a great positive effect on the learning environment in the classroom and served as a constant reminder that hard work by students was always expected.

Classroom Routines

Expectations for classroom efficiency were also set by Renah at the beginning of the year when she established routines for activities that would take place daily. I observed these practices during the first part of my student teaching, and then continued them after I took over. As mentioned before, the Do Now warmup problem was an integral piece of each class and played an important role in keeping class time organized and on track. Students knew that they needed to pick up a piece of scrap paper as they entered the room, and immediately begin working on the problem for their class; this routine helped students settle into class and review some of the material that they had just learned. By the time that the Do Now papers were collected, students were in the right mindset to go over the previous night's homework and prepare for that day's lesson

The Do Now routine served another valuable role, in that it gave me time at the beginning of each class period to do housekeeping work, such as take attendance, check students' homework, and gather my notes for that lesson. These activities were vital for the smooth functioning of a class, but needed to be done at a time that didn't waste precious learning time. Since students were occupied with working on the Do Now problem, I had about five minutes at the start of class to quickly take attendance and circulate around the room to check homework. Normally, once I finished checking students' homework and entering any absences into Engrade, most people would be done working on the Do Now and ready to review homework.

Homework was the last element of the daily classroom routine that needed to be taken care of, both in its review and assignment. I typically went over the previous night's homework at the start of the period so that I would be free to move onto the next topic afterwards. To maximize class time, I would have multiple students go up to the board to write up their work for

a problem at a single time. With this method, I would not have to individually review each problem, and students would also get the benefit of either seeing their peers' work or demonstrating their knowledge for others to observe. This routine allowed me to informally assess student work as well as free up more class time for learning. Homework assignment was also done smoothly and efficiently by having the textbook problems to be completed already written on the sideboard and on Engrade for students to view whenever they wanted. By not having to take time out of class to write down all of the assignment, I could simply ask students to copy down the problems or direct them to Engrade to check it later.

Classroom Standards

With routines and the classroom set up for engaging and efficient learning, students were also expected to do their part in making each day's lesson run as smoothly as possible. To accomplish this goal, students needed to follow the ground rules laid down by Renah at the beginning of the year, and enforced by both her and me. The standards we had followed common sense and were intended to maintain the basic level of respect for both the teacher and all students in the class. First and foremost, each student was asked not to speak when someone else was already talking, whether it was me teaching the lesson or another student asking a question. This rule is almost an unspoken guideline when working in any group setting, but I found that it was a difficult standard to which to hold students. If many students began talking at the same time, the class soon slowed down and little work could be done. As mentioned previously, Renah and I had to move seats in several classes to try to enforce this standard and keep class learning time on track. I often found myself reminding students that if they wished to speak, they would need to raise their hand and be called on; during group work or open discussions free talk was

allowed, but in every other situation, students who spoke out of turn caused everyone else's learning to suffer.

The other major standard set by Renah and me was that all electronic devices, especially cell phones, needed to remain away during the class period. Students who used their cell phone detracted from their own learning by distracting themselves from a topic that required their full mental energy. Cell phone usage also slowed down the general pace of the entire class, because students who were busy texting took longer to copy notes and complete example problems than their peers who were focused on the assigned task. Although I reminded students to put their phones away during class, I occasionally had to take some students' phones and put them on my desk to prevent them from using them during class. I tried to discretely take the phones, so as not to disrupt class, but I sometimes made an announcement to the whole class reminding them of the cell phone policy as a quick way to get students back on track with the lesson.

By observing these guidelines, students got the most out of class time and respected their peers and me. No matter how students behaved in class and whether their followed these standards or not, I still maintained a level of respect for each one. I believe that a teacher genuinely respecting their students is of the utmost importance in the classroom, and I based all of my interactions with students on that standard. When students seemed to be having trouble in class and were either not focusing or are acting out, I tried to involve Renah in the situation, and we dealt with the student from a position of respect. With this approach, we found that some students who broke the classroom standards were experiencing other emotions that prevented them from contributing positively to the classroom environment. At that point, Renah and I could involve the student's family or guidance counselor to try to help the student get to a healthy state of mind. I found that this level of respect for students resulted in a mutually beneficial

environment where I could effectively teach students who were ready to learn in a constructive, open-minded atmosphere.

CHAPTER 5

Promoting Equity

Part of making the classroom a welcoming and productive environment involved promoting equity and responsibility in all students. I had to make my lesson plans accessible to each student, regardless of their prior knowledge, proficiency in mathematics, or English language skills. In return, I hoped to see a genuine effort and a willingness to work hard put forth by every student. More often than not, when a student and I worked together like this, the student saw positive results in their learning and I was impressed by their achievement. A diversified lesson plan, honest effort, and achievement goals were the key components to creating an equitable classroom that encouraged the best out of all students.

Diversified Learning

In order to make the lessons and material accessible to every student, I needed to make my lesson plans as diverse as possible. Diversified learning seeks to accommodate students of all skill levels, learning types, and English language fluency. I found that incorporating review time into the beginnings of lessons allowed me to check students' understanding of prerequisite concepts and make gauge whether all students were ready to learn the new topic.

As part of my attempts to use varied techniques for different learning styles, my reviews took many forms; I used popcorn questions, group discussions, and note taking to present prerequisite concepts that I wanted to refresh before moving on. Popcorn questions engaged the class in a fun, interactive way, where a student would answer one of my review questions, then "popcorn" to another student that they chose to answer my next question. Students enjoyed this low-pressure review tactic, and they always had the option to ask for help from their classmates to answer their assigned question. In addition to popcorn questioning, I also held student-led

reviews, where I would ask groups or pairs of students to think of at least one fact about some prerequisite concept that they recalled; after giving students time to discuss, I would write the facts on the board, while challenging students to only state facts that hadn't been mentioned previously. Students who liked working in groups enjoyed this method of review, and I got to hear from each student by finding out what facts they were able to generate. Lastly, for students who preferred the more traditional note-taking style of learning, I also reviewed many concepts by writing notes on the board for students to copy and study later; this method gave students a comprehensive, detailed overview of the concept so that those with a weaker understanding of the material would be able to study and ask questions as needed. After learning material and prior to formal assessments, I used these same techniques, along with printed study guides and practice tests, to assist students in their review.

I saw that the diversified learning strategies that I implemented helped a wide range of students prepare, learn, and review the concepts presented in class. Not all students understood topics right after they were taught in class, so I encouraged students who were struggling to come afterschool for one-on-one help. Students could receive afterschool help from Renah, a student who worked as a Spanish language tutor, or me. I hoped that this approach would assist students who needed extra help, responded best to individual instruction, or needed assistance with the English language aspect of the material. As part of my effort to engage all students and their diverse needs, I tried to be available to any student that sought out extra help, especially those willing to take the time to come after school.

Encouraging Effort

I was more than willing to help any student that displayed an eagerness and desire to work hard and learn, but I first needed students to put forward an honest effort. I encouraged

students to develop good work and study habits and to demonstrate their effort to learn to Renah and me. Before any quiz or test, I held review sessions in class and distributed a study guide for students to fill in or a practice exam for students to complete. I stressed the importance of learning strong study habits, especially to students in the Pre-Calculus classes who were planning on attending college the following year. The study guides that I wrote up and presented were not completely filled in, and students were expected to follow along as I reviewed and write in the missing vocabulary terms and solve sample problems (see Appendix III.D for a sample Pre-Calculus study guide). More importantly, I provided a list of further exercises in the textbook that students could try on their own if they were still shaky on a particular concept; these exercises were provided to encourage students to take the initiative and demonstrate a strong effort to master a concept before an assessment. Students who developed a strong work ethic and study skills got the most out of my class, in my opinion, and I hoped that any studying techniques they learned in my class would carry forward with them into their future academic pursuits.

To truly get the full learning experience in class, I encouraged students to participate, focus, and ask questions every day. With a diversified teaching strategy, I tried to implement many different learning strategies in order to engage as many students as possible. That way, if a student had trouble participating in a traditional note-taking environment, they would be able to engage more during a group work session. I monitored student participation by circulating around the room when students worked in groups, lookied at student homework completion, and informally assessed their oral and written contributions during homework and exam review periods. At one point in my student teaching, I found that some students in Pre-Calculus were taking advantage of the open-note assessments and not fully participating in learning, and instead

just copying answers to the practice exam into their notes for later use on the test. I did not believe that this practice demonstrated any effort on the students' behalf and was a weak way to develop study skills. In order to get students to completely engage in learning, I made the final few assessments of my student teaching practicum closed-notes, but still gave plenty of review time and materials before any assessment. I quickly saw a difference in performance between students who took the effort to master concepts and practice their mathematical skills and those students who wanted to put in the minimal effort necessary to pass an exam. Renah and I both stressed to the students that picking up good study habits and participating fully in review sessions were the keys to seeing better grades on quizzes and tests; some students took this message to heart and displayed an increased effort prior to the next test. In the long run, the study skills learned from this change benefitted students by showing them the type of effort and hard work that is necessary to achieve success in academics and beyond.

Promoting Achievement

The measure of students' effort and dedication usually came in the form of grades on their formal assessments, such as weekly quizzes and tests. I stressed to students that improvements in achievement were secondary to their hard work, as higher scores would follow from participating in class activities, completing all homework assignments, and putting in time to review material. For some students, achieving in the top bracket of scores was not possible due to various circumstances; a few students struggled with learning disabilities or English language comprehension, and others were frequently out of school with medical or family burdens. Thus, it would be impractical and unfair for me to push these students to get an A on a quiz. Instead, I tried to look for improvements from one week's assessment to the next; if they could demonstrate that they were consistently working as hard as they could and putting forth a

solid effort, I praised them for their achievements. I tried to give them every opportunity and accommodation to succeed, and left it up to each of them to put in as much work as they chose.

On the other end of the spectrum, I had several students in each class that could easily achieve high grades on every formal and informal assessment. These students were not only gifted with an academic talent, but they also displayed a high degree of effort to participate fully in the learning experience. My challenge with such dedicated students was to keep them engaged while I focused on other students during class. To do so, I often spoke with them as I circulated around the room and posed additional challenge questions that would be more stimulating than the other examples that they had already completed. I also encouraged them to help their classmates nearby with the problems once they had finished working; not only did their peers benefit from the help, but the advanced students saw concepts in a new light by having to explain their thought process to another student. I tried to praise these students for their effort, dedication, and curiosity as a way to further motivate them to continue putting in the hard work necessary to master more difficult mathematical ideas.

CHAPTER 6

Meeting Professional Responsibilities

First and foremost in any of my duties as a teacher, I need to act as a responsible professional dedicated to promoting a love of mathematics in all of my students. I have to carefully observe legal and ethical boundaries when dealing with students while still being a morally compassionate person. In addition, I must fully draw upon all the resources and people around me to bring the best high school experience possible to all of my students. Despite my best efforts, I still have plenty of room to grow in my profession, and I spent a great deal of time reflecting on my student teaching experience and figuring out how I can best improve myself for the next group of students that I teach.

Legal, Ethical, and Moral Responsibilities

The legal responsibilities of being a teacher are well-defined and easily come to mind when picturing the job requirements of a high school teacher. I must cover the approved, mandatory curriculum specified by the Massachusetts Department of Elementary and Secondary Education (DESE) and ensure that students have mastered the material and are ready to continue on to future mathematics courses. My achievement of this goal is measured when students take the Massachusetts Comprehensive Assessment System (MCAS) exam throughout their academic career. Teachers should strive to prepare their students well for this test, as it is a partial indicator of their success in meeting the legal standards of their profession. I worked diligently to ensure that my lesson plans met the objectives stated in the Doherty High School Mathematics Department curriculum outline, which were adapted from the DESE standards. With these benchmarks in my lesson plan, I helped students prepare for the standardized testing that they would legally need to pass in order to graduate from high school.

Beyond the clear legal boundaries set for teachers, there are further ethical responsibilities that must be observed to maintain a professional status as a teacher. Teachers need to make a clear statement about what sort of behavior is ethical from both themselves and their students. I found that as a student teacher, I needed to reinforce these standards more strongly when interacting with the students that I taught; although some students looked at me as a peer, I behaved in a manner consistent with a full-time, professional teacher. When students asked about my social life as a college student, I maintained a friendly attitude but kept my answers professional. In addition, I also encountered a student in one of my classes that sent overly friendly messages via the Engrade website. Initially, I was unsure of how to deal with this situation, and turned to Renah who had much more experience with both setting firm ethical boundaries and seeing this sort of behavior from students. Together, we decided to respectfully ignore said messages to discourage the student from sending any more. These situations highlighted the importance of maintaining clear ethical standards as a teacher and using them to guide interactions with students.

The final aspect of working closely with students involved acting as a morally compassionate role model for students in need. Many students in my classes had unstable family lives and difficult financial situations to deal with outside of school, and I tried to be as understanding and helpful as possible. When I saw that one of my students seemed to be distressed during class time, I let Renah know so that she could contact the Guidance Department and check on the wellbeing of them. With the additional resources dedicated to assisting this student, Renah and I were able to make a small positive impact on that student's life. Unfortunately, this scenario happened several times during my practicum, including situations that were severe enough for students to miss school for large periods of time. It was my moral

duty as a teacher to help these students in any way that I could and to give them opportunities when they returned to catch up on the material and assignments. I tried to look out for the mental and emotional wellbeing of all of my students and seek out additional resources when possible, as I believe that teachers have a moral responsibility to care for their students both inside and outside of the classroom.

Involving Colleagues and Parents

The resources around me while I taught at Doherty were phenomenal and I attempted to take advantage of them as often as possible. Renah was by far my biggest supporter, and her guidance, advice, and experience helped me achieve far more than I would have if I had to work alone. She also put me in touch with the other great teachers in the Math Department who were further able to offer me physical materials and encouragement during my journey. I learned a tremendous amount about what it truly means to be a teacher by observing these experienced teachers as they worked and implementing their strategies in my own classes. As mentioned previously, the Guidance Department assisted me when dealing with student crises as they arose, which was an invaluable resource.

The Guidance Department also facilitated interactions with the parents of students in my classes. Though I could not directly speak with parents, I often provided information to Renah when she was contacting parents for various reasons. Renah and I worked with one student's parents who were concerned about their child's performance in class; I supplied Renah with data from Engrade about the student's classwork and assessment grades, and she then spoke with the parents about how the student could improve her effort. In addition, Renah spoke with another parent about a discipline issue that occurred in one of my classes, and I needed to outline the incident for her to explain to the student's parent. Though I wasn't able to directly work with any

parents, I did see the benefit of involving parents as closely as possible in a student's education, and I hope that I can continue to do so during my career. Overall, the entire Doherty community truly made me feel welcome as a student teacher and gave me the tools I needed to succeed during my practicum and in my professional career.

Promoting a Love of Mathematics

As part of my role as teacher, I needed to convey to my students why they should be interested in mathematics and what they could get out of my class on a practical level. To do so, I let my natural enthusiasm for the subject that I study shine through and hoped that it was infectious enough to engage students. I found that students did pick up on my energy and channel it into their group work and projects. While some students found my passion humorous, it ultimately engaged students and made them more willing to listen to my teaching. As a fun way to unwind while still learning about mathematics, we celebrated Pi Day on March 14th in each of my classes by bringing in baked goods and doing an experiment whose result provides an estimate of pi. Students were impressed that a simple test of how often a needle falls across parallel lines yields a result very close to pi.[30] I hoped that showing students some of the surprising and interesting sides of mathematics would inspire them to not only engage and participate in class, but also consider studying mathematics later in their education.

In addition to demonstrating my enthusiasm for mathematics to my students, I also let them know about the areas to which they could apply their knowledge. As mentioned previously, students were highly interested in learning about financial topics related to exponential functions and had many questions related to both the math behind loans and mortgages and what they could do in their own lives to personally manage their finances. Renah and I were able to answer

[30] J.F. Ramaley, "Buffon's Noodle Problem," *The American Mathematical Monthly* 76, no. 8 (1969).

all of their inquiries, giving students a renewed sense of respect for us as valuable sources of knowledge about these topics. I also brought real world applications into my lessons when I taught Pre-Calculus students about the types of graphs that commonly occur when modeling data, such as bell curves, exponential growth and decay graphs, and logistic growth curves. When introducing the topic, I drew the shape of the graphs on the board and asked students to brainstorm what sort of data might follow the pattern of those graphs; students were able to relate the graphs to subjects such as biology, environmental science, and trends in viral video sharing. I was very impressed by how engaged students were once they knew that what they were learning about could actually be applied in other areas of their life. I felt that I achieved one of my goals as a student teacher by demonstrating to students the useful and exciting aspects of mathematics that they could further explore.

Personal Reflection

Though I felt that there were several successes that I achieved over the course of my student teaching practicum, I know that I will always have room to grow as I strive to become the best teacher I can be. After reflecting on my performance as a teacher, I saw that I needed to improve in my ability to discipline disruptive students without slowing down the pace of the entire class. I often had trouble dealing with classes with quite a bit of chatter going on, so I would like to watch how master teachers quiet down students while maintaining the flow of the lesson and implement their strategies next time I teach. In addition, my disciplining of students that refused to follow instructions was a bit lenient, and I discussed ways that I could get better at being fair but firm with Renah during my practicum. I believe that discipline is one area of teaching that improves with teaching experience, so I hope that by learning new techniques and

spending more time in classrooms, I will develop my ability to discipline disruptive students in my classes.

My personal reflection also showed me that I could have benefitted by assigning more group work and projects over the course of my lessons. I tended to use formal assessments such as quizzes and tests rather than projects, but upon reflecting on how much students enjoyed the few projects Renah and I gave, I wished I had utilized them as assessments more often. Group work was also a favorite of the students in my classes, and I could have built more time into the structure of my courses to allow for peer-based activities. If I want to implement these techniques in the next classes I teach, I will need to carefully examine how I normally format my lessons and find ways to integrate more projects and group activities. Although this change will require more work on my behalf, I believe that the benefits for students will be enormous.

Finally, the last major area that I feel I need to improve upon based on my reflection would be finding additional material with which to challenge high-achieving students. Several students in each of my classes were far more advanced than their peers and could complete any exercise or homework with relative ease. I tried my best to supply those students with extra problems or ideas to muse over, but I know that they ultimately got less attention than their struggling peers. In the next class I teach, I would like to have pre-planned challenge exercises available at the start of each lesson for any student who is able to finish activities or in-class work ahead of their classmates. If I implemented this strategy, highly motivated students would be pushed to demonstrate their full potential and get more out of each lesson than they normally would.

CHAPTER 7

My WPI Education

The foundation of my teaching lies in my ability to convey mathematical knowledge to the students in my class and integrate the ideas that I have learned throughout my time at WPI into the lessons I present. If my students see me as a legitimate authority in mathematics, they are more likely to respect me and be interested in the topics I cover. I tried to bring both the academic material and teaching techniques that I've picked up at WPI into my classes, and many students seemed to enjoy learning about the various applications I showed them.

Knowledge of Mathematics and Mathematics Instruction

Studying mathematics at WPI has certainly prepared me to teach any type of mathematical course offered at the high school level. I have learned about topics far beyond the scope of what I taught in my classes, but I believe that it is important for mathematics teachers to be well-educated in the subject matters and topics that they are presenting. Some of the more specific areas that I have studied at WPI include: calculus, differential equations, linear algebra, graph theory, combinatorics, abstract algebra, and discrete math. I have thoroughly enjoyed these courses, and my passion definitely shines through whenever I am teaching students about mathematics.

Thanks to the Peer Learning Assistant program at WPI, I had practice instructing students about mathematics before I even began my practicum at Doherty. My experiences teaching conference sections of about thirty students greatly helped to prepare me for my student teaching; while leading conferences, I refined my presentation techniques, methods of reviewing material, and organization of topics. When I started teaching at Doherty, I had already become comfortable writing notes and math problems on the board, giving me a great head start. I owe

this advantage to my experiences at WPI, the mathematics professors I've had, and the work that I've done as a Peer Learning Assistant teaching mathematics to students.

I further learned about mathematics instruction by taking various teaching courses while at WPI. Studying about the psychology of education, educating English Language Learners, and teaching methods gave me a strong background to begin my student teaching practicum at Doherty. These courses gave me insight into the different ways that students learn, how to make material accessible to all students, and the theory behind teaching practices. Knowing the mathematical material alone is not sufficient when it comes to teaching at the high school level, because I need to be able to communicate my knowledge effectively to each of my students, regardless of their skill levels, learning abilities, or English language fluency. The teaching program at WPI prepared me well for my first experience in a real high school classroom, and I was able to bring my full skillset with me to my four classes.

Integrating Mathematical Knowledge into the Classroom

All of the professors that I have had at WPI that I truly admire manage to combine the two aspects described above: a passion and deep knowledge of the mathematical subject matter, and a strong interest in effectively presenting the material to their students. I have found that many of these great professors enjoy teaching by integrating both theory and applications into their lectures. For example, one of my favorite professors taught about linear algebra by first lecturing on the mathematics of vector spaces, then speaking about how he used them in his work in cryptography and coding theory. Even professors in non-mathematical subjects that I've had who utilize this teaching technique tend to engage students more than those professors who simply lecture about the subject matter. When I took the teaching methods class taught by Renah,

hearing about actual experiences she's had while teaching brought a whole new dimension to her lessons.

I hoped to use this same strategy in my teaching to encourage class participate and garner more attention from my students. In all of my lessons, I tried to include a section on the applications for that topic or interesting ways that they could see that material in a new light. Some topics, such as exponential growth and data modelling, lent themselves nicely to showing students practical examples and real-world usages. In other situations, such as the lesson about finding the zeros of polynomials, I used technology to give students a visual perspective on the work they were doing. Unfortunately, some lessons involved material that was difficult to provide easy applications for, so I needed to engage students via group work and other active methods of learning. I further tried to motivate students to focus during these lessons by foreshadowing how they would be using those skills in future lessons.

In addition to showing students how they would be using the current material in the near future, I also aimed to demonstrate the long-term usages of the topics in later courses of study. Some of my students were sophomores and juniors, and thus would be taking at least one more math class before leaving Doherty; with them, I mentioned courses such as Pre-Calculus, Statistics, and Calculus as possible continuations of their mathematical studies. I urged them to master the material now, so that they would be ready for the topics they encountered in the next few years. I had seniors in both of my Pre-Calculus classes, some of whom would not be taking any further math courses, and some of whom would be required to take college-level math classes as they pursued higher education. Towards the end of the school year in my Pre-Calculus classes, I began doing sample questions from the Accuplacer (a college math placement exam

used by state schools in Massachusetts) to benefit the latter group.[31] Renah and I hoped that by exposing students to this exam, we would both prepare them for their future placement test and demonstrate the ways in which they could expect to see this material later in their academic career. Given the opportunity to practice their mathematical problem solving before entering college, many students took advantage of the Accuplacer review during class time. By showing students future practical and academic applications of the mathematical topics in class, I saw an increase in class engagement in each of my periods, and I also felt satisfied knowing that my students left class with a broader understanding of how mathematics worked in the world around them.

[31] "About ACCUPLACER Placement Testing Systems," CollegeBoard, http://accuplacer.collegeboard.org/professionals.

CHAPTER 8

My Classes

Any description of my time working as a student teacher would not be complete without creating a vivid depiction of the actual students that I worked with on a daily basis. My students ranged from English Language Learners to native speakers, students with Individualized Education Plans (IEPs) to advanced learners, and from the highly motivated to the frequent class skippers. Each day at Doherty started when I arrived around 8:30 in the morning to prepare before my first class and settle myself into the classroom. This early morning ritual gave me time to collect my thoughts and materials and set up the classroom for the day's activities. Renah stressed the importance of this preparatory time at the beginning of my practicum, and I am extremely glad that I took advantage of the time in the mathematics break room next to the class; in addition, I was able to write the class objectives and Do Nows on the board in the classroom, as there was only a study happening during Period 2. Once the bell rang, my day of teaching began, and I needed to be at the top of my game to bring the best experience possible to all of my students.

Period 3

My first class of the day started around 9:15 in the morning and was my Period 3 College Preparatory Pre-Calculus course. With 29 students in total, this group of students was usually one of my more lively groups, which was a great way to start off each morning. I greeted them all at the door with a piece of paper to use for the Do Now, then checked homework and took attendance. In this class, I had one student with an IEP, as well as a handful of English Language Learning students, all of whom were at levels four or five. The student with the IEP needed both physical and educational accommodations, so I usually had to spend a few minutes at the

beginning of the class assisting him with the Do Now or making sure he was ready to start the class. Working with this student was far more time-consuming than helping the English Language Learners in that class, as they were all proficient enough to work either alone or in small groups. Within the group of English Language Learners, there were two very high achieving students who easily could have been in an Honors Pre-Calculus class; I felt that these two students chose to stay in the lower level class not because their mathematical skills were lacking, but because they were nervous about being able to comprehend all of the material that would be presented at a faster rate. I wanted to try to challenge these students with extra exercises or harder problems, but my time was usually mostly devoted to class discipline and the needs of the struggling students; in the end, I know I could have stimulated those students more and pushed them further, so I hope to work on my time management skills before I teach again.

Keeping the students in my Period 3 class focused and in-control behaviorally was a bit of a challenge on most days, as there were many high energy students in the class who liked to talk and joke during the lesson. While I was not against having fun while still being engaged in the material, I often found that the more talkative students liked to dominate the atmosphere and bring the class off track. This behavior was especially disruptive to the learning environment because there were many students in the class who struggled to understand the material even in the best of circumstances. Given this predicament, I switched the seating arrangement for these students about halfway through my practicum to limit the distractions, and found that after some initial resistance, students were more able to focus than previously. Overall, though teaching my Period 3 students could be challenging due to the wide range of learning abilities and attention levels, I truly did enjoy the energy and joy they brought with them to the class each day.

Period 4

After finishing my teaching in Period 3, I immediately had to greet my largest class of 31 students as they entered for Period 4. This class was an Honors Algebra II class and had a much different atmosphere than that of Period 3. Most students immediately began working on the Do Now upon sitting down, and some had questions ready to ask about the previous night's homework. In this class, I had one student with an IEP, but it only required physical accommodations if she was not feeling well. Additionally, there were a handful of English Language Learning students, all of whom were very proficient in English and required almost no assistance. The main challenge when teaching Period 4 came from its sheer size, as helping 31 students learn a new concept at once is never an easy task. Even the basic routines, such as checking homework and taking attendance, took longer than in any of my other, smaller classes. Every desk in the classroom was filled, making the importance of efficiency in each task that more vital.

When it came to teaching my lessons, I found the students in my Period 4 class to be the most receptive and focused overall. These students enjoyed participating in group exercises, board work, and question and answer sessions. At times, the number of students who wanted to give input or ask questions about the material could be a bit overwhelming, and I often had to remind students to raise their hands rather than blurt out their ideas. There was a mix of student abilities in this class, ranging from the highly proficient to students who were struggling in the Honors level. Balancing the needs of students on both ends of the learning spectrum was a difficulty I ran into, and the large class size only exacerbated the problem. Compounding everything, my Period 4 class also had a shorter class time each day than the other Algebra II class that I taught. Because of Doherty's rotating schedule, Period 4 only had an equivalent

amount of learning time as their other Algebra II counterparts once every six days; fitting in all of the material I planned to teach in such a short block made each class feel shorter than it already was. Despite the challenges of a large class size, varied learning abilities, and limited learning time, the students in Period 4 enthusiastically made the most out of every class, and I was more than happy to teach them each day.

Period 5

Depending on the lunch schedule, I either ate lunch immediately after Period 4, or taught my Period 5 class prior to my break. In sharp contrast to my previous class, my Period 5 Honors Algebra II class had only 17 students. Though there were far fewer students in this class, the needs of the students in it were more diverse and time-consuming. I had one student with an IEP in this class, and his accommodations allowed for extra time on assessments and general assistance when presented with new material. Although I tried to help this student with his academics, his behavior during class and limited effort put into homework and studying restricted the effectiveness of my efforts. I tried my best to reach this student, but I could only help him when he agreed to focus and truly engage during class time.

In addition, one of my students was taking this class as a senior, which was unusual compared to her mostly sophomore and junior peers. Her placement into this class was rather complicated, and involved a compromise between the Guidance and Math Departments. Though she needed to pass this class in order to graduate, her frequent absences and difficult focusing meant she was often behind in the lessons. I needed to work closely with Renah to ensure that this student stayed on track to graduate and attended enough of my classes to stay up-to-date with the material.

The last student that required extra attention was an English Language Learning student whose limited language fluency often caused her trouble with understanding the lesson. I tried to speak individually with this student at least once per class period to check her progress and encourage her to speak up if she didn't understand what was being presented. As she was very quiet and shy, I often didn't realize if she was having an issue until I spoke to her one-on-one as I circulated around the room; though she did relatively well with material once it was re-explained to her, I unfortunately found that she was frequently overshadowed in the class by her more vocal peers.

This class was not without its share of high achievers, and I tried to keep them engaged and interested in the material for the duration of the period while I also worked with their classmates. With the Doherty schedule giving Period 5 nearly 20 minutes more learning time per day than their Period 4 peers, I needed to maintain the pace of the lesson for the full class period without letting them get too far ahead of the other Algebra II class. To compensate for the extra time, I often spent more time reviewing homework and gave students longer to complete exercises than I normally would have. This increased class time and decreased class size gave my Period 5 students an advantage when it came to assessments, as they had had more interaction time with me, eventually leading to higher average test and quiz scores. The greater interaction time also gave me the ability to get to know these students better, and I thoroughly enjoyed the close-knit dynamic of my Period 5 class.

Period 6

My last period of the day was my Period 6 College Preparatory Pre-Calculus class with 24 students in it. I saw these students during the second to last class period of the day, so I needed to work hard to ensure that they were focused and engaged despite their mental fatigue

from a day full of classes. I found that this class had the widest array of learning abilities, motivational levels, and disciplinary records, so I had to prepare my lesson content to be as accessible to everyone as possible. Though I did not have any formal IEPs for students in this class, Renah and I both saw that there were several students who had difficulty processing the material in class; we tried to make special accommodations for these students to help them get the most as they could out of each lesson. For example, I had one student who could not take notes as fast as his peers, making it hard for him to keep up with the pace of the lesson. To assist him, I started printing out the pages in the textbook related to the day's lesson and giving them to him at the beginning of class; since I followed the textbook closely when writing notes on the board, he was able to follow along with the printed material and only add notes for extra examples and comments that I made.

In addition, I had several English Language Learning students in my Period 6 class whose limited language proficiency gave them trouble as they tried to follow along with the lessons. These students also struggled to grasp the mathematical concepts presented in class, so even when concepts were explained in simpler English to them, they often still could not understand the topic. I found that there were frequent miscommunications between those students and myself because I was never entirely sure whether their question was about the language used to present the idea or the actual mathematics behind it. Though Renah and I tried our best to help these students whenever possible, it became apparent that their English language skills were not the source of their troubles, but rather that their limited mathematical skills suggested that they should probably have taken a class with less demanding mathematical concepts.

Although a good portion of the students in my Period 6 class needed a great deal of review and reminders to stay focused during class, there were definitely a handful of students who could easily have succeeded in an Honors Pre-Calculus class. These students were a pleasure to work with and easily picked up concepts from the lesson, applied their knowledge to the homework, and scored well on assessments. Unfortunately, their learning experience was often compromised by the frequent breaks I needed to take to re-explain prior material and discipline students for disruptive behavior. I could see the frustration of both the high achieving students and their peers who were genuinely engaged in learning whenever I needed to stop to get the class back on track, but I ethically could not ignore the needs of the struggling students even when their difficulty was often caused by their inattentiveness and lack of participation in class assignments.

Period 6 presented me with the greatest overall disciplinary challenge out of any of my classes, but I still needed to maintain the same level of professionalism when teaching these students as I held myself to in each of my other courses. On days when most of the students were disengaged from the learning process, chatting with their classmates, and dismissive of my efforts to redirect the focus back to the lesson, I tried to remain calm and either speak individually to disruptive students or remind the entire class to quiet down and pay attention. Despite my best efforts, there were days that felt especially taxing on my patience; when I felt myself getting frustrated with the students, I often turned to Renah for advice on how to handle the situation. Her guidance and reassurance that it was natural to feel discouraged when working with an unruly group of students made me feel better about my struggles, and she encouraged me to remember the positive sides of each student. Though I did have my difficulties when teaching

my Period 6 class, I still enjoyed getting to know that group of students over the course of my practicum and the high-energy atmosphere that they all brought to every class.

CHAPTER 9

Conclusion

The entire experience of my student teaching at Doherty Memorial High School was an eye-opening and incredibly valuable step forward towards my goal of become a professional high school mathematics teacher. I gained insight into the challenges and rewards of educating a wide variety of students at an urban high school, and I do not think that I could have acquired this knowledge in any way other than being as fully immersed in the classroom as I was. Renah, Professor Goulet, and the Doherty community gave me priceless resources and wisdom to draw upon as I continue in my journey towards my eventual goal, and I cannot thank them enough for their support and guidance.

I believe that I have achieved competence in the five professional standards for teachers and that I am prepared to move ahead towards completing the requirements necessary for teachers in Massachusetts. Through the lesson plans, resources, and assessments that I have generated, I planned a robust and sound curriculum for the students in all of my classes. I then delivered effective lessons to my students using a variety of teaching techniques and informal and formal assessment methods. As I taught, the classroom climate that I maintained was set up to enable learning and encourage students to put forth their best effort and behave within the appropriate classroom standards. I gave every student an equitable opportunity to succeed in their studies, and applauded any student who put forward an honest effort and participated in the learning process. Finally, I followed all legal, ethical, and moral responsibilities outlined and expected of teachers, and did my best to foster a love of mathematics in my students. With those achievements in mind, I believe that I truly met every standard of professional teachers, and am ready to move forward in my quest of becoming a high school mathematics teacher.

Appendices

Appendix I: Resources

Section A: Algebra II Year-Long Outline Sample

Quarter 3

Chapter 5

Section 5.4 Factor and Solve Polynomial Functions

A.SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★ Factor a quadratic expression to reveal the zeros of the function it defines.

Section 5.5 Apply the Remainder Theorem

Understand the relationship between zeros and factors of polynomials.

A.APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by × – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

Section 5.6 Rational Zeros

A.APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. (+)

Section 5.7 Apply the Fundamental Theorem of Algebra

C.NC.9 9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Note: (+) standards are included to increase coherence but are not necessarily expected to be addressed on high stakes assessments.

Section 5.8 Analyze and Graph Polynomial Functions

F.IF.7.C Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Section 5.9 Write Polynomial Functions and Models
This section will assist in addressing the Modeling Component for the previous
standards.★
**Chapter 8 (This seems to be a supporting standard, therefore, cover only if time
allows)**
F.IF.7.D (+) Graph rational functions, identifying zeros and asymptotes when suitable
factorizations are available, and showing end behavior. 1
Section 8.2 Graph Simple Rational Functions
Section 8.3 Graph General Rational Functions
A.APR.D.7 (+) Understand that rational expressions form a system analogous to the
rational numbers, closed under addition, subtraction, multiplication, and division by a
nonzero rational expression; add, subtract, multiply, and divide rational expressions.
Section 8.4 Multiply and Divide Rational Expressions
Section 8.5 Add and Subtract Rational Expressions
Section 8.6 Solve Rational Expressions
**Note: (+) standards are included to increase coherence but are not necessarily
expected to be addressed on high stakes assessments.**

Section B: Pre-Calculus Year-Long Outline Sample

I. 3.3 Properties of Logarithm

A. Change of Base

1. Common Log

2. Natural Log

B. Properties of Logs (Expanding and Condensing)

1. Product Property

2. Quotient Property

3. Power Property

II. 3.4 Solving Exponential and Logarithmic Equations

A. Solving Simple Exponential and Logarithmic Equations

B. Solving More Complex Exponential (*Depending on the lesson, I would skip solving an exponential in quadratic form)*

C. Solving More Complex Logarithmic Equations

D. Check for Extraneous Solutions

E. Application Problems

III. 3.5 Exponential and Logarithmic Models

A. Review the 6 different Models and their Graphs

1. Discuss why each graph is shaped the way it is in everyday terms.

2. For example the Logistic Growth Model is shaped such because it models populations that have initial rapid growth, followed by a declined growth. One example could be the population that has iPhones or that have Facebook accounts.

B. Applications (The objective here is for students to be given a model and algebraically derive an answer that is reasonable given the domain (if provided)

IV. We are not covering 3.6

THIS CONCLUDES CHAPTER 3

V. 4.1 Radian and Degree Measure

A. Defining Terms

1. Initial and Terminal Side

2. Standard Position

3. Positive and Negative Angles

4. Radian and Degree

5. Coterminal Angels

B. Sketching and Finding Coterminal Angles

C. Converting From Degrees to Radians

D. Converting From Radians to Degrees

E. Complement and Supplement

F. Linear and Angular Speed

VI. 4.3 Right Triangle Trigonometry (*This is out of sequence)*

A. Right Triangle Definitions of Trigonometric Functions

B. Evaluating Trigonometric Functions

C. Evaluating Trigonometric Functions with Special Right Triangles, 45-45-90 and 30-60-90

D. Trigonometric Identities and Applications of Identities

VII. 4.2 Unit Circle

A. What is the unit circle? Why is it called the Unit Circle?

B. 6 Trigonometric Functions (start with the sine, cosine and tangent…then introduce the reciprocals)

C. Evaluating Trig Functions [on the Unit Circle] *See Kathleen for Unit Circle Dance activity if you wish

D. Period and Domain of Sine and Cosine

E. Using Period to Evaluate Sine and Cosine

VIII. 4.4 Trigonometric Functions of Any Angle

A. Evaluating Trigonometric Functions

B. Quadrant Angles

C. Reference Angles

D. Trigonometric Functions of Non Acute angles

E. Using Trigonometric Identities

IX. 4.5 Graphs of Sine and Cosine Functions

A. Parent Graphs for Sine and Cosine Functions (*Emphasize the similarities between these shifts and the shifts in other functions they have encountered)*

1. Vertical Shift

2. Vertical Stretch (amplitude)

3. Horizontal Shift (Phase Shift)

4. Horizontal Shrinking/Stretching (Period Change)

B. Graphing an Trigonometric Function

C. Writing and Equation

Appendix II: Lesson Plans

Section A: Sample Pre-Calculus Lesson Plan

Date	Objective	Do Now	Class Activities	Homework

Monday, 3/17/14 C Day	SWBAT define important vocabulary terms about angles, find coterminal angles, and convert between degrees and radians.	Draw a 30 degree angle on the board, on a straight line. Ask students to find the supplement of the 30deg angle. Answer: 150deg	• Review Do Now
			• Introduce angles using folded piece of paper
			• Write important vocabulary terms on the board
			  ○ Angle
			  ○ Initial side
			  ○ Terminal side
			  ○ Vertex
			  ○ Standard position
			  ○ Positive/negative angles
			  ○ Radians
			• Go over converting from radians<->degrees
				Page 262 #47-53 odd

Tuesday, 3/18/14 D Day	""	Write 150deg in radians.
		
		Answer: 5pi/6 radians
			• Go over Do Now
			• Go over Homework
			• Review vocabulary and conversion with closed notebooks
			• Introduce placing angles in proper quadrants
			  ○ First label quadrants with degrees and have them practice placing
			  ○ Then label with radians, have them practice placing
			  ○ Have students come up to the board to sketch angles
				Page 261 #13-23 odd

Wednesday, 3/19/14 A Day		Write 7pi/6 in degrees. Answer: 210deg	• Go over Do Now
			• Go over homework
			• Define coterminal angles
			  ○ Write definition on board
			  ○ Brainstorm some coterminal angles in degrees
			  ○ Introduce how to find coterminal angles in radians
				Page 261 #25-28

Thursday, 3/20/14	""	Find a positive coterminal	• Go over Do Now • Go over homework	Study for Chapter 3 Test

F Day		angle of 3pi/2 Answer: 7pi/2	• Practice quiz	
Friday, 3/21/14 E Day	“”	N/A	Test on Chapter 3	N/A

Section B: Sample Algebra II Lesson Plan

Date	Objective	Do Now	In Class Activities	Homework

Monday, 4/7/2014	SWBAT use the Fundamental Theorem of Algebra to construct polynomials, and Descartes' Rule of Signs to classify zeros.	Write a polynomial of least degree with zeros -1, 2, and 4.
		
		Answer: x^3-5x^2+2x+8
			• Go over Do Now
			• Finish examples on how to construct polynomials from zeros
			  ○ P3: finish Ex3; P4: pg381 GP 8
			• Go over Descartes' Rule of Signs
			  ○ We use Descartes' RoS to classify possible zeros. We need to know this so that we know where to look for zeros
			  ○ Do pg 382 Ex 4
			  ○ Have students make tables for GP #9,10
				Page 384 #30-36 even
				Bring graphing calculators if you have them

Tuesday, 4/8/2014	""	Write a polynomial of least degree with zeros 2 and *i*.
		
		Answer: x^3-2x^2+x-2
			• Go over Do Now
			• Go over Homework
			• Review Descartes' RoS
			  ○ Have students do another practice example
			  ○ Make sure they know how many rows to put in the table
				Page 384 #35-39 odd

Wednesday, 4/9/2014	SWBAT use equations of polynomials to deduce key behavior, and translate that behavior into a graph	Evaluate: $(2-3i)-(6-5i)$
		Answer: $-4+2i$
			• Go over Do Now
			• Go over homework
			• Do demo of how to find zeros of a polynomial after graphing
			  ○ Use pg 382 Ex 5, using DRoS before graphing
			  ○ Have students do GP pg383 #11
			  ○ As time permits, do pg 383 Ex 6
				Page 384 #53-55

Thursday, 4/10/2014			• Go over Do Now • Go over Homework • Review constructing polynomials, finding	Study for Quiz

			zeros, different terminology, Law of complex conjugates, law of irrational conjugates, DRos	
Friday, 4/11/2014		N/A	Quiz Section 5.7 and beginning of 5.8	N/A

Section C: Sample Pre-Calculus Lesson Plan

Day	*Objectives*	Do Now	Class Activities	Homework

Monday, 3/3/14	**SWBAT** apply properties of logarithms to expand and condense expressions and solve equations. Use the terms "expand" and "contract" when describing their steps for solving equations. Look for: using expansion when terms are being multiplied/divided, and contraction when terms are being added/subtracted, recall of previous properties to solve equations, using exponentiation only when expression is contracted.	Evaluate: 2*log(5)+log(4) Answer: 2	• Review Do Now
			• Review Homework (pg 207 #49-61 odd) by calling students up to board
			• Go over the condensing that was done in Khan Academy
			  ○ log(3)+log(2)=log(6)
			  ○ log(25)-log(5)=log(5)
			  ○ 2log(3)=log(9)
			• Now go over simplifying expressions using condensing
			  ○ Use Condensing Logs Practice Problems LHS as examples and practice. Use 2 from easy section, 2 from medium section.
			• We just need to remember exponentiation, and then we can solve equations
			  ○ Step 1: Condense each side into 1 log
			  ○ Step 2: Exponentiate both sides
			  ○ Step 3: Solve for the variable
				Pg 208, #69-80 all

Tuesday, 3/4/14	""	Solve for x: Log(x-2)-log(8)=1 Answer: x=82	• Review Do Now • Review Homework by calling students up to the board • Pass out Unscrambling Logarithms and calculators. Do 1 or 2 problems as examples, then have them get into Clock Buddies to finish the worksheet	**3.2 and 3.3 Homework Worksheet**
Wednesday, 3/5/14		Find the domain and range of y=log(x-1)+5 Answer: Domain=x>1, Range=**R**	• Review Do Now • Review Homework by calling students up to the board • Human Memory Model (pg 208, #108) ○ Pass out calculators, have students use the calculators to graph the function, find domain	**N/A**

			and range ○ Follow the questions in the book, having students use calculators to help find answers	
Thursday, 3/6/14	**“”**	Solve for x: $Log_8(-3x)-log_8(3)=2$ Answer: x=-64	• Review Do Now • Pass out Practice Test, give them class time to work on it	**Study for 3.1 and 3.2 Quiz**
Friday, 3/7/14		**N/A**	**Quiz**	**N/A**

Appendix III: Classroom Materials

Section A: Sample Algebra II Quiz Study Guide

Chapter 5.7 Summary

Vocabulary

- Repeated Solution Definition

  _____

- The _____ says that a polynomial of degree *n* will have exactly *n* solutions (factors/zeros/x-intercepts) when repeated, unique, real, and imaginary zeros are counted.
- Complex Conjugates Theorem

  _____

  _____
- Irrational Conjugates Theorem

  _____

  _____
- Descartes' Rule of Signs says that the number of *positive real zeros* is equal to

  _____
- Descartes' Rule of Signs says that the number of *negative real zeros* is equal to

  _____
- Descartes' Rule of Signs says that the number of *imaginary zeros* is equal to

  _____

Counting the Number of Zeros

The number of zeros of a polynomial is equal to _____

How many solutions does $x^3+5x^2+4x+20 = 0$ have? _____

How many solutions does $x^3-x+x^4-1 = 0$ have? _____

Practice Problems: pg 383 #3-9

Complex Numbers

In the number a+b*i*, the real part is _____, while the imaginary part is _____.

The complex conjugate of 2+3*i* is _____.

Add or subtract the following complex numbers:

(2-11*i*)+(5+6*i*) (2-11*i*)-(5+6*i*) (3+4*i*)+(10-13*i*) (3+4*i*)-(10-13*i*)

Practice Problems: pg 279 #12-20

Using Zeros to Make a Polynomial

Write a polynomial of least degree, with real rational coefficients, a leading coefficient of 1, and zeros of 4 and $1 + \sqrt{5}$.

Write a polynomial of least degree, with real rational coefficients, a leading coefficient of 1, and zeros of 3 and 3-*i*.

Practice Problems: pg #20-31

Descartes' Rule of Signs

Determine the number of positive real zeros, negative real zeros, and imaginary zeros of $f(x)=2x^4-8x^3+6x^2-3x+1$.

Determine the number of positive real zeros, negative real zeros, and imaginary zeros of $f(x)=x^3+2x-11$.

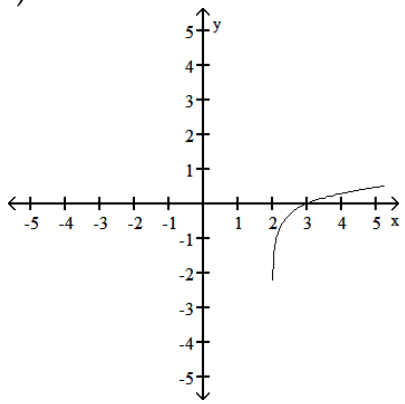
Practice Problems: pg 384 #34-41

Section B: Sample Pre-Calculus Practice Test

Pre-Calculus Practice Quiz
Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1)



A) y=log(x) B) y=log(x) -2 C) y=log(x-2) D) y=log(x+2)

2) What is the domain and range of the above graph?

A) Domain: All x, Range: y > 0 B) Domain: x > 3, Range: All y
C) Domain: x > 0, Range: y > 0 D) Domain: x > 0, Range: All y

SHORT ANSWER. Write your final answer on the line provided.
Evaluate or simplify the expression without using a calculator.

3) log 1000

4) log (1/1000)

Rewrite the following logarithms into either log base 10 or the natural log. DO NOT TRY TO FIND THE DECIMAL VALUE.

5) $\log_7 20$

6) $\log_{29} 353$

Use properties of logarithms to expand the logarithmic expression as much as possible. Where possible, evaluate logarithmic expressions without using a calculator.

7) $\log_5(7*11/13)$

8) $\log_b (yz^6)$

9) $\log_4$ sqrt(10x)

Use properties of logarithms to condense the logarithmic expression. Write the expression as a single logarithm whose coefficient is 1. Where possible, evaluate logarithmic expressions.

10) $\log_3$ (135) - $\log_3$(5)

11) $\log_c$(x) + $\log_c$ (y)

12) .5*log(8x) + log(8y)

Solve the logarithmic equation. Give the exact answer.

13) $\log_3$ (x - 2) = 1

14) $\log_3$ (x - 2) + $\log_3$ (x - 8) = 3

15) $\log_8$ 5 + $\log_8$ x = 1

Section C: Sample Algebra II Quiz

Name_____ **Period**_____

Identify the number of solutions or zeros.

1. $f(x) = 5x^3 - 6x^2 + 2x - 3$

Write the expression as a complex number in standard form.

2. $(4 - 3i) + (2 + 6i)$

3. $(-4 - i) - (4 + 5i)$

Write a polynomial function *f* of least degree that has rational/real coefficients, a leading coefficient of 1, and the given zeros.

4. $8,\ 2 + i$

Determine the possible numbers of positive real zeros, negative real zeros, and imaginary zeros for the function.

5. $h(x) = x^3 - 4x^2 + 5x + 9$

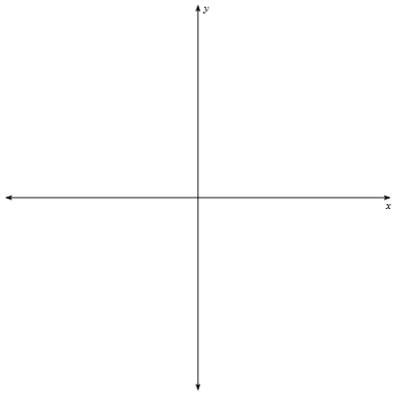
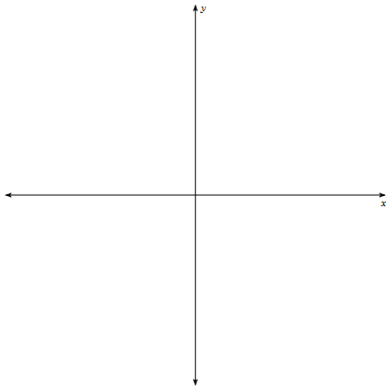
Section D: Sample Pre-Calculus Study Guide

Name:_____ Period:_____

Chapter 4.1 and 4.3 Test Study Guide

Chapter 4.1

Label the coordinate axes with:

Degrees	Radians
	

Degrees to Radians

To convert from degrees to radians, multiply the angle by _____.

Example: Convert 45° to radians

Practice Problems: page 262 #47-50

Radians to Degrees

To convert from radians to degrees, multiply the angle by _____.

Example: Convert $\frac{5\pi}{6}$ to degrees.

Practice Problems: page 262 #51-54

Complementary and Supplementary Angles

Complementary Angles: Definition

_____

_____

Supplementary Angles: Definition

_____

_____

Example: Find the complement and supplement of the following angles:

35° 95° $\frac{2\pi}{3}$ $\frac{\pi}{4}$

Practice Problems: page 262 #79-86

Coterminal Angles

To find a positive coterminal angle, I add _____° or _____radians. If my angle is still not positive, I _____.

To find a negative coterminal angle, I subtract _____° or _____radians. If my angle is still not negative, I _____.

Example: Find positive and negative coterminal angles of the following angles:

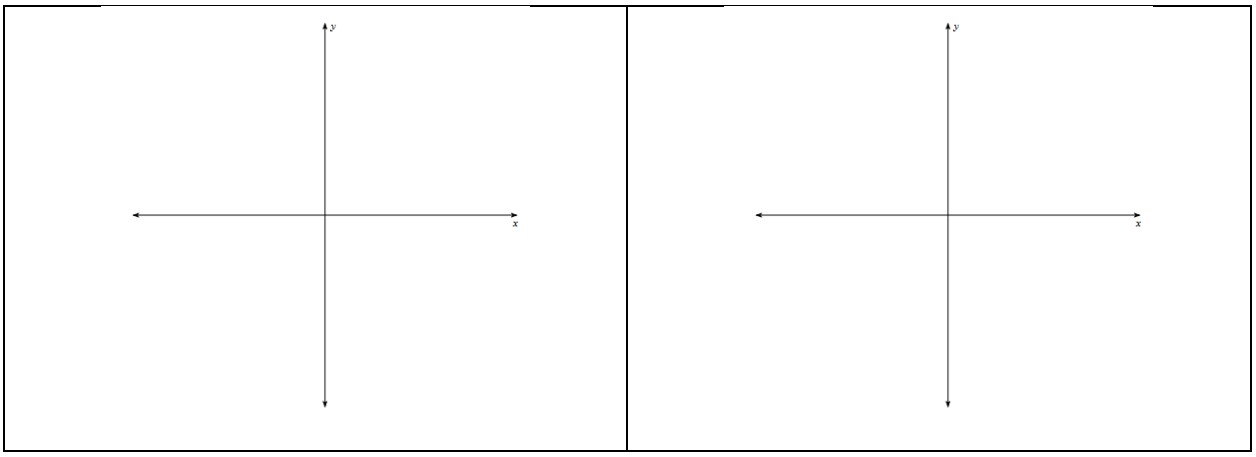
35° -400° $\frac{6\pi}{5}$ $\frac{-\pi}{3}$

Practice Problems: page 261 #25-28, page 262 #43-46

Drawing Angles

Example: Draw the following angles on the grids provided:

Positive 400° and Negative 400°	**Positive $\frac{2\pi}{3}$ and Negative $\frac{2\pi}{3}$**



Practice Problems: page 261 #19-24, page 262 # 37-42

Chapter 4.3

SOH-CAH-TOA

SOH-CAH-TOA stands for

_____.

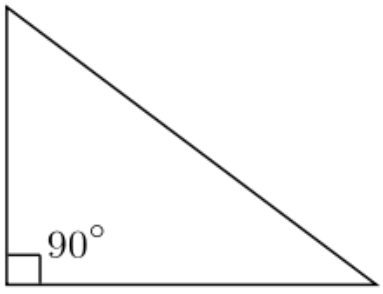
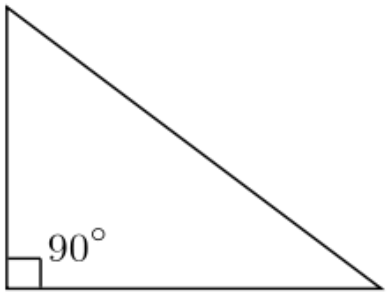
Match the trig function with its reciprocal:

Sin(θ)	Sec(θ)
Cos(θ)	Cot(θ)
Tan(θ)	Csc(θ)

Practice Problems: page 280 #1, 4-6

Special Triangles

Draw the following special triangles, and label their angles and side lengths:

45-45-90	**30-60-90**
	

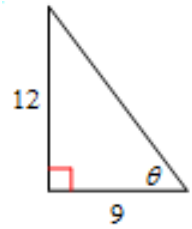
Fill in the following table, using the special triangles you drew above:

Angle	30°	60°	45°
Sin(θ)			
Cos(θ)			
Tan(θ)			

Practice Problems: page 280-281 #21-30

Using Right Triangles

Find the 6 trig ratios of θ.



Practice Problems: page 280 #7-10

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