A Study of the Relationship Between Teacher Characteristics and

Student Performance in High School Geometry

by

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Abstract

The purpose of this thesis is to investigate whether teacher characteristics, such as years of experience, degree level, degree type, certification type, race, or gender, impact student performance in high school geometry. Research has shown that each student's mathematical understanding and problem solving ability is primarily shaped by the teaching experiences they encounter in school (Mewborn, 2007). It is hypothesized that there are teacher characteristics that are associated with student growth, which is defined as the numerical score increase from pre-assessment to post-assessment. Teacher characteristic and student assessment data were collected from geometry teachers in a suburban western New York State school district; the data was then analyzed using statistics software to identify any statistically significant relationships between teacher characteristics and student growth means. Through empirical testing, it was found that a geometry teacher's years of experience, degree level, certification type, and gender all have an impact on student performance in high school geometry.

Chapter I- Introduction

The purpose of this thesis is to investigate whether objective teacher characteristics impact student performance in high school geometry. Objective teacher characteristics, such as years of teaching experience, gender, age, certification type, and education level, to name a few, are different than subjective teacher characteristics, such as pedagogical practices, teaching methods, and classroom management policies. There may be a relationship between, for example, the number of years of teaching experience and student performance in a high school mathematics course such as geometry. The goal of this research is to distinguish between various teacher characteristics and the effect that such characteristics may have on student geometry performance in a suburban Western New York school district. This is important because research has shown that each student's mathematical understanding and problem solving ability is primarily shaped by the teaching experiences they encounter in school (Mewborn, 2007). However, attempts in mathematics education research to understand the complexity of variables that influence teachers' instructional practices, and how these variables impact student performance, have been largely inconclusive (Mewborn, 2007).

Current descriptive research suggests that poor student performance in some core high school courses predicts a failure to graduate from high school (Clotfelter, Ladd, & Vigdor, 2009). Therefore, more research is needed to better understand what teacher characteristics affect student performance. If teacher credentials, experience, and teacher demographics impact how a student performs in high school geometry, then this research may inform policymakers and school administrators about teacher characteristics that are linked with higher student performance. One implication of this research is that it may help to guide a school district administrator to more informed hiring decisions. This and other similar research in the future

may be able to provide school districts with the information that is necessary to more confidently

hire teachers based on having a certain characteristic (i.e. holding a Master's degree in

mathematics, having more than ten years of teaching experience, prior experience teaching a

geometry course, etc.) or on the basis that a specific teacher characteristic is not associated with

better student performance. It would be unfortunate, for example, for a school district to exclude

all potential candidates for employment based on whether they meet a certain requirement or

accomplishment if research has not found that characteristic to have a significant impact on

student performance. As an overall goal, school district leaders, building administrators,

teachers, and other school personnel should desire for their students to be as successful as

possible and to reach their individual potential. It is known that quality teachers impact student

performance (Ackerman, Heafner, & Bartz, 2006; Rivkin, Hanushek, & Kain, 2005) and by

knowing which teacher characteristics positively or negatively affect students' performance in

geometry, school districts may be more informed about hiring quality teachers for one of the

required Carnegie units for high school graduation.

The Geometry Course

Geometry is a course that is set apart from other mathematics courses at the high school

level. Because many students begin to take the SAT test in tenth grade, or shortly thereafter,

geometry is frequently placed in the high school mathematics curriculum between Algebra I and

Algebra II with Trigonometry. This sequence is believed by policymakers to allow students to

gain a core mathematical background and earn a higher score on the SAT. Geometry provides

students an opportunity to make conjectures about various geometric situations and to prove,

both formally and informally, that their conclusion follows logically from their hypothesis.

Geometry is meant to lead students to an understanding that reasoning and proof are fundamental

aspects of mathematics and something that distinguishes it from the other sciences, including other mathematics courses (New York State Education Department, 2011).

Research Questions

This research is focused on the relationship between teacher characteristics and student performance in a geometry course. It is hypothesized that there are teacher characteristics that are associated with student performance and growth. Growth is defined in this research as the number of points that students increase their scores from the pre-assessment, given in September 2012, to the post-assessment, given in June 2013.

The two research questions that will be explored in this thesis are:

- Which geometry teacher characteristics, if any, are statistically significant in impacting student performance and growth?

- Are there objective geometry teacher characteristics that significantly impact student growth more than others?

The main goal of this research is to answer these questions using empirical testing in an educational setting. The findings may provide educators with answers to the research questions above and further the research scope on this topic. In the following chapter, a brief review and summary of existing literature will set the stage for the current research. Subsequent sections describe the methods, share and analyze the results, and discuss the implications of the findings.

Chapter II- Literature Review

It is not surprising that research on teacher characteristics and student performance has revealed that the students are substantially affected by the teachers they are assigned and that teacher quality can be related to student performance (Wayne & Youngs, 2003; Ackerman, Heafner, & Bartz, 2006). Research recognizes that the greatest determinant of student performance is the teacher; however, questions remain regarding which teacher characteristics, if any, are the most impactful (Ackerman, Heafner, & Bartz, 2006; Rivkin, Hanushek, & Kain, 2005). What is known is that each student's mathematical understanding and problem solving ability is primarily shaped by the teaching experiences they encounter while in school (Mewborn, 2007).

There has not been a consensus among researchers on the significance or effects of specific teacher characteristics such as teacher experience, teacher education, or other measurable teacher characteristics. In the grand scheme of education, empirical evidence does not find a strong place for teachers in the determination of students' academic performance. This may be because measurable characteristics such as those sought to be researched in this thesis do not provide adequate explanations for the variation in teacher quality (Rivkin, Hanushek, & Kain, 2005). However, it is assumed that teachers will inevitably add to student progress and growth from the pretest to the posttest, especially in mathematics since mathematics is mostly learned in school and may be more directly influenced by teachers. Perhaps this explanation can provide some insight as to why individual teachers, along with their respective characteristics, are associated so closely with student performance (Wayne & Youngs, 2003; Nye, Konstantopoulos, & Hedges, 2004).

Studies that simultaneously assess more than one teacher characteristic are more reliable than those studies that only assess one characteristic (Wayne & Youngs, 2003). In addition, it has been found that the effects of teacher characteristics are more prominent in mathematics than reading since mathematics is usually mostly learned in school; this indicates that mathematics teachers may more directly influence student achievement and growth because of how, how well, or how much teachers teach mathematics in the classroom (Nye, Konstantopoulos, & Hedges, 2004). Therefore, the premise of this proposed research is important; it will hopefully allow the researcher to identify which teacher characteristics significantly impact student performance in high school geometry. The following sections of the literature review will explore prior research regarding the relationship between a specific teacher characteristic and student achievement.

Teacher Experience

Teacher experience is an observable teacher characteristic that is commonly studied in order to find a possible relationship between student performance and the number of years that the teacher has been teaching (Rockoff, 2004; Ackerman, Heafner, & Bartz, 2006; Nye, Konstantopoulos, & Hedges, 2004; Clotfelter, Ladd, & Vigdor, 2010, Darling-Hammond, 2000; Rivkin, Hanushek, & Kain, 2005). In general, the results of these studies show that teacher experience does positively affect student performance; however, the relationship is not entirely linear, but rather there is a cutoff point where additional experience does not make a difference. Consequently, it has been found that any gains from increased experience often occur in the first five years of teaching (Rockoff, 2004; Ackerman, Heafner, & Bartz, 2006; Nye, Konstantopoulos, & Hedges, 2004; Clotfelter, Ladd, & Vigdor, 2010, Darling-Hammond, 2000). According to the Digest of Education Statistics (2008a), 12.8% of public school teachers in New York State had less than three years of experience, 38.0% had between three and nine years of

experience, 28.5% had between ten and 20 years of experience, and 20.6% of teachers had over 20 years of experience. Fairly consistent with the statewide public school percentages, the percentages of secondary mathematics teachers with a certain number of years of experience are as follows: 13.9% for less than three years, 36.4% for three to nine years, 29.5% for ten to 20 years, and 20.2% for over 20 years of experience (Digest of Education Statistics, 2008b).

Teacher Education

The details of a teacher's education are another teacher characteristic that has been researched in the past (Rivkin, Hanushek, & Kain, 2005; Angrist & Guryan, 2004; Goldhaber & Brewer, 1997). The level of teacher education and college major may play a role in affecting student performance in a high school geometry course. One aspect of teacher education programs that is often criticized is that the percentage of teachers that specialize in an academic subject (i.e. mathematics) rather than the field of education itself is quite low (Angrist & Guryan, 2004). There is controversy among academics regarding the value of teacher education programs; this may be partly due to the data that shows that the SAT scores of incoming college freshman into teacher education programs is 32 points lower than the average SAT score for all college bound seniors (Angrist & Guryan, 2004). Research suggests that mathematics teachers who have taken more mathematics coursework at the college level have students who score higher on mathematics tests (Ackerman, Heafner, & Bartz, 2006; Monk & King, 1994). As an example, there is controversy between mathematicians and educators regarding the idea that a teacher who holds an education degree with a focus in mathematics is, or is not, the same thing as a mathematics major who minors in education. There may be a relationship between the teacher's degree (mathematics vs. education) and student performance in high school geometry.

Under the same umbrella of teacher education, existing research finds conflicting results regarding a teacher's degree level. From 1971 to 1991, the percentage of teachers nationally that had a Master's degree almost doubled (Angrist & Guryan, 2004). According to the Digest of Education Statistics (2008a) there were a total of 228,100 public school teachers in New York State in 2008. Of these public school educators, 11.8% had earned a Bachelor's degree; the remaining percentage had earned a Master's degree or higher. Nationally, the percentage of public school teachers with a Bachelor's degree was 47.4%, 44.5% had a Master's degree, and the remaining teachers had earned a higher degree. A teacher having a Master's degree versus a Bachelor's degree may or may not relate to student performance on mathematics tests, specifically in geometry. On one hand, Ackerman, Heafner, and Bartz (2006) found that degree level is not significant in affecting mathematics achievement. On the other hand, a study by Goldhaber and Brewer (1997) found that mathematics students whose teachers had Master's degrees in mathematics had higher achievement gains than those teachers who did not have an advanced degree. It was also found that student achievement in mathematics is positively influenced by have a teacher who holds a Bachelor's or Master's degree in the field of mathematics (Goldhaber & Brewer, 1997). After an extensive review of existing research on this topic, Wayne and Youngs (2003) concluded that high school students learn more mathematics when their mathematics teachers have a Master's degree or higher in mathematics.

Teacher Certification

There are various pathways to gain teacher certification in a certain subject area, and all New York State (NYS) teachers are required to obtain a NYS teaching certificate in order to work in a public school. The most common pathway to certification is by earning an initial certificate, valid for five years, and then earning an advanced level certificate, called a

professional certificate. The professional certificate requires the teacher to obtain a Master's

degree and three years of teaching experience, which may be why such a large percentage of

NYS teachers hold a Master's degree as compared with other states (NYS Office of Teaching

Initiatives). There is very little research evidence that exists that explores the effectiveness of the

teacher certification and licensure system, in terms of how those teachers perform once

certification is obtained (Goldhaber & Brewer, 2000).

Teacher certification and licensure is an additional teacher characteristic that may affect

student performance in high school mathematics. For example, students having teachers with a

professional certificate may outperform students whose teachers hold an initial certificate;

however, there is no guarantee that this is the case (Goldhaber & Brewer, 2000). In Texas, school

districts that employ teachers who earned a higher average score on standardized certification

assessments have higher student performance in mathematics (Ferguson, 1998). In a national

study, the findings show that students whose teachers hold a standard or professional

certification in their field have 12th-grade mathematics test scores that are seven to ten points

higher than the students whose teachers hold an initial or emergency certification (Goldhaber &

Brewer, 2000). Evidence such as those mentioned suggests that teacher licensure requirements

can affect student outcomes.

Teacher Race and Gender

The issue of whether the demographic interactions between students and teachers actually

matter has not been extensively researched. The infrequent results of these previous studies have

been contradictory and there is no consensus on whether a student placed in a class with a same-

sex or same-race teacher makes any difference at all (Dee, 2005). A student's assignment to a

same-gender or same-race teacher could be educationally relevant since it could affect student

engagement or behavior, ultimately influencing student performance in the course (Dee, 2006).

In studies by Ehrenberg, Goldhaber, and Brewer (1994) and Ackerman, Heafner, and

Bartz (2006), strong evidence was found that teacher's race and gender do not play a statistically

significant role in student performance. However, if indeed the teacher's gender and race do

affect student performance, one explanation involves a teacher's "passive" teacher effects, which

are activated solely by a teacher's racial or gender identity, not attributed to specific teacher

behaviors (Dee, 2005). A teacher's race and gender are more likely to influence teachers'

subjective evaluations of their students than they are to influence how much their students

objectively learn (Ehrenberg, Goldhaber, & Brewer, 1995). Student performance may be affected

by teacher race and gender when a demographically similar teacher is able to raise a student's

academic motivation and expectations (Dee, 2005). This is called the "role model" effect (Dee,

2005, 2006).

Chapter III- Methods

Sample

This research took place in a high school that enrolls about 1,600 students in grades nine through twelve. The geometry students whose scores have been analyzed for this research are mostly tenth graders; however, ninth grade and eleventh grade students who took the geometry course during the 2012-2013 school year are also included. The professional staff in the building consists of over 110 teachers, with the remaining staff members as teacher's aides, paraprofessionals, assistant principals for each grade level, and one building principal. The math department consists of thirteen full time teachers, of which seven teach the geometry course. This New York State high school has been teaching the same geometry curriculum since the 2008-2009 school year. The school year consists of 180 school days, each day being comprised of eight, forty-six minute class periods.

This study consists of seven high school geometry teachers, each who holds a faculty position in the mathematics department at the same suburban high school in western New York State. Each teacher was asked to participate in two different capacities. Firstly, teachers would agree to allow student pre-assessment and post-assessment scores to be shared with the researcher and, secondly, teachers would complete a short questionnaire. Potential participants would review a statement of informed consent, seen in Appendix A, at the beginning of the study to notify them of the objectives and procedures for the research. In the consent document, potential participants were informed that they were under no obligation to participate in this research and may exercise that option by not completing and/or not returning the questionnaire. Each of the seven geometry teachers then agreed to the district providing the researcher with

existing pre-assessment scores for their respective students, along with existing New York State

Geometry Regents exam data for the 2012-2013 school year.

The pre-assessment, as seen in Appendix B of this paper, was given to each of the

students enrolled in a geometry class with one of the teachers in the sample. The test was given

and completed in September 2012 and was made up of ten multiple-choice questions and four

open-ended questions. The pre-assessment questions were designed regionally to confidently

represent a subset of the content that would be tested on the post-assessment, the NYS Geometry

Regents exam that was given in June 2013. The post-assessment, as shown in Appendix C, was

designed and administered by New York State and consisted of 28 multiple-choice questions and

ten open-ended questions. Therefore, the student data that was used for this research consisted of

pre-assessment and post-assessment data for each geometry student in this particular school

district. Although test scores do not capture nearly all of the aspects of student learning and

student performance, they are valuable pieces of quantitative data. Test scores were used in this

study because they are widely available, objectively scored, and are generally recognized as

important indicators of student achievement by teachers, school administrators, policymakers, as

well as the public (Rockoff, 2004).

Data Collection

Data collection began shortly after the Institutional Review Board (IRB) and school

district administrators approved the research proposal. The school district provided September

2012 pre-assessment scores and June 2013 Regents exam scores for geometry students who

began and ended the school year with the same teacher. Controls were made to ensure that the

only performance scores that were included in the study were from students who had both pre-

assessment and post-assessment scores while enrolled in the geometry course with the same

teacher from start to finish. For example, the study excludes students whose schedule required them to switch geometry teachers between the pre- and post-assessments. Similarly, students who chose not to attend the final exam in June were excluded due to the absence of post-assessment data. In total, there were 229 students whose performance scores were gathered; students' scores were then paired with their respective geometry teacher for analysis. The assessment data was provided with no student names or identifiers, other than gender. Of the 229 pieces of student data, 113 were male students and 116 were female students.

In order to gather the teacher characteristic data, a short questionnaire (Appendix D) was distributed via e-mail to the geometry teachers in the school district. The questionnaire asked questions regarding teacher characteristics that were self-reported on the survey. The questions were chosen because they referenced objective teacher characteristics as opposed to subjective ones, like pedagogical practices, teaching methods, classroom management, etc. Once the teacher characteristic questionnaires were returned to the researcher through e-mail, the responses were linked with the existing pre-assessment and post-assessment scores using the individual teacher's last name. Then, teacher names were removed and were subsequently referred to as Teacher 1 (T1), Teacher 2 (T2), etc.

Data Analysis

Because of the difficulty of randomization in educational studies, the research design that has been most convincing in this type of research has been a nonrandomized quasi-experimental design. This design allows researchers to reduce the potential for alternative explanations by accounting for prior achievement using test scores and student background characteristics (Wayne & Youngs, 2003). Because student achievement and performance is a cumulative function of various family, community, and school experiences, the study of the entire process of

student achievement would require an in-depth analysis of all dimensions of a child's life: family, academic, social, and community histories (Rivkin, Hanushek, & Kain, 2005). This extensive set of data is rarely, if ever, accessible and therefore, research involving student performance is susceptible to a slew of bias stemming from omitted variables (Rivkin, Hanushek, & Kain, 2005).

A "value-added" model, which considers prior academic achievement as a factor for future performance, is frequently used to attempt to minimize the likelihood of specification bias in this type of research (Rivkin, Hanushek, & Kain, 2005; Wayne & Youngs, 2003; Goldhaber & Brewer, 2000). After controlling for prior achievement, resulting classroom differences in achievement and growth are considered a reflection of teacher quality, since the most obvious factor that differs among classrooms is the teacher (Rivkin, Hanushek, & Kain, 2005). In a Summers and Wolfe study in the 1970's, one strength is that the authors controlled for a large number of additional variables in order to focus on the teacher characteristic being studied. Being able to control for certain other factors, such as student attendance or disciplinary atmosphere, can help increase the likelihood that researchers can pinpoint the specific characteristic that affects student performance in the classroom (Wayne & Youngs, 2003). Otherwise, the results of the study may be subject to various interpretations, deeming the results inconclusive and misleading. Because the data set for this research does not include prior student achievement scores or other information about the students, other than gender, growth is defined as the number of points that students increase their scores from the pre-assessment to the post-assessment. The focus is on if, and to what degree, the objective geometry teacher characteristics affect student performance.

Each of the 2,977 cells of data was entered into IBM's statistics program SPSS, a predicative analytics software. The spreadsheet includes 229 rows, each representing one geometry student, and thirteen columns, each representing a specific category. The first column shows the teacher who was assigned to teach the child: T1, T2, T3, etc. Student gender is represented using zeroes and ones in the second column. The third and fourth columns show each individual student's pre-test score and post-test score out of 100 points, while the fifth column shows student growth, found by subtracting the student's pre-assessment score from the post-assessment score. The subsequent columns show the characteristics associated with the teacher listed in column one: education (public or private), degree level (Bachelor's, Master's, or higher), degree type (education degree or mathematics degree), certification level (initial, temporary, or professional), gender (male or female), age (number of years), experience (number of years), and experience specifically teaching a geometry course (number of years).

Chapter IV- Results

Teacher Experience

The analysis of the data set began with a focus on the potential significance that the number of years of teaching experience has on student growth in high school geometry. Teacher experience numbers from the data set were recoded, as shown in Table 1, in order to compare the current set of data with the research findings as discussed in the literature review. In general, the results of previous studies on this topic show that any gains from increased experience often occur in the first five years of teaching (Rockoff, 2004; Ackerman, Heafner, & Bartz, 2006; Nye, Konstantopoulos, & Hedges, 2004; Clotfelter, Ladd, & Vigdor, 2010, Darling-Hammond, 2000). In order to test the hypothesis that geometry teachers have students who show more achievement gains in their first five years of teaching compared with student achievement after their five years of experience, student test scores would be needed for all of the first five years of a teacher's

Table 1
Comparison of student growth means in high school geometry based on teacher's years of experience

Number of years of teacher experience	Original coding	Final coding for analysis	Mean
1-2	1	0	n=46
3-4	2	0	61.87 (12.930)
5-6	3	1	
7-8	4	1	
9-10	5	1	
11-12	6	1	n=183
13-14	7	1	57.34 (11.084)
15-16	8	1	
17-18	9	1	
19+	10	1	

career. Since the current data set for this research only includes one year of student growth

scores, we compute the means of student growth for teachers with less than five years of

experience and teachers with five or more years of experience.

The means were compared using an independent samples T-test assuming equal

variances. It was to be determined whether there was a significant difference in the means of

student growth based on teacher experience. The t-value given was 2.394 and the p-value was

0.017 in a two-tailed test. These results show that students who had teachers with less than five

years of experience showed more growth in geometry than students whose teachers had five or

more years of experience, and that this effect did not occur by random chance. However, because

only one of the teachers in this research had less than five years of experience, the results may

not be solely due to years of experience.

Teacher Education

The relationship between student growth in geometry and teacher education is also

explored in this research. The level of teacher education (Bachelor's, Master's, or higher) and the

teacher's declared major (education or mathematics) may affect student growth in high school

geometry. Student growth means were compared for teachers who had a Bachelor's degree

versus a Master's degree. In the sample used for this research, there were no teachers who held a

degree higher than a Master's. Table 2 shows the data used in an independent samples T-test.

The same results were found as above in the teacher experience test; students whose geometry

teacher held a Bachelor's degree showed more growth than students whose geometry teacher

held a Master's degree. The similar results to the teacher experience test may be due to the fact

that the one teacher in the current sample who had less than 5 years of experience was also the

same teacher who held only a Bachelor's degree.

Table 2
Comparison of student growth means in high school geometry based on teacher's degree level

Bachelor's degree	Master's degree
n=46	n=183
61.87	57.34
(12.930)	(11.084)

The next comparison was whether or not there was a statistical difference in student growth between students whose teacher had a degree in the field of mathematics as opposed to a degree in the education field. Table 3 shows the student growth means for this comparison. When an independent samples T-test was completed for this data, with equal variances assumed, we found a t-value of -0.573 and a p-value of 0.567. These results indicate that there was no significant difference in growth between the students whose teachers held a mathematics degree and those whose teachers held an education degree.

Table 3
Comparison of student growth means in high school geometry based on teacher's degree type

Mathematics degree	Education degree
n=105	n=124
57.77	58.65
(11.584)	(11.631)

We also sought to find a possible relationship between student growth and the type of institution, public or private, from which the geometry teacher earned his/her degree. Table 4 shows the student growth means for students whose geometry teacher holds a degree from one of these two types of universities. An independent samples T-test was conducted using these means, and a t-value of -1.309 and a p-value of 0.192 were found. This indicates that there is no significant difference in student growth based on the type of institution that the teacher attended.

Table 4
Comparison of student growth means in high school geometry based on teacher's institution type

Public	Private
n=98	n=131
57.09	59.11
(11.547)	(11.594)

Teacher Certification

In the sample used for this research, five of the teachers had a professional certification and one had an initial certification. The one teacher with the initial certification is the same teacher who had less than five years of experience and a Bachelor's degree. Therefore, the student growth means for geometry teachers with a professional certificate versus an initial certificate, shown in Table 5, are the same as in the previous sections. The results indicate that students whose geometry teacher held an initial certificate showed more growth than students whose teacher held a professional certificate.

Table 5
Comparison of student growth means in high school geometry based on teacher's certification level

Initial Certificate	Professional Certificate
n=46	n=183
61.87	57.34
(12.930)	(11.084)

Teacher Race and Gender

This research also investigated whether a significant difference exists in student growth based on teacher race and gender. Since there was little to no racial diversity amongst the geometry teachers in the district that was used for this research, there are no results or

conclusions for student growth based on teacher race. However, in this sample, four of the

geometry teachers are male and two are female. Table 6 shows student growth means for

students whose geometry teacher was male and students whose geometry teacher was female. An

independent samples T-test, with equal variances not assumed, showed a t-value of -2.345 and a

p-value of 0.020. This p-value indicates a significant difference in student growth for students

who were taught by male teachers versus female teachers. The research finds, according to the

current data set, that female teachers have geometry students who showed more growth during

the school year than the male teachers.

Table 6

Comparison of student growth means in high school geometry based on teacher gender

Male teacher	Female teacher
n=143	n=86
56.79	60.67
(10.368)	(13.089)

The research also determined to investigate the possible relationship between student

gender and teacher gender with regards to student growth. The relationships that are established

are male student with a male teacher, male student with a female teacher, a female student with a

male teacher, and a female student with a female teacher. Table 7 shows the student growth

means for these four relationships. A chi-squared test is used to determine the potential statistical

significance of this information. The chi-squared statistic value is 0.748 which renders a non-

statistically significant result. Therefore, there was no significant difference in student growth

scores based on student-teacher gender relationships.

Table 7

Comparison of student growth means in high school geometry based on student-teacher gender relationships

		Teacher Gender	
		Male	Female
Student Gender	Male	n=70 56.70 (9.773)	n=43 58.91 (13.315)
	Female	n=73 56.88 (10.975)	n=43 62.44 (12.770)

Chapter V- Conclusions

Limitations

After seeking and gaining participation from geometry teachers in the school district used in this study, it was known that the teacher sample size for the research was fairly small. Because one of the geometry teachers in the school district only taught geometry classes that included students needing the extra support of a consultant teacher, it was requested that the individual geometry teachers' data, along with student assessment scores, be excluded from the study. This decreased the teacher sample size to six geometry teachers. Even within the small sample size, there was little diversity when it came to certain teacher characteristics, such as race. The lack of diversity in some areas provided too little information to draw conclusions about that particular teacher characteristic.

Another limitation in research that involves test scores is that when the data is linked to a specific teacher, teacher approval must be given in order to release his or her students' pre-assessment and post-assessment scores. Not all teachers would be likely to share "personal" numerical data that could ultimately be used to support a negative result, such as proving teacher ineffectiveness or showing that one teacher had students who indicated significantly less growth than another individual who holds the same faculty position. At a time when curriculums, mathematics standards, and teacher evaluations are changing, and significant controversy surrounds those changes, teachers may be hesitant to subject themselves to potential criticism.

Another weakness may be that the only student assessment data that could be collected for this research was pre-test and post-test scores. The high school that was used for this study does not currently use common assessments throughout the school year for the various units of study, nor did the school enact other formative assessment techniques that would allow for a closer study of student performance and growth in geometry throughout the entire school year.

Although test scores are valuable pieces of information that can indicate student performance, using state standardized test scores may not adequately show student learning. Since standardized tests may not always assess the content that is actually taught in a given school, a test score may not show student gains when growth is actually occurring (Marzano, 2003). Teachers may interpret the curriculum in different ways, which may guide their instruction in varying ways; in this way, the state Regents exam may not assess what was specifically taught in the classroom.

Discussion

Using the current set of data, which can be generalized to similar, suburban school districts in western New York State, one of the research questions posed earlier has been answered. The first research question asked which geometry teacher characteristics, if any, are statistically significant in impacting student performance and growth. Through empirical testing, it has been found that a teacher's years of experience, degree level, certification type, and gender all have an impact on student performance in high school geometry. These results are surprising and counterintuitive since they indicate that teachers with fewer years of experience, a lesser degree level, and a less permanent certification have students who show more growth in geometry than those teachers with more years of experience, a higher degree level, and a more permanent teaching certificate. However, the number of teachers with these objective characteristics was comparatively small, so, at best, the conclusion that can be made is that more research is needed in this area. The result that teacher gender affects student performance at a significant level is also important; it indicates that female geometry teachers have students who show more growth than male teachers. However, more research is needed in this area before any conclusions can be generalized.

The second research question asked whether there are objective geometry teacher characteristics that significantly impact student growth more than others. Since the results were identical for several of the tests, we cannot conclude whether one of the teacher characteristics was more impactful on student growth in geometry than another characteristic. Therefore, the second research question is not fully answered. With continued research, the findings may be solidified and it may be found that there are teacher characteristics that have more of an impact on student performance than others.

Opportunities for future study

Quantitative studies provide information about specific areas that need more research. In the future, there are countless opportunities for further study on this topic. Given a larger, more diverse teacher sample size and data set, there would be much to discover regarding the possibility of certain teacher characteristics predicting or impacting student performance. Also, given multiple years of student performance data, one could track student performance as it relates to teacher characteristics throughout consecutive years. In addition to high school geometry, there are other core mathematics courses such as algebra I, algebra II, trigonometry, pre-calculus and calculus that may provide similar or unique results when teacher characteristics are compared with student performance and growth. This research intentionally focused solely on geometry due to its uniqueness in the high school mathematics curriculum; however, there are many topics left unexplored.

There may also be opportunities to explore the relationship between teacher pedagogy and student performance, which would be considered a subjective teacher characteristic. This research explored how objective teacher characteristics may or may not predict student performance in high school geometry. This research lacks any exploration of *how* the teachers

teach the geometry content, which may also play a role in student performance. From one classroom to another, there may be significantly different instructional emphases, expectations for students, or classroom management techniques. For example, one existing study found that a geometry teacher who places an instructional emphasis on spatial visualization and requires the drawing of a diagram for each and every geometry problem had students who performed better on a geometry test than a teacher who only encourages students to draw a diagram (Battista, 1990). Researching how and how well a geometry teacher can teach the course would be an interesting topic to further explore.

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Appendix A

Statement of Informed Consent

The purpose of this action research project is to determine whether there is a correlation between teacher characteristics and student performance in high school geometry. Teacher characteristics include number of years of experience, gender, age, race, years of geometry experience, certification type and/or education details. This research study is being conducted in order for the researcher to fulfill the final Master's degree requirement in the Department of Education and Human Development at The College at Brockport, SUNY.

In order to participate in this study, your informed consent is required. You are being asked to make a decision whether or not to participate in the project. If you want to participate in the project, and agree with the statements below, your completion of the questionnaire indicates your consent. <u>You may change your mind at any time and leave the study without penalty, even after the study has begun.</u>

This project has been approved by SUNY College at Brockport's Institutional Review Board. Approval of this project only signifies that the procedures adequately protect the rights and welfare of the participants. Please note that absolute confidentiality cannot be guaranteed due to the limited protections of Internet access.

I understand that:

1. My participation is voluntary and I have the right to refuse to answer any questions.
2. My confidentiality is protected. In any publication results from this research, I would not be identified by name.
3. There will be no anticipated personal benefits because of my participation in this project. There is a minor risk in the time that it takes to complete the questionnaire.
4. My participation involves reading an electronic questionnaire of 10 questions and answering those questions. It is estimated that it will take no more than 5 minutes to complete the questionnaire.
5. The answers to this questionnaire are important because in order to interpret students' assessment results in the intended manner, your answers will be linked with the numerical data from your 2012-2013 geometry students.
6. Approximately ten people will take part in this study. The results will be reported in aggregate form only. The research is being conducted to fulfill a final Master's thesis requirement and will be submitted to Digital Commons at The College at Brockport, SUNY.
7. Data will be kept on a password protected computer and will be erased when the research has been completed.

I am 18 years of age or older. I have read and understand the above statements. All my questions about my participation in this study have been answered to my satisfaction. I agree to participate in the study realizing I may withdraw without penalty at any time during the process. Submitting the questionnaire indicates my consent to participate.

If you have any questions you may contact:

Student Researcher: Faculty Advisor:
Amie Ellerhorst   Dr. Carol Wade
(585) 750-6817   (585) 395-5569
amie_ellerhorst@gateschili.org   cwade@brockport.edu

Appendix B

September 2012 Geometry pre-assessment

Part I

Answer all 10 questions in this part. Each correct answer will receive 2 credits. No partial credit will be allowed. For each question, write on the separate answer sheet the numeral preceding the word or expression that best completes the statement or answers the question.

1. Which equation represents the circle whose center is $(-2,3)$ and whose radius is 6?
   1. $(x-2)^2 + (y+3)^2 = 6$
   2. $(x+2)^2 + (y-3)^2 = 6$
   3. $(x+2)^2 + (y-3)^2 = 36$
   4. $(x-2)^2 + (y+3)^2 = 36$

2. What is the distance between the points $(-2,-2)$ and $(2,-4)$?

   1. $2\sqrt{2}$
   2. $2\sqrt{3}$
   3. $5\sqrt{2}$
   4. $2\sqrt{5}$

3. In plane R, lines d and f intersect at point A. If line k is perpendicular to line d and line f at point A, then line k is

   1. contained in plane R
   2. parallel to plane R
   3. perpendicular to plane R
   4. skew to plane R

4. In the diagram below of circle O, chords $\overline{AB}$ and $\overline{CD}$ intersect at E.
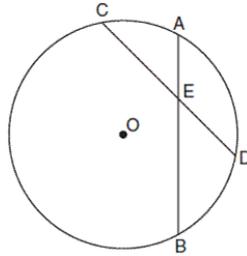
If $CE = 8$ $ED = 6$, and $AE = 4$, what is the length of $\overline{EB}$?

1. 16
2. 12
3. 10
4. 6

5. Which statement is true about every parallelogram?
    1. opposite angles are congruent
    2. consecutive angles are complementary
    3. diagonals are congruent
    4. all four sides are congruent

6. How many points are equidistant from the x and y axis and also 4 units from the origin?
    1. 0
    2. 2
    3. 3
    4. 4

7. Which statement is logically equivalent to "If it is warm, then I go swimming"?

    1. If I go swimming, then it is warm.
    2. If it is warm, then I do not go swimming.
    3. If I do not go swimming, then it is not warm.
    4. If it is not warm, then I do not go swimming.

8. In the diagram below of $\triangle ABC$, medians $\overline{AD}$, $\overline{BE}$, and $\overline{CF}$ intersect at G.
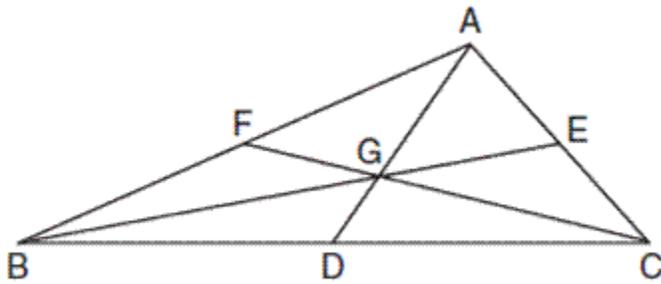
If $CF = 24$, what is the length of line segment GC?

1. 8
2. 10
3. 12
4. 16

9. In the diagram below, $\overline{SQ}$ and $\overline{PR}$ intersect at T, $\overline{PQ}$ is drawn, and $\overline{PS} \parallel \overline{QR}$.
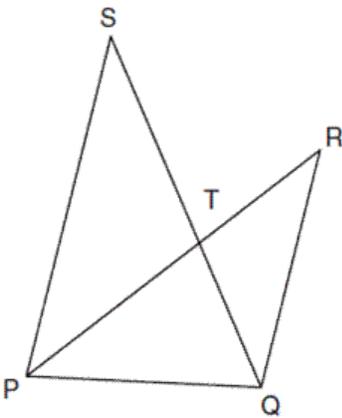
Which technique can be used to prove $\triangle PST \sim \triangle RQT$?
1. SAS
2. SSS
3. ASA
4. AA

10. In the diagram below, $\triangle ABC$ is shown with $\overline{AC}$ extended though point D.
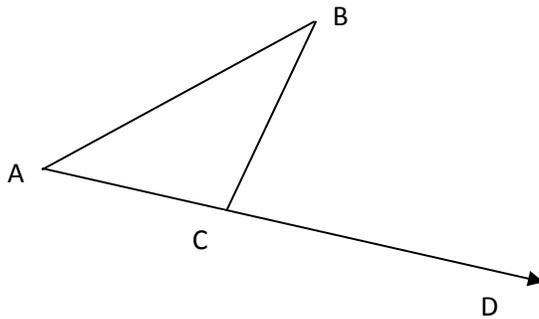
If $m{<}BCD = 6x + 50$, $m{<}BAC = x{+}70$, and $m{<}ABC = 3x$, what is the value of x

1. 6
2. 10
3. 20
4. 22

Part II

Answer the two questions in this part. Each correct answer will receive 2 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.

11. Using a compass and straightedge, construct the angle bisector of <*ABC* shown below. [Leave all construction marks.]

A

C

B
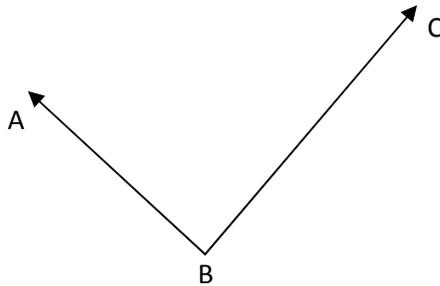
12. Find an equation of the line passing through the point (5, 4) and parallel to the equation

$2x + y = 4$
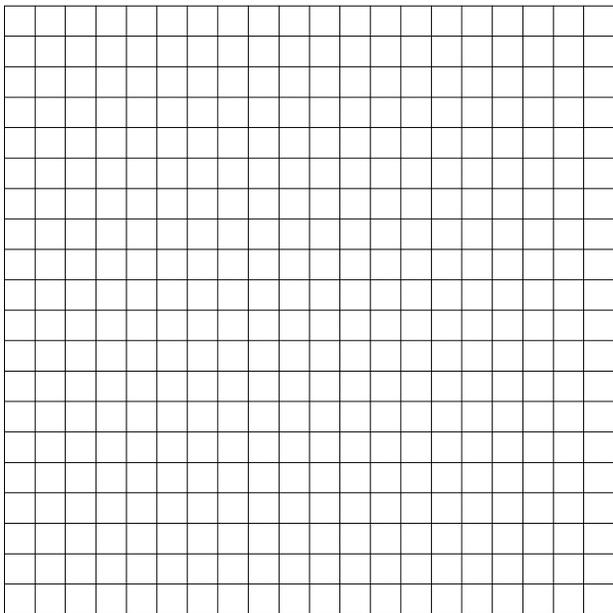
Part III

Answer the question in this part. The correct answer will receive 4 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For the question in this part, a correct numerical answer with no work shown will receive only1 credit.

13. Triangle *ABC* has coordinates *A*(2,-2), *B*(2,1), and *C*(4,-2). Triangle *A'B'C'* is the image of Δ*ABC* under $T_{5,-2}$. On the set of axes below, graph and label Δ*ABC* and its image, Δ *A'B'C'*. Graph and label Δ *A"B"C"*, the image of Δ *A'B'C'* under a reflection in the x-axis. State the coordinates of Δ *A"B"C"*.
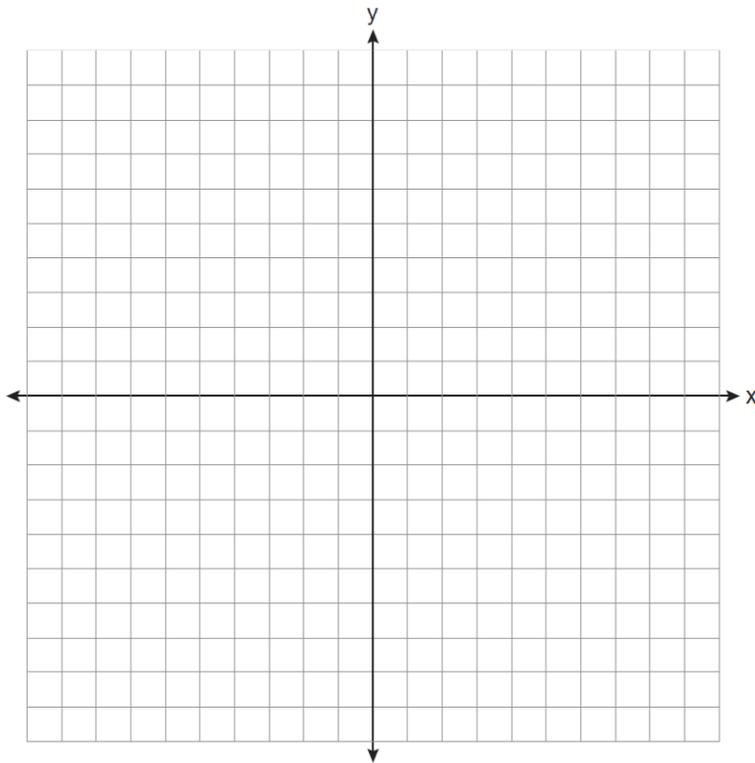
Part IV

Answer the question in this part. The correct answer will receive 6 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For the question in this part, a correct numerical answer with no work shown will receive only1 credit.
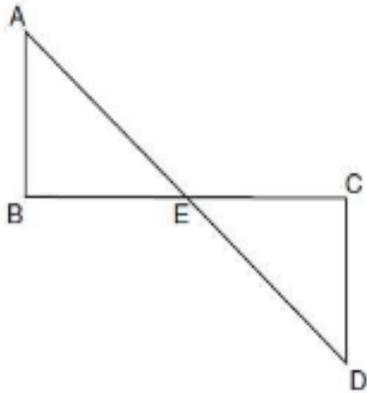
14. In the picture above it is given that $\overline{AD}$ bisects $\overline{BC}$ at point E and that $\overline{AB}$ is parallel to $\overline{CD}$. Prove that $\overline{AE} \cong \overline{ED}$. Be sure to justify every conclusion.

Appendix C

June 2013 Geometry Regents Exam

Part I

Answer all 28 questions in this part. Each correct answer will receive 2 credits. For each statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Record your answers on your separate answer sheet. [56]

1 In trapezoid *RSTV* with bases $\overline{RS}$ and $\overline{VT}$, diagonals $\overline{RT}$ and $\overline{SV}$ intersect at *Q*.

If trapezoid *RSTV* is *not* isosceles, which triangle is equal in area to $\triangle RSV$?

1) $\triangle RQV$

2) $\triangle RST$

3) $\triangle RVT$

4) $\triangle SVT$
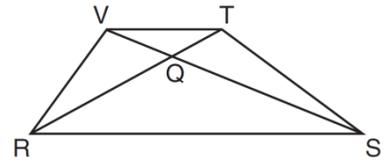
2 In the diagram below, $\triangle XYV \cong \triangle TSV$.

Which statement can *not* be proven?

1) $\angle XVY \cong \angle TVS$

2) $\angle VYX \cong \angle VUT$

3) $\overline{XY} \cong \overline{TS}$

4) $\overline{YV} \cong \overline{SV}$
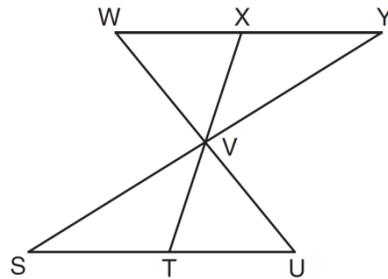
3 In a park, two straight paths intersect. The city wants to install lampposts that are both equidistant from each path and also 15 feet from the intersection of the paths. How many lampposts are needed?

1) 1

2) 2

3) 3

4) 4

4 What are the coordinates of A', the image of $A(-3,4)$, after a rotation of 180º about the origin?

1) $(4,-3)$

2) $(-4,-3)$

3) $(3,4)$

4) $(3,-4)$

5 Based on the construction below, which conclusion is *not* always true?

1) $\overline{AB} \perp \overline{CD}$

2) $AB = CD$

3) $AE = EB$

4) $CE = DE$
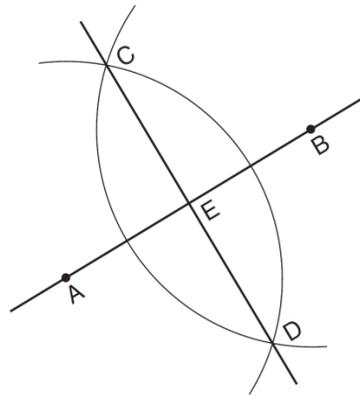
6 Which equation represents the circle whose center is $(-5,3)$ and that passes through the point $(-1,3)$?

1) $(x+1)^2 + (y-3)^2 = 16$

2) $(x-1)^2 + (y+3)^2 = 16$

3) $(x+5)^2 + (y-3)^2 = 16$

4) $(x-5)^2 + (y+3)^2 = 16$

7   As shown in the diagram below, when right triangle *DAB* is reflected over the *x*-axis, its image is triangle *DCB*.
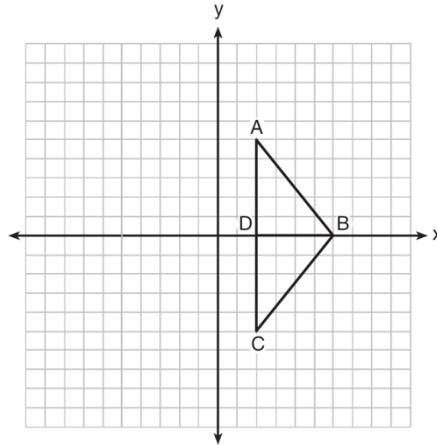
Which statement justifies why $\overline{AB} \cong \overline{CB}$?

1)   Distance is preserved under reflection.

2)   Orientation is preserved under reflection.

3)   Points on the line of reflection remain invariant.

4)   Right angles remain congruent under reflection.

8   In $\triangle ABC$, $m\angle A = 3x + 1$, $m\angle B = 4x - 17$, and $m\angle C = 5x - 20$. Which type of triangle is $\triangle ABC$?

1)   right

2)   scalene

3)   isosceles

4)   equilateral

9   What is the equation for circle *O* shown in the graph below?

1) $(x - 3)^2 + (y + 1)^2 = 6$

2) $(x + 3)^2 + (y - 1)^2 = 6$

3) $(x - 3)^2 + (y + 1)^2 = 9$

4) $(x + 3)^2 + (y - 1)^2 = 9$
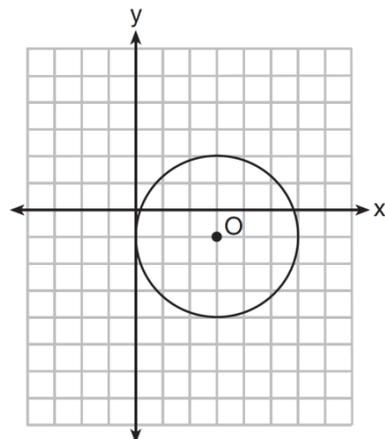
10 Point *A* is on line *m*. How many distinct planes will be perpendicular to line *m* and pass through point *A*?

    1) one

    2) two

    3) zero

    4) Infinite

11 In $\triangle ABC$, *D* is the midpoint of $\overline{AB}$ and *E* is the midpoint of $\overline{BC}$. If $AC = 3x - 15$ and $DE = 6$, what is the value of *x*?

    1) 6

    2) 7

    3) 9

    4) 12
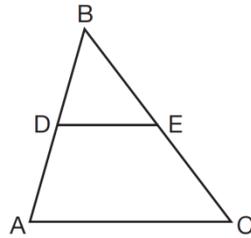
12 What are the coordinates of the center of a circle if the endpoints of its diameter are $A(8,-4)$ and $B(-3,2)$?

    1) $(2.5,1)$

    2) $(2.5,-1)$

    3) $(5.5,-3)$

    4) $(5.5,3)$

13 Which graph could be used to find the solution to the following system of equations?

$$y = (x+3)^2 - 1$$
$$x + y = 2$$

1)
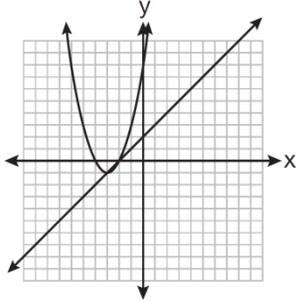
2)
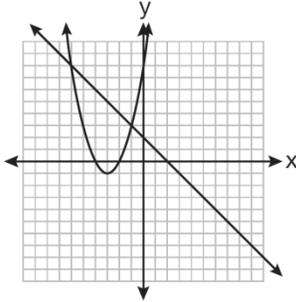
3)
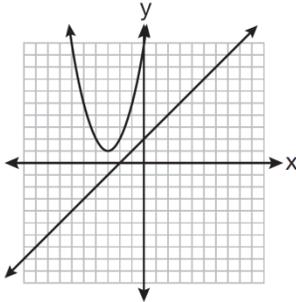
4)
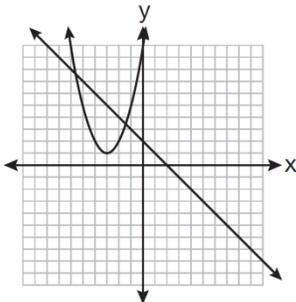
14 What is the converse of "If an angle measures 90 degrees, then it is a right angle"?

    1)   If an angle is a right angle, then it measures 90 degrees.

    2)   An angle is a right angle if it measures 90 degrees.

    3)   If an angle is not a right angle, then it does not measure 90 degrees.

    4)   If an angle does not measure 90 degrees, then it is not a right angle.

15 As shown in the diagram below, a right pyramid has a square base, *ABCD*, and $\overline{EF}$ is the slant height.

    Which statement is *not* true?

    1) $\overline{EA} \cong \overline{EC}$

    2) $\overline{EB} \cong \overline{EF}$

    3) $\triangle AEB \cong \triangle BEC$

    4) $\triangle CED$ is isosceles
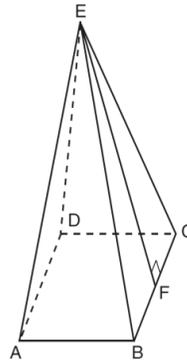
16 What is the equation of a line passing through the point $(6, 1)$ and parallel to the line whose equation is $3x = 2y + 4$?

    1) $y = -\frac{2}{3}x + 5$

    2) $y = -\frac{2}{3}x - 3$

    3) $y = \frac{3}{2}x - 8$

    4) $y = \frac{3}{2}x - 5$

17 The volume of a sphere is approximately 44.6022 cubic centimeters. What is the radius of the sphere, to the *nearest tenth of a centimeter*?

    1)   2.2

    2)   3.3

    3)   4.4

    4)   4.7

18 Points $A(5,3)$ and $B(7,6)$ lie on $\overleftrightarrow{AB}$. Points $C(6,4)$ and $D(9,0)$ lie on $\overleftrightarrow{CD}$. Which statement is true?

1) $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$

2) $\overleftrightarrow{AB} \perp \overleftrightarrow{CD}$

3) $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ are the same line.

4) $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect, but are not perpendicular.

19 Which set of equations represents two circles that have the same center?

1) $x^2 + (y+4)^2 = 16$ and $(x+4)^2 + y^2 = 16$

2) $(x+3)^2 + (y-3)^2 = 16$ and $(x-3)^2 + (y+3)^2 = 25$

3) $(x-7)^2 + (y-2)^2 = 16$ and $(x+7)^2 + (y+2)^2 = 25$

4) $(x-2)^2 + (y-5)^2 = 16$ and $(x-2)^2 + (y-5)^2 = 25$

20 Transversal $\overleftrightarrow{EF}$ intersects $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$, as shown in the diagram below.

Which statement could always be used to prove $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$?

1) $\angle 2 \cong \angle 4$

2) $\angle 7 \cong \angle 8$

3) $\angle 3$ and $\angle 6$ are supplementary

4) $\angle 1$ and $\angle 5$ are supplementary
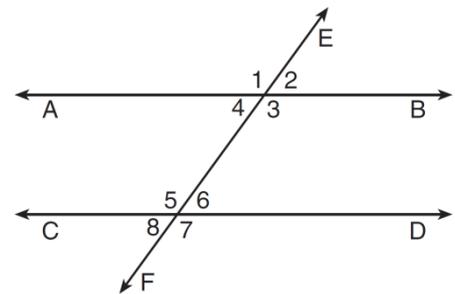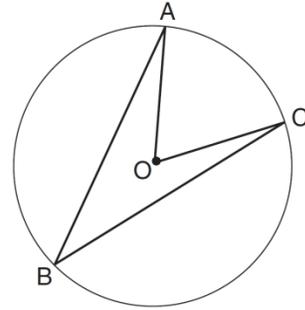
21 In $\triangle ABC$, $m\angle A = 60$, $m\angle B = 80$, and $m\angle C = 40$. Which inequality is true?

1) $AB > BC$

2) $AC > BC$

3) $AC < BA$

4) $BC < BA$

22 Circle *O* with $\angle AOC$ and $\angle ABC$ is shown in the diagram below.

What is the ratio of $m\angle AOC$ to $m\angle ABC$?

1) $1:1$

2) $2:1$

3) $3:1$

4) $1:2$

23 A rectangular prism has a base with a length of 25, a width of 9, and a height of 12. A second prism has a square base with a side of 15. If the volumes of the two prisms are equal, what is the height of the second prism?

1) 6

2) 8

3) 12

4) 15

24 In triangles *ABC* and *DEF*, $AB = 4$, $AC = 5$, $DE = 8$, $DF = 10$, and $\angle A \cong \angle D$. Which method could be used to prove $\triangle ABC \sim \triangle DEF$?

1) AA

2) SAS

3) SSS

4) ASA

25 Which graph represents a circle whose equation is $x^2 + (y - 1)^2 = 9$?

1)

2)

3)

4)
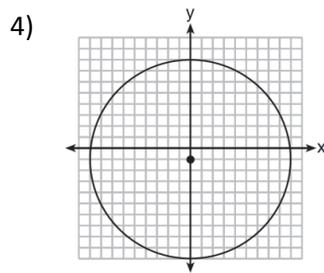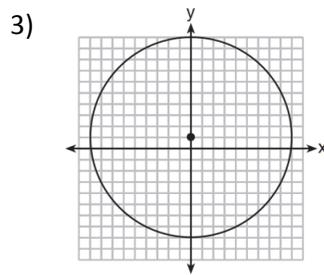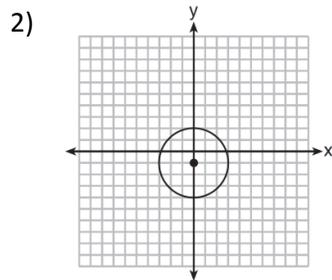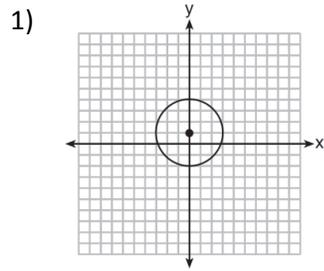
26 What is the perimeter of a rhombus whose diagonals are 16 and 30?
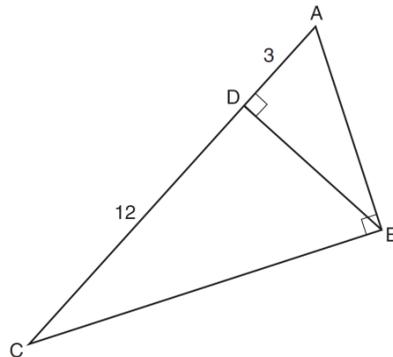
1) 92

2) 68

3) 60

4) 17

27 In right triangle *ABC* shown in the diagram below, altitude $\overline{BD}$ is drawn to hypotenuse $\overline{AC}$, $CD = 12$, and $AD = 3$.

What is the length of $\overline{AB}$?

1) $5\sqrt{3}$

2) 6

3) $3\sqrt{5}$

4) 9

28 Secants $\overline{JKL}$ and $\overline{JMN}$ are drawn to circle *O* from an external point, *J*. If $JK = 8$, $LK = 4$, and $JM = 6$, what is the length of $\overline{JN}$?
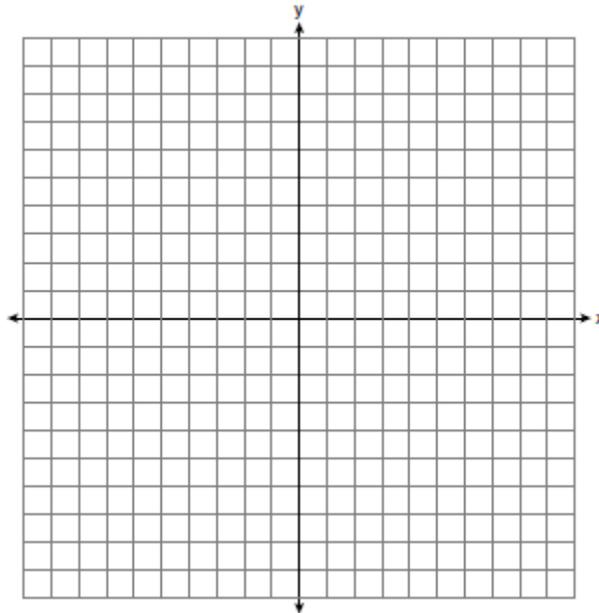
1) 16

2) 12

3) 10

4) 8

Part II

Answer all 6 questions in this part. Each correct answer will receive 2 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit. All answers should be written in pen, except for graphs and drawings, which should be done in pencil. [12]

29 A right circular cylinder has a height of 7 inches and the base has a diameter of 6 inches. Determine the lateral area, in square inches, of the cylinder in terms of π.

30 Determine, in degrees, the measure of each interior angle of a regular octagon.

31 Triangle *ABC* has vertices at $A(3,0)$, $B(9,-5)$, and $C(7,-8)$. Find the length of $\overline{AC}$ in simplest radical form.

32   On the ray drawn below, using a compass and straightedge, construct an equilateral triangle with a
     vertex at *R*. The length of a side of the triangle must be equal to a length of the diagonal of rectangle
     ABCD.

D   C

A   B

R →

33   On the set of axes below, graph the locus of points 4 units from the *x*-axis and equidistant from the
   points whose coordinates are $(-2,0)$ and $(8,0)$. Mark with an **X** all points that satisfy *both* conditions.

34   The coordinates of two vertices of square *ABCD* are $A(2,1)$ and $B(4,4)$. Determine the slope of side $\overline{BC}$
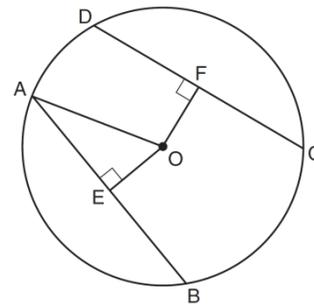
Part III

Answer all 3 questions in this part. Each correct answer will receive 4 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit. All answers should be written in pen, except for graphs and drawings, which should be done in pencil. [12]

35 The coordinates of the vertices of parallelogram *SWAN* are $S(2,-2)$, $W(-2,-4)$, $A(-4,6)$, and $N(0,8)$. State and label the coordinates of parallelogram $S''W''A''N''$, the image of *SWAN* after the transformation $T_{4,-2} \circ D_{\frac{1}{2}}$. [The use of the set of axes below is optional.]
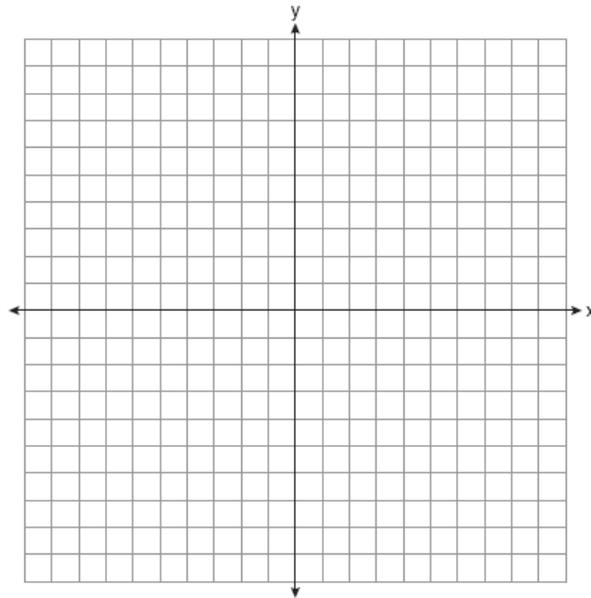
36 In circle *O* shown below, chords $\overline{AB}$ and $\overline{CD}$ and radius $\overline{OA}$ are drawn, such that $\overline{AB} \cong \overline{CD}$, $\overline{OE} \perp \overline{AB}$, $\overline{OF} \perp \overline{CD}$, $OF = 16$, $CF = y + 10$, and $CD = 4y - 20$.

Determine the length of $\overline{DF}$. Determine the length of $\overline{OA}$.

37 If $\triangle RST \sim \triangle ABC$, $m\angle A = x^2 - 8x$, $m\angle C = 4x - 5$, and $m\angle R = 5x + 30$, find $m\angle C$. [Only an algebraic solution can receive full credit.]

Part IV

Answer the question in this part. A correct answer will receive 6 credits. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. A correct numerical answer with no work shown will receive only 1 credit. The answer should be written in pen, except for graphs and drawings, which should be done in pencil. [6]

38   In the diagram of $\triangle MAH$ below, $\overline{MH} \cong \overline{AH}$ and medians $\overline{AB}$ and $\overline{MT}$ are drawn.

Prove: $\angle MBA \cong \angle ATM$
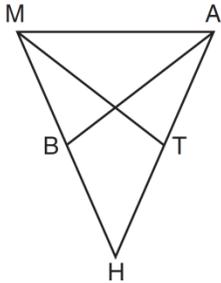
Appendix D

Teacher Questionnaire

1. What college/university did you attend to earn your *education* degree? _____

2. What type of college/university is the school mentioned in #1 considered to be?

3. Do you hold a *mathematics* degree (as opposed to a mathematics education degree) at the Bachelor's level or higher? (circle one)

> Yes   No

4. What is the highest level degree that you have earned? (circle one)

> Bachelor's   Master's
>
> Doctorate   Other (please list) _____

5. What type of NYS certification do you hold? (circle one)

> Initial   Professional
>
> Temporary   Other (please list) _____

6. What is your gender? (circle one)   Male   Female

7. What is your age? (circle one)   21-25 26-30 31-35 36-40 41-45 46-50 51-55 56+

8. What is your race? (circle one)

> White, non-Hispanic   African-American
>
> Hispanic   Asian-Pacific Islander
>
> American Indian   Other (please list) _____

9. How many years of experience do you have teaching mathematics at the secondary level? _____

10. How many years of experience do you have teaching a high school *geometry* course? _____