Does Mentoring a Graduate Student Effect Student Achievement?

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Abstract

In this quantitative study (*N* = 160), we explored the relationship between preservice elementary teachers performance on a common geometry final and the mentoring status of their instructor. A Chi-Squared test indicated no statistically significant differences in the students' course grades between instructors, but an ANOVA test revealed statistically significant differences on the final exam scores. Students of instructors involved with mentoring scored higher than students who completed the course under the direction of instructors not involved with mentoring. Our findings suggest mentoring may enhance student achievement and advocate the need for administrators to support mentors. These results may be strengthened by increasing the number of mentees and exploring the perceived benefits of mentoring for both the mentee and mentor, via qualitative research.

Key Words: Geometry, Graduate Student, Mentoring, Student Achievement

Introduction

Ehrenberg (2000) documented that starting in 1994 universities no longer required mandatory retirement of their tenured faculty, which resulted in additional financial expenses for universities. In order to compensate for this expense, universities attempted to reduce costs by hiring an increased number of adjunct instructors and requiring graduate students to have more teaching responsibilities. According to Bettinger and Long (2004), 70% of graduate students have at least some teaching responsibility. Despite the fact that hiring of adjunct and graduate student instructors has lead to financial savings for universities, it has also lead to a negative impact on student achievement and interest in mathematics (Bettinger & Long, 2004; Carrell & West, 2008; Kezim, Pariseau, & Quinn, 2005; Sonner, 2000). For example, these instructors tended to negatively impact the number of subsequent courses that students take in the subject area and students' decision to major in that content area. In contrast, they generally had positive effects on students' GPA due to grade inflation in the course. One way to possibly alleviate some of these problems is to mentor adjunct and graduate student instructors (Luna & Cullen,1998). Unfortunately, much of the research related to mentoring adjunct and graduate student instructors did not measure the effectiveness that mentoring has on undergraduate students' learning. Rather, the literature (Busch, 1985; Little, 1990; Luna & Cullen, 1998; Rose, 2003, 2005; Wang, 2000) focused on mentor's perceptions of mentoring, perceived benefits of having a mentor, qualities that a mentee seeks in a mentor, and mentoring practices.

The purpose of this research is to contribute to the literature regarding mentoring graduate students, but through a quantitative lens. Unlike previous investigations, we do not concentrate on benefits for the graduate students (although this is valuable), rather we attempted to measure the impact that mentoring graduate students has on students' performance in the classroom. Specifically, we addressed the following questions:

1. Are there statistically significant differences in students' course grades in a geometry course for preservice elementary teachers based on the instructor i.e. tenured faculty, adjunct faculty, and mentored graduate student?
2. Are there statistically significant differences in students' performance on a common item exam related to content specific to geometry for preservice elementary teachers based on the instructor?

Literature Review

In this section we described how students are effected when they complete courses under the direction of an adjunct faculty member or a graduate student. We also provided a working definition of mentoring and summarized literature delineating perceived benefits to the mentor and the mentee.

Influence of Alternative Faculty

Alternative faculty tend to include adjunct faculty members and graduate student instructors (Bettinger & Long, 2004; Carrell & West, 2008; Kezim, Pariseau & Quinn, 2005; Sonner, 2000). According to Bettinger & Long (2004) adjunct faculty members were less involved in scholarship and knowledge acquisition; their primary focus was teaching. On the other hand, tenure-track and full time faculty tended to have stronger academic knowledge and scholarly responsibilities (Sonner, 2000). Unlike adjunct faculty members, graduate student instructors were actively involved with both teaching and scholarship, which manifested in their course work and research (Sonner, 2000). Thus, graduate student instructors had to balance the world of adjunct faculty members and the land of tenure-track professors, but the literature

(Bettinger & Long, 2004; Carrell & West, 2008) suggested their teaching had the same effect on students as teaching by adjunct faculty**.**

In their research, Bettinger and Long (2004) concluded entering students who completed courses taught by adjunct and graduate assistant instructors were less interested in subsequent subjects compared to students taught by full-time tenure-track faculty. These results were based on a longitudinal study in which the researchers collected student data related to completion rates of future courses, ACT scores, and choice of major prior to enrolling at the university. Bettinger and Long (2004) found no significant relationship between type of instructor and time of day in which the class was offered. Bettinger and Long (2004) claimed their research addressed a gap in the literature concerning how instructor rank effected students' academic decisions.

Bettinger and Long (2004) also documented that the Modern Language Association, the National Institute of Education, and the Education Commission of the States issued statements that link the use of part-time instructors to a decline in educational quality. These researchers found the outcomes tied to the use of adjunct instructors for any mandatory course did not appear to have significant long term consequences on students' success in subsequent courses. However, Carrell and West (2008) found that in the hard sciences the effects were significant and negative in the long run. In other words, students of instructors, who did not possess terminal degrees, performed better in contemporaneous courses, but performed worse in subsequent related courses. Carrell and West (2008) concluded "less academically qualified instructors may spur (potentially erroneous) interest in a particular subject through higher grades, but these students perform significantly worse in follow-on related courses that rely on the initial course for content" (p. 20).

In their 10-year longitudinal study, Carrell and West (2008) explored the effects of instructor on student achievement at the Air Force Academy. Students (N =12,560) were randomly assigned to over 30 different core courses. Students enrolled in calculus I, calculus II, and introduction to statistics participated in this study. The researchers found large and significant differences in students' performance across professors in contemporaneous courses; however, students performed significantly worse in follow-up courses as instructor quality decreased. For example, students who completed calculus I under the direction of an adjunct professor, tended to earn a lower grade in calculus II and III under the direction of a tenure-track faculty member. Specifically, instructor academic rank, teaching experience, and terminal degree status were negatively correlated with contemporaneous student achievement, but positively related to follow-up course achievement.

A possible way to alleviate this situation is to increase communications between alternative faculty and tenure-track faculty. This is especially valuable for graduate students who may be teaching for the first time and whose teaching is a key component of their professional training (Bettinger & Long, 2004). Increased communications may be attained through mentoring.

Mentoring

Anderson and Shannon (1988) explored diverse definitions of mentoring, some of which stipulated that the mentor must be a male or an older person, albeit all proposed definitions delineated functions of the mentor. In an attempt to encompass the diverse aspects of definitions, they defined mentoring as:

> *a nurturing process in which a more skilled or more experienced person, serving as a role model, teaches, sponsors, encourages, counsels, and befriends a less skilled or less experienced person for the purpose of promoting the latter's professional and/or*

> *personal development. Mentoring functions are carried out within the context of an ongoing, caring relationship between the mentor and protégé* (p. 40).

Since this definition entailed teaching and the authors provided examples for mentoring teachers, we found this definition appropriate for our research. Anderson and Shannon (1988) also provided a model illustrating how mentors can open themselves up to the mentee, lead incrementally, and express care and concern. For example if one is mentoring a graduate student in the area of teaching, mentors may open themselves up by providing opportunities for the mentee to observe them teaching. This can lead to discussions regarding the mentor's decisions and performances. Mentors can lead incrementally by observing the graduate student teaching and providing feedback. Expressions of care and concern may be demonstrated by holding support meetings with the graduate student. The mentor in our research followed these guidelines in her mentoring process. Rose (2003, 2005) also used this definition of mentoring in her research.

Rose (2003) created the Ideal Mentor Scale (IMS) to determine what qualities graduate students sought in a mentor. Two characteristics that graduate students used to define a mentor were the ability to communicate and the ability to provide honest feedback, whether it was positive or negative. As part of her findings, she also found that graduate students desired mentors with integrity, who could provide guidance, and with whom they could build a relationship. These three traits are in line with the functions described by Anderson and Shannon (1988).

In a follow-up study Rose (2005) investigated the relationship between graduate students' demographic and academic characteristics and three traits (integrity, guidance, and relationship) desired in a mentor. Her primary results indicated age, gender, and citizenship influenced graduate students' perception of the ideal mentor. She found older nontraditional graduate students often struggled with the re-adjustment to the role of student, and were less likely to have a mentor. Other researchers support these findings. For example, Levenson et al. (1978) claimed reluctance of nontraditional students to receive mentoring could be due to the preference of the graduate student, bias from the mentor, or a combination of both. Wilde and Schau (1991) reported nontraditional graduate students who had a mentor were less likely to receive help from their mentor in professional development activities.

In examining the role of gender and mentor qualities, Rose (2005) reported men and women were equally likely to experience mentoring, had an equivalent number of mentors, and had the mentoring experience of the same duration. Although the number of mentors and the mentoring duration did not differ, women were prone to seek mentors with integrity. The males and females were equally likely to prefer a mentor who provided guidance and who was willing to build a relationship with the mentee. This contrasts prior research, which indicated female mentees received more psychosocial support than men. Such support transpired in the form of acceptance, confirmation, a role model, and a counselor from their mentors (Noe, 1988). Similar findings in the medical field suggested males were more likely to report that their mentor facilitated their external visibility and benefited the mentees careers, while women were more apt to report that their mentors used the mentee's work to benefit the mentor (Fried et al., 1996). On the other hand, women were also more likely to view their mentor as a friend with whom to socialize outside of the school environment. Women also claimed their mentors served as a support system, helped instill confidence, provided growth opportunities, and opened doors (Collins, 1983; Wilde & Schau, 1981).

Rose (2005) also addressed international graduate student's needs and preferences in a mentor. International students frequently had different learning styles and their sociopolitical views may have affected their studies. Many of these students reported higher stress due to the adjustment to the new environment and perceived prejudice towards them. Typically, English is not the native language of international students, which results in the added challenge of learning new content without a mastery of the English language. Thus, Rose (2005) suggested international students may need mentors who befriend them and help them develop the required social and communication skills necessary to succeed. They may also seek a mentor who demonstrates cultural sensitivity and is patient with their struggle to master the English language.

In summary the roles of graduate student mentors are diverse and include such functions as advising and providing information to the graduate student, supporting the graduate student in departmental socialization and meeting departmental goals, advocating for the graduate student, acting as a role model for the graduate student, socializing the graduate student in the occupational field, serving as a counselor to the graduate student, and assisting the student to obtain professional development opportunities (Fried et al., 1996; Little, 1990; Noe, 1988; Rose, 2005; Wang, 2001; Winston & Polkosnik, 1984). These are all time-consuming tasks for the mentor, but these responsibilities may benefit the university, the mentored graduate instructor, and the students of the mentored student. Luna and Cullen (1998) stated graduate students regarded their relationships with faculty as the single most important aspect determining the quality of their graduate experience. Mentoring novice instructors, such as graduate students may also benefit the political and organizational concerns of the institution. Research indicated that mentored individuals were more committed to the organization, had better socialization, and performed better than non-mentored novice instructors (Green & Bauer, 1995; Little, 1990). Luna and Cullen (1998) also contended a mentoring program for new faculty assisted with recruitment and retention of faculty, not only for university faculty but also for elementary and secondary.

Wang (2000) and Little (1990) both examined the effects of mentoring novice, PK-12 teachers. Little (1990) claimed the increase in mentoring of the novice instructor is a result of political interests and institutional concerns. She believed the increase in public attention to certification, tenure for instructors, and instructor evaluation has been a driving force in the development of mentors. She also stated that in the local schools, mentoring has three basic functions: (1) to support teacher induction, (2) to create a cadre of teacher consultants, and (3) to assist with curriculum development. In our research the mentoring supported teacher induction and assisted with curriculum development since the graduate student had not taught the course.

Wang (2000) examined the roles of mentors in the United States, the United Kingdom, and China and found each country had a different emphasis on what the mentors taught the mentees. In the United States, mentors generally stressed the need to understand individual students and to develop varied teaching styles. These mentors emphasized the need for novices to develop their own teaching philosophies and spent more time with novice instructors helping to create and to organize a specific curriculum or lesson plan. In contrast, the mentors from the United Kingdom generally emphasized the novice's commitment to the culture and procedures of the particular school or department. They also stressed cultural diversity, but provided little attention to individual students. Finally, the Chinese philosophy of mentoring was clearly related to their instructional contexts. The Chinese mentors had an authoritative and consistent prescribed curriculum and assessment structure. They expected the novice teachers to study the curriculum and to develop a shared understanding and attitude towards teaching. The Chinese mentor's goal was to help the novice learn to teach the required curriculum but they did not focus on the individual student or the needs of the novice. Wang (2000) advocated instructor education reformers embrace the mentor/novice instructor relationship as a strategy to support novice teachers to learn to teach and to improve the quality of their teaching. Wang (2000) maintained effective mentors must also be effective instructors, but this alone does not guarantee that one will be an effective mentor. Unfortunately, none of these studies considered how mentoring may benefit students – we attempted to address this in our investigation. Below we discuss our theoretical perspective and follow this with a description of our methods of inquiry.

Theoretical Perspective

Recent research has attempted to quantitatively measure the effectiveness of professional development for mathematics teachers by investigating the impact that it has on their teaching (Desimore, Porter, Garet, Yoon, & Birman, 2002) and how it effects student achievement (Hill, Rowan, & Ball, 2005; Jacob & Lefgren, 2004). Other researchers (Harbison & Hanushek, 1992; Mullens, Murnane, & Willet, 1996) explored the relationship between teachers' mathematical knowledge and gains in students' mathematics achievement. We also incorporated this postpositivist lens into our research. This perspective is used to examine causes that possibly influence outcomes and diminishes concepts into a "small discrete set of ideas to test, such as variables that constitute hypothesis and research questions" (Creswell, 2009, p. 7). This requires careful observations and measurements of the objective reality that exists in the world. In this study, we hypothesized that the mentoring status of the instructor would influence student achievement in a geometry course for preservice elementary teachers. Thus, we set out to investigate if there was a statistically significant difference between students' performance in the course based on the instructor's mentoring status.

Methods

Participants and Setting

The participants for the research were students enrolled in geometry for preservice elementary teachers, at a midsized doctoral granting institution. This 3-credit class is the third course in a three semester sequence of mathematics courses designed for preservice elementary teachers. The text, *Geometric Structures: An Inquiry-based Textbook for Prospective Elementary Teachers,* (Aichele & Wolfe, 2008), which is constructivist in nature was used in the course. The text is designed to promote cooperative discovery learning, whole class discussions, writing, problem-solving, and the use of manipulatives. The primary emphasis of the course is to develop preservice elementary teachers' spatial reasoning. Topics focused on properties of two- and three-dimensional shapes, measurements, constructions, and transformations. There were between 20 and 30 students in each of the six sections of the course, for a total of 160 participants. Of these participants, 18% were seniors, 33% were juniors, 49% were sophomores and less than 1% were freshman.

Dr. Shiva was a tenured faculty member who served as the course coordinator and taught two sections of the class. As course coordinator, she wrote the course syllabus, communicated course goals, provided feedback on all exams, and served as a resource for all instructors. The course syllabus and course goals were shared during a meeting at the beginning of the semester. At this time all instructors agreed to have common questions on the comprehensive final. There were three other instructors for this course. Ms. Adrianna and Ms. Annalisa were both adjunct faculty with previous experience teaching this class; they each taught one section of the course, as part of their 12-hour teaching load. Ms. Adrianna had a masters in mathematics education and had experience teaching secondary mathematics, while Ms. Annalisa had a masters in pure mathematics. Ms. Gwen was a graduate student enrolled in a mathematics education doctoral program and taught two sections of the course for the first time. She had experience teaching collegiate mathematics, while earning her masters in mathematics education. Since this was her first time teaching the course, and the course followed a constructivist perspective in teaching and learning, Ms. Gwen requested weekly meetings with Dr. Shiva to discuss weekly lessons.

In response to this request Dr. Shiva invited all instructors to participate in weekly discussions, but both adjunct faculty members declined this invitation. Thus, Dr. Shiva and Ms. Gwen met for an hour each week to create lesson plans including: warm-up activities, group activities, homework, quizzes, and exams. These materials were shared with the adjunct faculty members immediately following the weekly meetings. All quizzes and exams contained at least one question requiring the preservice elementary teachers to provide explanations from the viewpoint of a future teacher. An example included: Give three different ways in which you could convince a student that the area of a triangle is ½ the product of the base and height of the triangle. Dr. Shiva requested the adjunct faculty members include such teaching scenario questions on their assessments, but they were reluctant to do so because they took longer to grade.

Along with the weekly meetings, Dr. Shiva and Ms. Gwen observed each other's class on three occasions. They shared their critiques about the lesson during informal meetings. During this time the person who taught was able to explain why she proceeded in a manner that might be questionable to the observer. For example, during one of her lessons Ms. Gwen began the class with a warm-up activity, provided an overview of the new material, and assigned the students an activity where they would discover the relationship between the circumference and diameter of a circle and π. As the students worked in groups, she walked around and answered questions. As a group finished a task, she assigned the new homework. During their informal meeting, Dr. Shiva asked Ms. Gwen why she didn't summarize the relationship with the entire class. At this time, Ms. Gwen responded that she was having trouble with a student and felt it would be best to summarize the results at each table. This led to another conversation related to student misconduct, which is an aspect of mentoring. This mentoring process allowed for the three dispositions (opening ourselves, leading incrementally, and expressing care and concern) as described by Anderson & Shannon (1998).

The Instrument

The process for creating the common questions for the comprehensive final began with Dr. Shiva suggesting items to all instructors. Each instructor replied with changes, Dr. Shiva took the recommendations, revised the common items, and resubmitted the common items to the instructors in a similar manner until all instructors agreed upon the final questions (see Appendix A). This process provided content validity (Huck, 2008).

The initial item set contained three teaching scenario questions, but since these questions were not representative of items found on exams of the adjunct faculty, they were reduced to only include one such question. It is question number 4. In the end, everyone agreed on 11 questions, with some questions containing multiple parts. Thus, there were 19 common items, which focused on (1) polygons and angle relationships, (2) characteristics of polygons, (3) relationships between perimeter, area, and volume, (4) properties of similar figures, and (5) transformations. Dr. Shiva and Ms. Gwen administered the same final exam, with 33 items. Ms. Annalisa's final exam consisted of 31 items and Ms. Adrianna's final exam contained 39 items. These totals included the 19 common items.

In an effort to maintain student anonymity, care was taken to ensure we had no record of which exam came from which student. Therefore, we were unable to address the predictive validity of the instrument via students' course grade, midterm grade, GPA, or ACT. On the other hand, we were able to explore the distribution of final student grades (A, B, C, D or F) per instructor. Statistical tests for internal consistency suggested the students' responses on the exam items likely reflected variation within a single construct (Cronbach's $\alpha = .80$), thus we used the total score on all nineteen common exam items as the response variable in our analysis. Two researchers scored all the questions, following a rubric that they created and obtained an inter-rater reliability of $r = 0.88$. Using a range from 0-3 for each item, the total scores could range from 0 to 57 points.

Results

We began our analysis by investigating whether there was a statistically significant relationship between the final course grades and the instructor. After this, we explored students' performance on the common items by treating the score as a continuous response variable and using the statistical software *Minitab* for our analysis.

Course Letter Grades

Frequency data and a 4×4 chi square analyses comparing course letter grades (A, B, C, D or F) and instructor were calculated to determine if there was an association between the course grades and the instructors. The scales, used by all instructors, to determine the course letter grades were: $90 \le x \le 100$ = A, $80 \le x < 90$ =B, $70 \le x < 80$=C, $x < 70$ = D or F. Data coded as D or F also included students who withdrew from the course. Table 1 displays percentages of students, with counts in parentheses, for instructors by course letter grade. A chi-square test of homogeneity did not detect systematic differences in the letter grades assigned by the various instructors (χ^2 (9, N=160) = 11.78, p = 0.23). In other words, the distribution of course grades did not appear to be related to instructor.

Instructor	A	B	C	D or F	Total
Dr. Shiva	35% (17)	35% (17)	17% (8)	13% (6)	48
Ms. Gwen	38% (22)	40% (23)	14% (8)	8% (5)	58
Ms. Annalisa	24% (8)	35% (12)	38% (13)	3% (1)	34
Ms. Adrianna	31% (9)	28% (8)	28% (8)	13% (4)	29
Total	56	60	37	16	169

Table 1. Count of students' course letter grades by instructor.

Continuous Scores for Common Items

We continued our investigation by considering the raw scores as a continuous variable. Analysis of the residuals for influential cases or departures from the assumptions of an ANOVA presented no evidence for problems. Thus, we utilized a one-way ANOVA to contrast the overall mean scores of the students' exams for each of the four instructors and we used the partial eta squared (η_p^2) to measure the effect size. Our results suggested there were statistically significant differences in the mean scores based on instructor, (F(3,156) = 25.51; MSE = 68.7, p = .000). Table 2 contains descriptive statistics for the common item scores and Figure 1 illustrates the confidence intervals for the means based on instructor. Both of these indicate the students enrolled in the course coordinator's and graduate student's class performed statistically significantly higher than the student's enrolled in the adjunct faculties' class. There were no statistically significant differences between the students' scores in Dr. Shiva's and Ms. Gwen's course. On the other hand, there were statistically significant differences in the mean scores of the students enrolled in the two adjunct faculty members class. The effect size of $\eta_p^2 = .32$ was high (Huck, 2008) and thus, our results suggest practical significance i.e., mentoring the graduate student had a large effect on the students' performance.

Teacher	*N*	Mean	Standard Deviation
Ms. Adrianna	28	37.79	9.33
Ms. Annalisa	31	29.45	10.79
Ms. Gwen	55	43.75	6.87
Dr. Shiva	46	44.43	7.2

Table 2. Descriptive Statistics for Common Item Scores

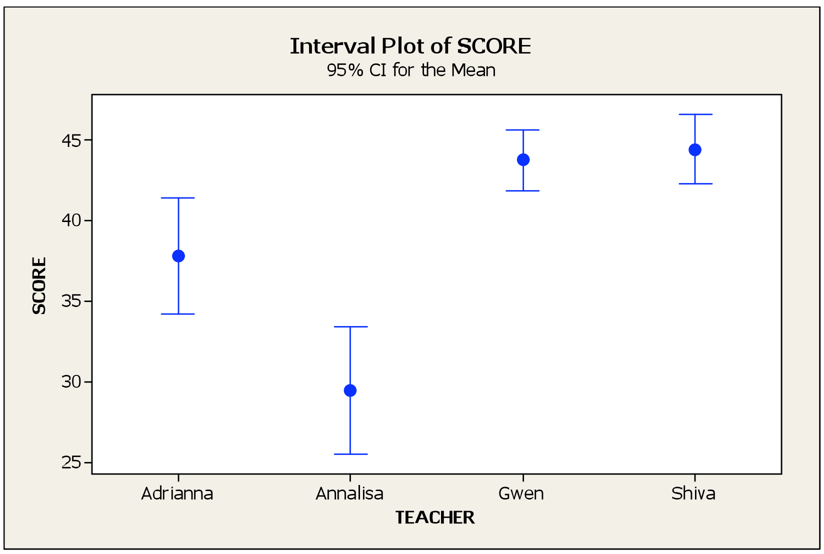

Figure 1. *Confidence Intervals for Common Items*

After scoring the exams, we converted the raw score to a letter grade, using the same criteria as described above. A chi-squared test confirmed the results obtained by treating the raw score as a continuous variable and indicated a statistically significant association between the number of letter grades on the exam and the instructor ($\chi^2(9, N=160) = 41.36, p < 0.0001$). A high effect size of $\phi = .51$ indicated our results also possessed practical significance (Huck, 2008).

Discussion and Implications

Our results indicate that mentoring the graduate student affected her students' performance on the common items, although this did not influence the overall performance in the course. Students who completed the course under the direction of the course coordinator and the mentored student performed significantly higher than the students enrolled in the other courses. This may be a result of grade inflation (Kezim, Pariseau, & Quinn, 2005) or other unobserved occurrences. In this section we provide some plausible explanations for the results as well as implications of our results. Some possible explanations include initial differences in students' mathematical background, different expectations on the common item questions, and instructor's background.

First it is possible there was an initial difference in the students', that is students enrolled in Dr. Shiva or Ms. Gwen's class were mathematically stronger. A post-hoc analysis of students' ACT scores and performance in the two pre-requisite courses indicated this was not the case. The average verbal ACT score for students in each course ranged from 21 to 23 ($p = .37$), while the average math ACT scores ranged from 19 to 22 ($p = .06$). In both cases, the students enrolled in Ms. Adrianna's course had the lowest average and the students enrolled in Ms. Annalisa's course had the highest average. We also investigated whether there was a statistically significant difference in students' performance in the two prerequisite courses based on the students' course grade. A Chi-Square analysis indicated no statistically significant differences. Furthermore, the percentage of transfer students was less for Ms. Annalisa compared to the percentage of transfer students enrolled in the other sections. It is noteworthy that Ms. Annalisa's students had the highest average on their ACT scores, but their average scores on the common items were the lowest. Thus, it appears our findings cannot be attributed to students' mathematical background.

Another potential explanation is students' familiarity with the type of questions posed. For example, the adjunct faculty did not expect students to answer questions like the one posed in question 4, and these were standard questions for the students enrolled in the other sections. The adjunct faculty only required students to compute perimeter, area, and volume and not think about it in terms of the number of units, square units, and cubic units respectively. They also commented that they devoted very little class time on volume in order to spend time on origami projects, where the students created a "monster stellated polyhedra." It's possible the adjunct faculty viewed these activities as fun and more useful since preservice elementary teachers often believe that fun mathematics classes contain value for students (Gellert, 1999). Question 8 is another item that may have appeared novel since the adjunct faculty tended to ask students to identify a transformation as a reflection, rotation, translation, or glide reflection. They did not require students to perform a transformation. Thus, this question might have challenged their students since they were required to perform a composition of transformations. On question 4, the average scores (out of 3) for Ms. Annalisa, Ms. Adrianna, Ms. Gwen and Dr. Shiva were 0.03, .68, 1.25, and 1.5 respectively. On question 8 the average scores (out of 3) for Ms. Annalisa, Ms. Adrianna, Ms, Gwen, and Dr. Shiva were .84, 1.07, 1.93, and 2.24 respectively. These scores indicate these types of questions may have contributed to the students' performance and in turn impacted our results. Although, a similar trend occurred for the remaining items, which were standard questions posed by all the instructors.

A third, and possibly the most plausible explanation for the results may be due to the teachers' background. Ms. Annalisa had a strong mathematical background, but had no training in mathematics education while, Ms. Adrianna had a background in mathematics education and had completed some mathematics education courses at the doctoral level. Thus, Ms. Adrianna may be more attuned to literature regarding prospective elementary teachers and the teaching and learning of mathematics. On the same note Ms. Gwen and Dr. Shiva were actively involved in research centered on preservice elementary teachers and teaching and learning mathematics. Furthermore, Ms. Gwen actively sought out assistance in teaching the course which indicates a desire to meet the needs of the students and to satisfy departmental goals.

Our results support the value of mentoring and indicate that mentoring graduate students may affect students' performance in a class. Although the literature (Rose 2003, 2005) delineates the bountiful benefits for the mentee, this research suggests that it also benefits students of the mentees. In this case it appeared the students, the mentee, and the mentor all benefited from the interaction. Mentoring takes time for everyone involved, but this mentoring model allowed the two parties to create, share, and compare lesson plans. In the end it saved both the mentor and mentee time and it allowed the coordinator to create a detailed outline of the course for future instructors. Following a lesson-study format may improve the mentoring model used in this research and be more inviting to all involved, especially the adjunct faculty who may be preparing for multiple courses. This format might also meet the second goal described by Little (1990) of creating a cadre of teacher consultants for future graduate students. A lesson-study format would allow for discussions to instill a shared understanding and attitude toward teaching the course as described by Wang (2000). In order for such interactions to take place and to be successful requires the support of administrators. Thus, we recommend administrators consider providing incentives for mentors and the mentees.

A limitation of our study is the fact that the experimental unit is the teacher and the observed data are student responses. A study that randomizes students rather than teachers would provide stronger statistical evidence, but this is ethically difficult to conduct. Further research with a quasi-experimental study with more mentees and mentors are needed to substantiate our results. The mentees may include graduate students, adjunct faculty, and new faculty. We also suggest qualitative methods to explore the perceived benefits of mentoring, to explain students' achievement, and to investigate how adjunct faculty may become more receptive to mentoring. It may also be of value to explore how mentoring alters the mentors teaching.

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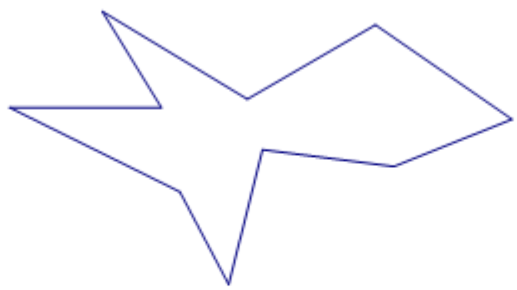
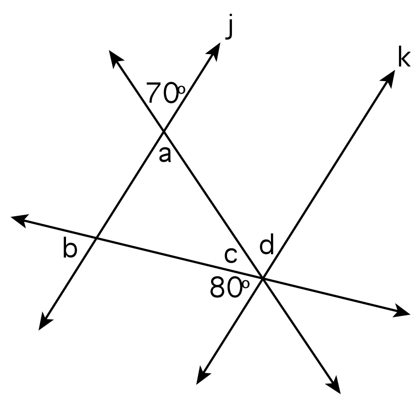
Appendix A: Common Items on Final

1. Use mathematical reasoning to find the angle sum of the following polygon. Explain your reasoning. <u>Measuring the angles does not count!</u>



2. Suppose a regular polygon has an angle sum of 5940 degrees.
   a. How many sides does the regular polygon have?
   b. What is the angle measure of each interior angle of the polygon?

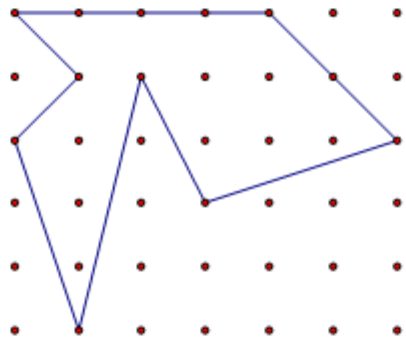
3. In the figure below, lines *j* and *k* are parallel to one another. Find the angle measure of each of the marked angles in the following figure. Using mathematical reasoning, explain how you obtained your answer in a logical order. (Angles are not drawn to scale.)
   a. Angle a =
   b. Angle b =
   c. Angle c =
   d. Angle d =



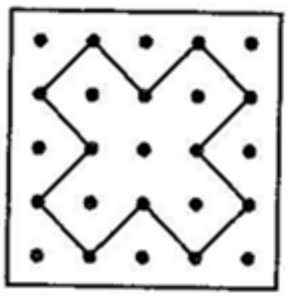
4. Talisa is confused with perimeter, area, and volume. <u>Briefly,</u> explain what each term means and how you would explain the difference between these concepts to her.

5. True or False: Determine whether each of the following statements is true or false. If the statement is false, give a counterexample that illustrates that the statement is false with an explanation. If the statement is true, give a mathematical reason why the statement is true.
   a. Every isosceles triangle is equilateral.
   b. Every rhombus is a kite.
   c. An isosceles trapezoid is also a parallelogram.

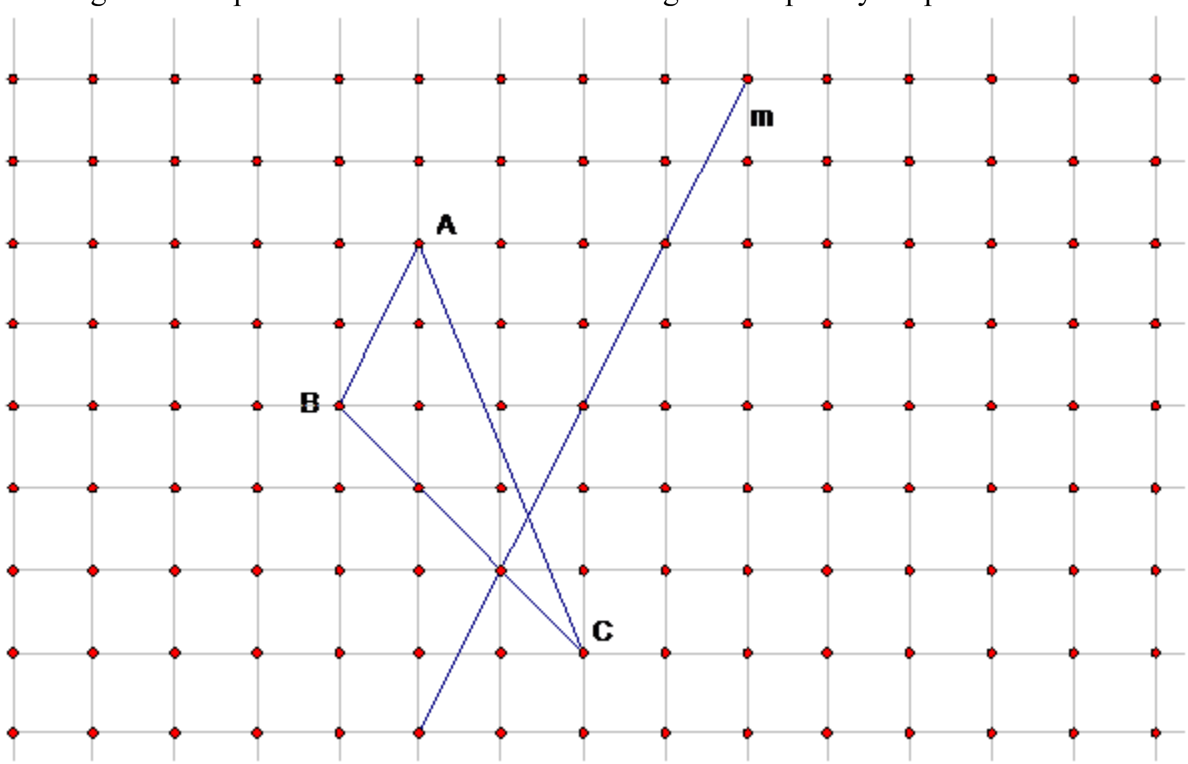
6. Find the perimeter of the following region. <u>Leave your answer in simplified radical form</u>.



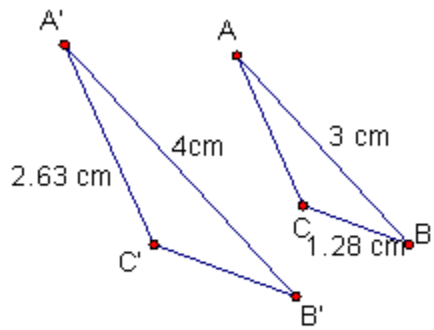
7. Find the area of the following figure. Be sure to state which method you used to find the area.



8. Perform a glide reflection of triangle *ABC* about the given line *m* and with a translation of to the right 2 and up 4. Be sure to label our final image and explain your process.



9. The two figures shown below are similar. The measure of angle ACB is 134 degrees.



   a. What is the measure of angle A'C'B'?
   b. What is the measure of length B'C'?
   c. What is the measure of length AC?

10. If a small can of paint covers 15 square yards, how many cans of paint are needed to cover a wall that is 20 feet by 9 feet?

11. Mark and Mary are flying a kite. Mark has let out 120 feet of string and the kite is directly above Mary's head. Mary is 90 feet away from Mark. How far above Mary's head, is the kite? (Note: Mary's head is level with the end of the string.)