

MATH AS A PROXY FOR POST-SECONDARY PERSISTENCE AMONG GEDS

by

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## DISSERTATION ABSTRACT

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Title: Math as a Proxy for Post-Secondary Persistence Among GEDs

This is a study of the statistical difference in post-secondary attendance between high school graduates and 16-to 18-year-old GED recipients controlling for parental socioeconomic status, 10<sup>th</sup> grade test scores in math, and the number of high school math classes taken. Although GEDs can be the cognitive equivalents of high school graduates, they often lack non-cognitive skills like self-discipline and persistence that are essential components of human capital. The GED certificate is not the equivalent of the high school diploma in terms of post-secondary success because of the magnitude of the negative effect of earning the GED instead of the diploma; this study examines *how* the effect produced the outcomes.

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## CHAPTER I

### INTRODUCTION AND LITERATURE REVIEW

#### **The GED and History of Its Development**

Originally established as a high school equivalency, the GED (General Educational Development) certificate carries mixed connotations since by definition, a GED recipient (from this point on a GED recipient will be referred to as a “GED”, or plural “GEDs”) is someone who was unable to complete the basic task of finishing their public education. Since the early 1990’s studies based on the test (Cameron, 1993; Boesel, 1998), have argued that the GED certificate is not the equivalent of a high school diploma. Their data showed that GEDs earned less money, completed less schooling and training after high school, and dropped out of the military more frequently than regular high school graduates. Furthermore, those studies' authors asserted that in addition to not measuring essential non-cognitive skills like persistence and self-discipline, the GED actually discourages their development because of the inconsistent effort required to earn it — for some, earning the GED is too easy. More recent literature (Trebino, 2006) following the more rigorous 2002 test version indicates that those who obtain this GED show higher income and post-secondary attainment than simple dropouts but less than high school graduates. These studies suggest that completing 11th and 12th grade also has a positive correlation on income and post-secondary achievement.

**The early years of the GED.** The American Council on Education (ACE) developed the GED in 1942 to provide returning veterans who had not graduated from high school with an opportunity to demonstrate that they possessed the same intellectual capabilities as high school graduates, and therefore were prepared to attend college and university (ACE, 2009). The test today is a seven-hour math, reading, social studies, science and writing exam taken over two days; it consists of multiple choice questions, constructed responses, and an essay. Initially, in the 1950’s, the number of GED test-takers was small--around 42,000 nation-wide. In the 1960’s, when federal and state programs increased funding for the GED, the number of GED test takers

increased to more than 800,000 by the 1980's. Beginning with the Johnson Administration, the War on Poverty established adult education programs in which the GED was defined as a successful outcome. The Adult Basic Education Program of 1964, the Guaranteed Student Loan Program of 1965, and the Welfare Reform Act of 1988 established the GED as a determinant of eligibility for federal money (Murnane, 2000; Tyler, 2005). The Welfare Reform Act of 1988 listed Adult Education as a prime objective with GED achievement as a measure. The Workforce Investment Act (WIA) of 1998 further emphasized the importance of the GED by awarding it the same weight as the high school diploma as a measure of successful participation in the program. Since 1968, the National Center for Educational Statistics (NCES) has included the GED in the national graduation rate. However, this bureaucratic equating of the GED with the high school diploma appears to be changing: The No Child Left Behind Act (NCLB) excludes the GED from the graduation rate (Heckman, 2007). This lack of congruence in educational policies is nowhere more apparent than with the GED admission policies of most U.S. colleges and universities. Nearly all college and universities in the U.S. will consider a GED for admission, although most require a score substantially above 450, the current passing score. For example, the University of Oregon's cut score is 580 which, according to the GED Testing Service, represents the top 15% of test takers.

The minimum age to take the test was 18 until 1988, when GEDTS introduced the GED Option Program, which permits 16 and 17 year olds to take the test if they are a full year behind their cohort and can read at least at the eighth grade level. Eleven states, including Oregon (as of 2002), participate in the GED Option Program. A secondary feature of the program allows students to continue with their high school education after passing the test which would enable the GED recipient to take more high school classes like auto shop, welding, or trigonometry without having to enroll in a community college. There is no record of the number of younger GEDs who go on to graduate from high school, but program experience in Central Oregon from 2001 to present, with 1,086 younger GED recipients, indicates that none have graduated from

high school (COIC, 2010). In 2006, 133,565 young people nationwide between the ages of 16 and 19 passed the test. Of these, 76,241 were 16 or 17 years old. The most frequent grade completed for this group was 10<sup>th</sup> grade compared with 11<sup>th</sup> grade for 18 and 19 year olds. In Oregon, 1,950 16 and 17 year olds passed the test compared with the 910 eighteen and 19 year olds who also passed (Zhang, 2009).

**Changes to the exam.** The General Education Testing Service (GEDTS) revised the test in 1978, 1988, and most recently in 2002 to reflect the increasing performance expectations for high school students; the introduction of a written essay in 1988 is an example of the expanded scope (American Council on Education, 2010). In 2012 the GEDTS contracted with Pearson to develop a newer test that will go into effect Jan 1, 2014.

To establish a baseline score for the 2002 version of the test, the GEDTS tested over 10,000 high school seniors randomly selected from the population of all American high school seniors likely to graduate from 359 schools across the U.S. Normalized to score like the SAT exam, 50% of this population scored 500, and the passing score was set at 450, the score above which 60% of this population achieved. The GED testing service asserted that 60% of graduating seniors nationwide would pass the test (George-Ezzelle, 2007), a significant departure from the 1988 test, whose difficulty was set so that 70% of graduating seniors would pass. In other words, the new test is harder than the old one. This reference testing was done annually from 2001-2005 to assure score stability (Benner, 2006), although Tyler (2003) noted that there was no pressure for the high school test sample to score as high as possible and that a “non trivial” percent of GEDs took the test more than once.

**Impact of the GED.** The GED certificate pervades American culture. Tyler (2003) asserted that “...one in every seven high school “diplomas” issued every year is a GED credential...” (p. 541) and Reeder (2007) noted that in 2005 the U.S. population included 14 million GEDs, 159 million high school graduates, and 33 million dropouts, defined as anyone who enrolled in high school — or should have enrolled — and did not graduate. In 2006, more recent data, 2,799,250

students graduated from high school; 14% of these, or 419,352, were GEDs (Laird, 2009; Zhang, 2010). The numbers of GEDs have become non trivial relative to high school graduates as Table 1 shows (US Census Bureau, 2003; GED Testing Service, 2009; Chapman et al., 2011).

Table 1

*GED Test Passers Compared with High School Graduates by Year*

<b>Year</b>	<b>Number of Test Passers</b>	<b>Number of High School Graduates</b>
1949	30,000	1,200,000
1964	85,000	2,658,000
1979	416,000	3,043,000
1994	520,000	2,520,000
2009	472,000	3,039,000

Although the average grade completed is 10th grade, which has not changed since 1958, most recipients, the mode, finished the 11<sup>th</sup> grade. Data collected by the GEDTS in 2009 indicate that 31% of examinees who passed the test were between the ages of 16 and 18, 36% between 19 and 24, 13% between 25 and 29, and the rest were distributed in a decreasing manner (GED Testing Service, 2009). The percentage of 16-18 year olds who passed has declined slightly from 1989, when it was 32.3% (Rachal, 2004); this is probably a function of the increased difficulty of the 2002 test.

Additionally, the GED may encourage high school students to drop out when faced with academic difficulties or challenges, preferring the option of "...High School Lite..." (Rachal, 2004, p 38) offered by the GED. Rachal and Bingham further observed that because the GED exam is a test of adult basic education, GED preparation generally focuses on passing the test as quickly as possible, and that adult learners, as opposed to high school students, generally know what they need to learn and why they need to learn it. This environment encourages 16 and 17 year olds not to complete the 11<sup>th</sup> or 12<sup>th</sup> grade, generally important years for acquiring habits of self-discipline and persistence.

## **Critics of the GED as a High School Equivalent**

Critics of the GED claim that recipients of the credential do not have the same skills as high school graduates and base their assertions on comparisons of income, military records, and post-secondary outcomes (Boesel, 1998; Heckman 1993). The military experience with the GED is startling. Before 1980, the military treated GEDs as high school graduates. After 1980, the military did not (Upchurch, 1976; Means, 1984). According to Boesel, Alsalaam, and Smith (1998), between 1977 and 1983, GEDs were twice as likely as high school graduates to drop out of the military within 36 months of enlistment. In certain parts of the country, the Army still considers GEDs for enlistment, but they are required to score 60% higher on the Armed Services Vocational Aptitude Battery (ASVAB) (US Army, 2010).

Cameron and Heckman (1993), economists at the University of Chicago conducted the landmark study comparing the wages, military testing, and post-secondary educational outcomes of GEDs, dropouts, and high school graduates. This descriptive study is pivotal for any analysis of the GED by establishing the following benchmarks against which GEDs fall short of high school graduates: a) scores on other cognitive tests; b) post-secondary school completion; and c) annual earnings. Using 1979-1987 data from National Longitudinal Survey of Youth (NLSY), they observed that wages of GEDs were closer to those of dropouts than high school graduates, although they noted that the top 10% of GED recipient earners were indistinguishable from high school graduates. They termed this the *Bill Cosby* effect, after the famous actor who eventually earned a Ph.D. after his GED. In other words, income was usually related to years of high school completed. Comparison of scores on the Armed Services Qualifying Test (ASQT) revealed that the scores of GED examinees were, on average, 17% lower than those of high school graduates. Post-secondary completion rates told a similar tale. A 1986 study from the University of Wisconsin showed that only 31% of all GEDs completed the first four semesters compared with 41% of the bottom 20% of high school graduates. And of those who finished the semester, only 73% of GEDs managed a second semester of college compared to 95% of high school graduates.

One group in the Cameron and Heckman study did show an economic benefit from the GED—the eighth grade dropouts who earned the GED after a prolonged academic struggle. Cameron and Heckman suggested that the group was so low skilled that any further education increased income.

**Debate over the criticism.** However, there are two weaknesses in the Cameron and Heckman study. First, the NSLY data relies on a population born between 1960 and 1963 whose cohort graduated from high school between 1977 and 1982, the height of the post-Vietnam era and the Carter presidency, a time characterized by distrust and cynicism. Second, the actual sample size was small; there were only 372 GEDs, 869 dropouts and 3,503 high school graduates in the sample.

Using High School and Beyond (HS&B) data, a longitudinal compilation of 1980 high school sophomores with follow-ups conducted by the US Department of Education in 1982, 1984, 1986, and 1992, Murnane et al. (2000) also examined whether the GED improved wages. They found that, like Cameron and Heckman, GEDs as a single group did not earn as much as high school graduates and earned only slightly more than dropouts. However, they did observe that dropouts who left school with weak cognitive skills and eventually earned the GED did achieve higher income than similar dropouts who did not earn the GED. The authors were unable to conclude whether this was the result of the actual cognitive skill acquisition or a change in behavior related to the work ethic gained by persisting in learning the material to pass the exam.

**More recent information.** Trebino (2008) disagreed even further with Cameron and Heckman, basing her conclusions on 1999-2006 data from the Current Population Survey (CPS). The differences between CPS population and the NLSY population of Cameron and Heckman are significant; the CPS population had taken the 1988 and 2002 test which was more rigorous than the 1978 test on which Cameron and Heckman based their study and the CPS Population was born between 1934 and 1981 and graduated from high school between 1951 and 1998, a span ranging from the Eisenhower 1950's to the Clinton era, incorporating a much wider range of generation

attitudes and experiences. She found: GED holders earn more than dropouts; eighth grade GEDs are more affected than 12th grade recipients; an eighth grade dropout earns 28% less than a graduate, but an eighth grade dropout with a GED earns only 10% less. She offered two further explanations for the differences: either that the GED was a signal of motivation and qualification, or that the recipient acquired income-producing skills in the process of earning the GED.

In 2008, the American Council on Education (ACE) commissioned a study on the economic outcomes of GEDs, dropouts and high school graduates based on the 2003 National Assessment of Adult Literacy (NAAL) data set of 19,258 adults which examined labor force participation, work history, weekly wage, and personal income (Song and Hsu, 2008). The results also contradicted those of Cameron and Heckman. Forty-six and one half percent of GEDs were employed compared to 46.3% among high school graduates and 35.7% of non-graduates. Mean weekly wage was \$566.40 for non-graduates, \$645.54 for GEDs, and \$698.80 for graduates. GEDs are more likely to have held a paying job within the last three years than both graduates and dropouts.

These last two studies suggest that the increased rigor of the more recent GED tests correlated with improved economic outcomes of GEDs. Consistent through all the studies is that the value of the GED is related to the effort required to earn it.

### **Cognitive Skills and Post-Secondary Outcomes – The Current State**

Because the post-secondary experience of most GEDs has been unequivocally bleak, in 2003, the ACE began a three-year longitudinal study of GEDs' post-secondary experience examining the *entire population* of GED test passers. That year, 327,993 passed the exam, and 132,119 (40%) enrolled in post-secondary education, of whom only 17,597 (11%) graduated by September 2009. The youngest age group (16-24) was most likely to enroll but least likely to graduate. Not surprisingly, the rate of graduation in all age groups was 54% higher for those scoring above 572 (Patterson, 2010 A). In an earlier pilot study, the same authors noted that 77% of GED earners attending college drop out before the second semester (Patterson, 2009). In 2005

the National Household Education Survey (NHES) and the National Assessment of Adult Literacy (NAAL) identified GEDs, high school graduates, and dropouts, and connected them to post-secondary educational and economic outcomes. They found that GEDs score in between graduates and dropouts in all categories (Reder, 2007). None of these studies, however, identify the number of GEDs placed in post-secondary remedial math and writing classes. Nearly one-third of first-year college students take remedial classes, which suggests that neither passing the GED nor graduating from high school prepare all students adequately in terms of academics for college (Mellard, 2007). Yet common to all these studies is that high school graduates complete post-secondary programs at a much higher rate than GEDs. Reder (2007) defines the key ingredient that GEDs lack as a non-cognitive skill, persistence — which enables an individual to obtain a two- or four- year degree or remain enrolled in a two- or four-year college.

**Non-cognitive skills: the role of persistence and self-discipline.** Heckman and LaFontaine (2007) assert that GEDs lack perseverance, motivation, and self-discipline in spite of possessing high school graduates' cognitive ability. Heckman and Rubinstein (2001) grimly described the missing non-cognitive skills and how their absence characterizes GEDs. Perseverance, dependability and consistency are the traits most predictive of job and academic success, and the authors demonstrate statistically that these are the precise traits that GEDs lack. In fact, they assert that because GEDs initially possessed more cognitive skills than dropouts, they never cultivated the non-cognitive skills that dropouts were forced to acquire. Finally, Tyler and Lofstrom (2010), noting that the role of the GED in moving dropouts into post-secondary education is a "...woefully understood area...." (p. 813), examined data from Texas schools to follow a cohort of at-risk eighth graders through two decision points: completing four years of high school and graduating or dropping out *and* obtaining a GED. They conclude that those who obtain the diploma are far more likely to enroll in post-secondary education and then complete more credits. It appears that late adolescence is when Americans develop persistence, self-

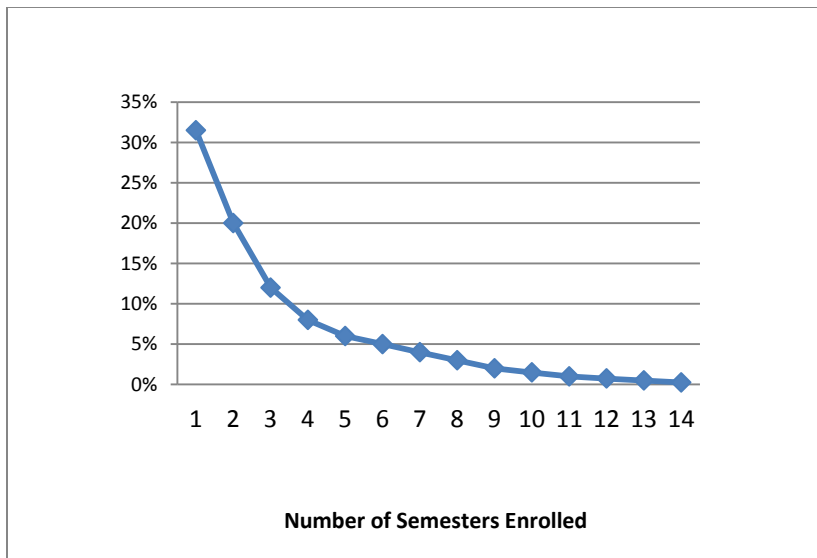
discipline, and the ability to work with others, and that the quality of these traits is dependent on the amount and relative difficulty of the school work performed and years of school attended.

**Life circumstances.** The data are quite clear that minority students disproportionately earn the GED (Reder, 2007). The data are equally clear on parental income and education—the parents of GEDs earn significant less money and have less education than parents of those earning the diploma although more than parents of dropouts (Cameron and Heckman, 1992; Tyler, 2005). Non high school completers with low expected lifetime earnings choose the GED (Tyler, 2003). 42% of GEDs' parents attended college vs. 62% of high school graduates' parents and 18% of GEDs' parents did not finish high school vs. 8% of high school graduates parents (Guison-Dowdy and Patterson, 2011). From this one can infer that parents' socio economic level is an important factor in the choice of GED over the high school diploma.

**High school credit taking.** Trebino (2006) demonstrated that the number of years of high school completed before obtaining the GED is more directly related to post-secondary income than earning the GED. Eighth grade dropouts earned 28% less than graduates, but those who earned the GED earned 10% less, a 18% gain. Twelfth grade dropouts earned 15% less than graduates but those who earned the GED earned 6% less than graduates, a 9% gain. Earning the GED has more benefit for eighth grade dropouts than 12<sup>th</sup> grade dropouts. Ezzelle and Chu (2007) note that the most difficult area for GED test takers is math; their study compared GED math results between GEDs and high school graduates who both took the GED exam noting that GEDs lagged high school graduates in this area begging further examination between the two. Finally, in a recent study, still using NLSY79 data, Heckman et al. (2010) make an even more compelling argument for the non cognitive difference between GEDs and high school graduates with no post-secondary education: after controlling for pre-existing cognitive ability graduates show significantly increased income.

**Post-secondary academic success.** In the previously cited series of longitudinal studies (Patterson et al., 2009; Patterson et al., 2010; Zhang et al., 2011), the post-secondary outcomes of

more than 750,000 GEDs from 2003 and 2004 were matched against National Student Clearing House (NSC) data for six years. Key findings of the reports note 43% of GEDs went on to post-secondary education and less than 12% of those who enrolled earned a certificate, two-year or four-year degree. Among high school graduates for the same period, 80% had enrolled in a post-secondary institution and 49% of those had earned a certificate, associate's degree or a bachelor's degree by 2009. Of those who began a four year college, 68% earned a bachelor's by 2009 (Ross et al., 2012). Figure 1 shows the percentage of 2003 GED test passers who completed successive semesters of college. Heckman (2010, p. 38) shows a bar graph showing that by 2006, 67% of NLSY79 high school graduates had enrolled in a two or four year institution with 9% earning a two year degree and 32% having earned a four year degree. 49% of the GEDs from the cohort had enrolled in a two or four year institution with 7% earning a two year degree and 6% earning a four year degree.



*Figure 1.* Number of Post-secondary Semesters Enrolled 2003 - 2008 for 2003 GED Recipients.

Reproduced from Patterson (2010, p.17).

Note. If the high school graduates' data were included, their semester 1 value would have been 80% and their semester 14 value would have been 32%.

In comparing high school graduates to dropouts, Zhang et al. (2011) observed similar demographics and SES but besides the obvious difference in attendance patterns, they additionally noted: (a) GEDs who completed the twelfth grade (without fulfilling the requirements for graduation) were nearly twice as likely to graduate from college as other dropouts, (b) there was no difference in graduation rate between those who completed 11<sup>th</sup>, 10<sup>th</sup>, 9<sup>th</sup>, and 8<sup>th</sup> or less and (c) those whose GED scores were in the 80<sup>th</sup> percentile or higher were a nearly 70% more likely to graduate than those in the other quartiles. Something transformative relating to persistence or cognitive ability, or both, appears to occur by attending the 12<sup>th</sup> grade or by the process of obtaining a high GED score.

Both Heckman et al. (2010) and Zhang et al. (2011) address the same issue of persistence and why GEDs underperform relative to graduates touching on what might be the causal factor in their discussion of preparation time to pass the exam. Heckman compares the average preparation time of 20 hours (calculated from the survey required of all GED test takers) to the 1,000+ hours of class time per year required to graduate from high school. Following his logic, a high school graduate has put in more than 4,000 hours of class time (depending on attendance) versus the 20 hours of prep time for the average GED recipient. However, Heckman fails to observe that by the same logic an 11<sup>th</sup> grade dropout has put in up to 3000 hours. He also asserts that the GED recipient is characterized by having taken the easy way out instead of graduation, but he fails to acknowledge that many graduates have also taken an easy way to graduation by avoiding challenging coursework, seeking out easy teachers and attending the minimum to achieve passing grades. Clearly, the difference in preparation time is not 20 hours vs. 4,000, but closer to 3,000 versus 4,000, begging the question of which of the 1,000 hours difference are affective.

Zhang, on the other hand, has refined the focus of the argument, noting that GEDs who are 12<sup>th</sup> grade completers are much better at post-secondary outcomes than 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup> or 11<sup>th</sup> grade completers whose post-secondary performance is about the same as each other.

## **Research Purpose: Refining the Practical Differences Between the GED and High School Diploma**

All these micro-arguments miss the point that non cognitive skills like persistence, reliability, and motivation hide behind cognitive and academic skills and may be as simple as those acquired by succeeding in a relatively difficult high school math class. The incoherence in the literature is that if the GED were the cognitive equivalent of a high school diploma, then the difference in outcomes could only be explained by GED's lacking the non-cognitive qualities required to succeed in school. However, in the academic setting of the American high school, cognitive and non-cognitive skills are bound; there is no question that *both* the non-cognitive skills of persistence, reliability and motivation and cognitive academic skills are required to pass any high school class.

The practical issue is that given the generally disparate post-secondary outcomes between GEDs and graduates, how can one measure the marginal difference between GEDs and diplomas in terms of the high school experience with an eye toward improving GED post-secondary outcomes? In this context, the GEDs may in the unfortunate position of being akin to the canary in the coal mine by serving as an indicator of borderline skills and experiences required for post-secondary success. Numerous arguments and studies have linked race and ethnicity to post-secondary performance; class and life circumstances like poverty trump all factors. If GEDs and graduates have been blocked for social class, as implied by the Zhang (2011) study, the essential difference between the GED and graduates is the contrast between declarative knowledge on the one hand *and* both procedural and declarative knowledge on the other.

As noted earlier, the literature has also shown that math is the one area on the GED test where GEDs' scores lag those of high school graduates, particularly in the area of algebra, functions, and patterns (Ezzelle and Chu, 2007). The Tyler and Lofstrom (2010) study that compared the post-secondary enrollments of GEDs and high school graduates who were at-risk 8<sup>th</sup> graders noted that the at risk GEDs' 8<sup>th</sup> grade math scores were one third standard deviation lower than

those of graduates. However, Tyler and Lofstrom also note that their observations about the eventual outcomes “may be a tenuous proposition because these groups are already substantially different academically in the 8<sup>th</sup> grade” (2010, p. 818), begging the question of comparing a sample of GEDs and graduates more closely aligned academically, one to two years from graduation instead of four. This question is further refined by the issue of *which* additional classes in high school—if any—differentiates the GED from the graduate. Because there is more uniformity in math classes than other classes, it makes sense to examine the two groups in terms of math classes taken in high school.

Math classes beyond Algebra I may serve as a proxy for the life skills that are hiding behind the cognitive skills. This study will examine the differences in outcomes between similarly blocked GEDs and graduates whose high school math classes after the 10<sup>th</sup> grade range from none to Pre-Calculus. It will investigate whether there is a relationship between the number of math classes and the months of attendance in a post-secondary educational institution during the two year period after graduation. This is the first hypothesis.

By blocking the GEDs and high school graduates on 10<sup>th</sup> grade math scores, socio-economic status (SES), and math classes, their educational differences will be limited to one year of non-math classes, assuming a constant dropout rate and GED acquisition between 11<sup>th</sup> and 12<sup>th</sup> grade. And without the more rigorous math classes that either select persistence or teach it, GEDs and graduates will show about the same months of continuance in post-secondary attendance. This is the second hypothesis.

In other words, the number of post-secondary months attended will be a function of cognitive math academic skills nested with the non-cognitive skills like persistence that are acquired by succeeding at additional math classes. This is the third hypothesis which leads to the research question: How does the difference in post-secondary outcomes between GEDs and high school graduates vary based on the additional number of math classes taken by graduates controlling for

SES and 10<sup>th</sup>-grade math test scores? This logic is illustrated conceptually by the model in Figure 2.

*Post-secondary Success Model*

Graduates blocked for test-scores and SES

$$\text{Postsecondary Attendance} = f [(\text{Post } 10^{\text{th}} \text{ grade math classes and related skill acquisition}) + (\text{non cognitive skills related to graduation})]$$

GEDs blocked for test-scores and SES

$$\text{Postsecondary Attendance} = f [(\text{Post } 10^{\text{th}} \text{ grade math classes and related skill acquisition})]$$

*Figure 2.* Conceptual model showing post-secondary enrollment.

The logic begs an alternative question: If there is a difference in post-secondary attendance outcomes for GEDs and graduates who have taken the same math classes, what is the role of the non--cognitive skills related to graduation?

## CHAPTER II

### METHODOLOGY

#### **Data and Sample**

The Education Longitudinal Study of 2002 (ELS 2002) contains a sample of 16,197 students surveyed as 10<sup>th</sup> graders in the spring of 2002. The sample was from 1,200 public, Catholic and other private schools of which around 750 participated. Of the 17,600 eligible 10<sup>th</sup> graders, 15,400 completed the questionnaire. There were six elements to the survey: (a) math assessments specific to ELS: 2002 using items from NELS:88, NAEP and PISA; (b) student survey; (c) parent, teacher, administrator and librarian surveys; (d) first follow-up, a 2004 survey of students in their graduation year determining their graduation status (graduate, dropout or GED); (e) 2004-2005 transcript study in which the related high school transcripts were compiled—these data are restricted to license holders, and (f) second follow-up in 2006 in which all original students are respondents. Variables measured included sex, race/ethnicity, parent education, income, occupation, family circumstance, and educational aspirations, school location and region, and weekday hours employed. 14,540 completed cognitive assessments in math tied to NAEP and PISA prior to the survey. Cameron and Heckman (1993), whose study was described in the literature review, used Bureau of Labor Statistics data of 1972 high school graduates. Murname et al. (2003), also described in the literature review, used National Center of Education Statistics data for 1982 graduates. The ELS 2002, thus, represents a continuation of the series with data representing current educational trends in high school.

The first follow-up was in spring 2004 when the participants were seniors, and the second follow-up was conducted in 2006, two years after the expected graduation date. A third follow up should have been completed in 2012 but the data will not be available to the public until later in 2013. There were 612 GEDs between 2003 and 2004 of whom 198 started post-secondary education by '06; these and the 10,183 graduates who started post-secondary school by January, 2006 will make up the sample for this study. Additionally, ELS 2002 included transcripts as a

restricted data-file, gathered in spring of 2005 detailing the courses taken during the high school careers of both GEDs and graduates; some of these data were recoded for inclusion in the ELS 2002 public data files. The second follow-up in 2006 also includes enrollment data in two and four year post-secondary institutions. The overall response rate was 88%.

### Study Design

This study follows two groups—2004 high school graduates and the GEDs who dropped out and received the certificate in 2004 or before—both of whom attended a post-secondary institution by January, 2006. The study will block the groups for parents’ SES and uniformity of 10<sup>th</sup> grade NELS:88, NAEP and PISA equivalent scores in math and follow their attendance by month in two or four year post-secondary institutions. The blocking elements are all fields in the data set and are listed and described in Table 2. The ELS 2002 data file documentation further explains that the data already categorize postsecondary enrollment into a calculation field designated F2RTYPE as whether the student is a “standard enrollee,” one who was enrolled by October 2004 and was still enrolled in 2006, or a “leaver,” one who began post-secondary enrollment, but has no 2006 enrollment (Ingels et al., 2007). This designation is listed in Table 2.

Table 2

*Classification rules for F2RTYPE, by respondent type: 2006*

Respondent type	Any post-secondary enrollment after high school?	“On time” post-secondary enrollment?	Any reported post-secondary enrollment in 2006	Enrolled in high school when interviewed
Standard enrollee	Yes	Yes	Yes	No
Delayer	Yes	No	Yes	No
Leaver	Yes	Yes	No	No
Delayer-leaver	Yes	No	No	No
Nonenrollee	No	na	na	No
High school student	na	na	na	Yes

na Not Applicable

*Note.* Reproduced from Ingels, S.J., Pratt, D.J., Wilson, D., Burns, L.J., Currivan, D., Rogers, J.E., Hubbard-Bednasz, S., (2007, p 45).

However, this seems unnecessarily complicated; simply comparing the number of months attended between the two groups will have answered the research question.

### Variable Selection

The purpose of this study is to investigate the relationship between enrollment in post-secondary education and independent variables, including parental socio economic status (SES), 10<sup>th</sup> grade math scores, the number of high school math classes taken, and graduation versus GED. The focus is the additional math courses taken by the graduates and other additional courses leading to graduation. In other words, does the type of class taken in high school indicate post-secondary readiness operationalized by the number of postsecondary months enrolled? Accordingly, related variables were selected from the publicly available Educational Longitudinal Survey (ELS) 2002 database (Ingels, et al., 2007). If necessary, selected variables were recoded or aggregated before statistical analyses were conducted.

**Independent variables.** Five independent variables were selected and are listed in Table 3. Also, brief descriptions for each variable (self-explanatory variable label, variable type, and additional description) are provided in the table. The variable name and label are from the original public data codebook (Ingels, et al., 2007).

Table 3

#### *Independent Variables*

Variable Name	Variable Label	Type	Additional Description
F2HSSTAT	High School Completion Status in 2006	categorical	Source: High School Transcript.
BYF2EVRGED	Ever earned GED / equivalency	dichotomous	The source of this data is student transcript, GED Testing Program, First and Second Follow-up questionnaires.
BYSES2QU	Quartile coding of BYSES2	ordinal	Public Composite variable composed of father's and mother's education and occupation, and family income; 1 is lowest.
BYTXMQU	BYTXCSTD scores assigned quartiles.	ordinal	Public Composite assigned to test scores on the ELS 2002 math assessment; 1 is lowest.
F1RMAT_P	Units in mathematics	ordinal	Public use version of restricted use transcript variable, constructed to avoid disclosure.

**Dependent variables.** ELS 2002 described the postsecondary enrollment based on the type of institution in which the student enrolled and whether the student was enrolled for the particular month for the period between January 1, 2004 and January 30, 2006. Additionally, there was a variable, F2PSPR\_4 to indicate the number of months of post-secondary enrollment before January, 2004 with categories to show that the student was enrolled for 1-3 months, 4-6 months or more than 7 months. The following table, Table 4, lists the dependent variables. For brevity, 23 variables from F2PS0402, Enrolled in postsecondary institution in February, 2004 through F2PS0512, Enrolled in postsecondary institution in December, 2005, were omitted. The entire list is included as Appendix A. The variable name and label are from the original public data codebook (Ingels, et al., 2007).

Table 4

*Dependent Variables*

Variable Name	Variable Label	Type	Additional Description
F2PSPR_4	Number of months of post-secondary enrollment before January 2004	categorical	Public use version of the restricted use variable F2PRPRE4. Categories indicate 1-3 months, 4-6 months, or more than 7 months.
F2PS0401	Enrolled in post-secondary institution in January 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0402 – F2PS0512	February '04 – December '05 omitted for brevity; see Appendix A for complete list		
F2PS0601	Enrolled in post-secondary institution in January 2006	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.

**Recoding the Dependent Variables and Independent Variables**

Variables for this study were created based on variables available on the publicly available Education Longitudinal Study of 2002 (ELS 2002) data. The dependent variable was created such

that it would measure the number of months of enrollment. Independent variables were created to measure the following: (a) GED or graduate, (b) 10<sup>th</sup> grade quartile math score, (c) socioeconomic status quartile, and (d) number of math classes taken as terciles. The short descriptions of the dependent and independent variables are provided in Table 5. A detailed description of the recoding process is provided as Appendix B.

Table 5

*Final Independent and Dependent Variables*

Variable Name	Variable Label	Type	Description
revTotpsec	Post-secondary	Dependent Continuous	Total post-secondary enrollment in months
GEDGrad	GED	Independent Dichotomous	GED or Graduate 1 = HS Graduate 2 = GED
BYSES2QU	SES	Independent Ordinal	Quartile coding of SES2 (BYSES2) 1 is lowest.
BYTXMQU	Math score	Independent Ordinal	Test score quartile (1=low).
revF1RMAT_P	Units in Math	Independent Ordinal	0 – 1 Carnegie Units = 1 1 – 3 Carnegie Units = 2 4 – 6 Carnegie Units = 3

**Additional Data Selection**

Only students who had received the Diploma or GED and had attended at least one month of post-secondary education (GED or graduate > 0 and Total Post-secondary Enrollment > 0) were included in the data set—students who did not attend post-secondary education were outside the scope of this study.

**Descriptive Statistics**

Data contained 10,381 GEDs and high school graduates who attended a postsecondary school before January 1, 2004 and during the period January 1, 2004 through January 1, 2006. The mean attendance for graduates was 14.45 months. The mean attendance for GEDs was 9.70 months. The medians were 16 months and 7 months for graduates and GEDs, respectively. The median

SES quartile for both the GED and graduate was 3. The median Math score for the GED was 2 while that of the graduate was 3. Similarly, the graduates showed a higher median value for revised units of math, 3, while the GEDs' median value was 2.

The disparity in numbers of GEDs versus graduates should also be noted: there were 10,381 graduates with post-secondary attendance compared with 198 GEDs with post-secondary attendance. Not surprisingly, GEDs and graduates showed a difference in the standard deviations of their attendance: that of the GEDs was 7.63 while that of the graduates was 4.82. Surprisingly, however, SES appeared evenly distributed across GED and graduates. This suggests that although GEDs in general are of lower SES than graduates, among those who seek postsecondary education, SES is comparable. These data are summarized in Table 6 with cross tabulated data in Table 7. The comparisons are shown graphically in the bar graphs in Figure 3.

### **Mean Comparisons between GEDs and Graduates**

Both the study design and the descriptive statistics suggest a comparison of group means of Post-secondary, broken down by GED, SES, Math score, and Units in Math.

Because there are four levels of SES, four levels of Math score, three levels of Units in Math and two levels of GED, there will be 96 group means for comparison. The group means of graduate Post-secondary, broken down by the levels of Units in Math, Math score, and SES, are listed as Appendix C. The group means of GED Post-secondary are also broken down by the levels of Units in Math, Math score, and SES and are listed in Appendix D. A 4-way ANOVA was conducted to investigate interactions between the variables.

Table 6

*Summary Descriptive Statistics for Graduates and GEDs with at least 1 month of post-secondary education*

		Post-secondary	SES	Math score	Units in Math
N total	Valid	10381	9898	10271	9669
	Missing	0	483	110	712
N GED	Valid	198	185	195	162
	Missing	0	13	3	36
N Graduates	Valid	10183	9713	10076	9507
	Missing	0	470	107	676
Mean Months		14.36	2.84	2.88	2.51
	GED	9.70	2.69	2.42	1.85
	Graduate	14.45	2.84	2.89	2.53
Std. Deviation		4.93	1.090	1.04	.55
	GED	7.63	1.07	1.02	.56
	Graduate	4.82	1.09	1.04	.54
25 <sup>th</sup> percentile		13.00	2.00	2.00	2.00
	GED	4.00	2.00	2.00	1.75
	Graduate	13.00	2.00	2.00	2.00
50 <sup>th</sup> percentile		16.00	3.00	3.00	3.00
	GED	7.00	3.00	2.00	2.00
	Graduate	16.00	3.00	3.00	3.00
75 <sup>th</sup> percentile		18.00	4.00	4.00	3.00
	GED	14.25	4.00	3.00	2.00
	Graduate	18.00	4.00	4.00	3.00

Table 7

*GED and High School Graduate Cross tabulation of SES, Math score and Units in Math with Mean Months Attended in Post-secondary School and Standard Deviations*

Variable	Level	N	GED			High School Graduate			
			%	mean months	sd	N	%	mean months	sd
SES									
	1	32	17%	7.16	5.34	1549	16%	12.96	5.62
	2	47	25%	7.91	6.60	2036	21%	13.7	5.18
	3	53	29%	9.64	7.11	2562	26%	14.43	4.64
	4	53	29%	12.26	9.24	3566	37%	15.6	3.93
	Total	185	100%	9.52	7.61	9713	100%	14.47	4.79
Math score									
	1	42	22%	8.29	6.79	1287	13%	11.9	5.80
	2	66	34%	8.62	6.11	2180	22%	13.62	5.26
	3	51	26%	10.11	8.17	3007	30%	14.74	4.59
	4	36	18%	12.86	9.58	3602	36%	15.66	3.73
		195	100%	9.72	7.67	10076	100%	14.46	4.80
Units in Math									
	1	40	25%	9.37	8.04	186	2%	11.81	6.73
	2	107	66%	10.67	7.92	4137	44%	13.66	5.43
	3	15	9%	9.27	5.54	5184	55%	15.19	3.96
		162	100%	9.82	7.73	9507	100%	14.46	4.79

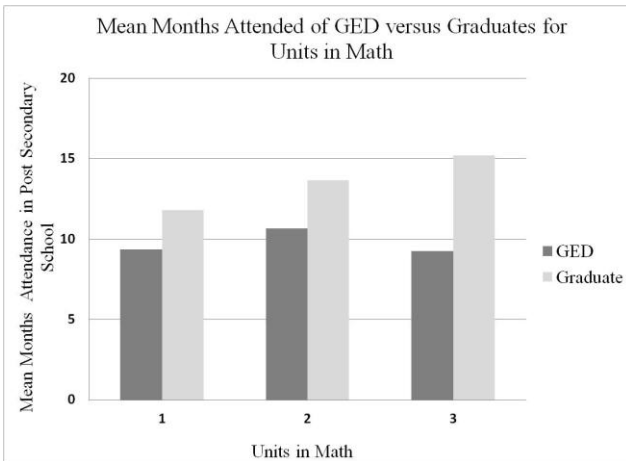
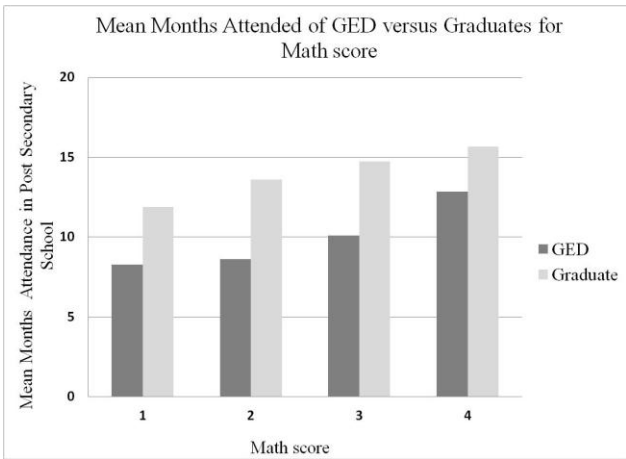
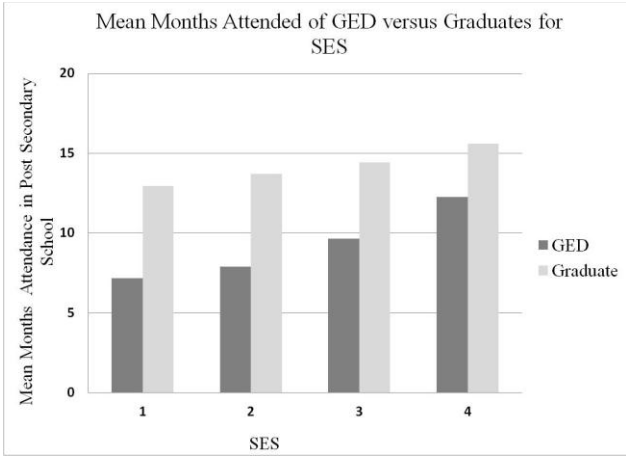


Figure 3. Mean Months Attendance for GEDs versus Graduates across SES, Math score and Units in Math.

## CHAPTER III

### RESULTS

The mean comparisons between GEDs and high school graduates (from this point on a high school graduate will be referred to as “graduate”) illustrate the complexity of comparing the mean values of the dependent variable to address the research question -- how the difference between GEDs and graduates’ months of post-secondary enrollment varies based on the number of math classes taken, if the groups have been blocked for SES and 10<sup>th</sup>-grade math test scores. The multiple levels within the independent variables and the possibility of interaction between them, point to using a factorial analysis of variance (ANOVA) technique to provide initial inferential statistics. Because there were four independent variables, a 4-way ANOVA was conducted in which four main effects, six 2-way, four 3-way and one 4-way interaction effects were examined. A post hoc analysis by an independent samples t-tests or 1-way ANOVA was also done when appropriate. All calculations were done by means of SPSS software and Cohen’s *d* was calculated by Dr. Lee Beckers Effect size calculator (Becker, 2000).

#### **Statistical Test Results of 4-Way ANOVA**

The ANOVA examined the effects of GED, Units in Math, Math score, and SES on the dependent variable, Post-secondary that are shown in Table 8. The 4-way interaction effect between the four independent variables was statistically significant:  $F(10, 9156) = 4.72, p = .00$  indicating that there were one or more three-way interactions across the levels of a fourth variable – which was borne out by all four 3-way interactions being statistically significant. The  $R^2$  value was .12, which is considered small (Leach et al., 2011).

All 3-way interactions were significant. When a 3-way interaction is significant, it can be interpreted that a two-way interaction between two variables is not consistent across the levels of the third variable. The interaction between GED, Units in Math, and Math score was significant:  $F(6, 9156) = 5.28, p = .00$ . The interaction between GED, Units in Math, and SES was significant:  $F(6, 9156) = 2.77, p = .01$ . The interaction between GED, Math score, and SES was

significant:  $F(9, 9156) = 4.41, p = .00$ . The interaction between Units in Math, and Math score and SES was significant:  $F(18, 9156) = 2.85, p = .00$ .

Table 8

*ANOVA 1: GED, Units in Math, Math score, and SES  
Tests of Between-Subjects Effects*

Dependent Variable: Post-secondary						
Source		Type III Sum of Squares	df	Mean Square	F	p
Main Effect						
	GED	682.58	1.00	682.58	32.52	0.00
	Units in Math	24.79	2.00	12.39	0.59	0.55
	Math score	305.82	3.00	101.94	4.86	0.00
	SES	405.79	3.00	135.26	6.44	0.00
2-way Effect						
	GED * Units in Math	57.51	2.00	28.76	1.37	0.25
	GED * Math score	3.38	3.00	1.13	0.05	0.98
	GED * SES	47.99	3.00	16.00	0.76	0.52
	Units in Math* Math score	666.31	6.00	111.05	5.29	0.00
	Units in Math* SES	454.75	6.00	75.79	3.61	0.00
	Math score * SES	435.07	9.00	48.34	2.30	0.01
3-way Effect						
	GED * Units in Math* Math score	664.91	6.00	110.82	5.28	0.00
	GED * Units in Math* SES	348.95	6.00	58.16	2.77	0.01
	GED * Math score * SES	833.88	9.00	92.65	4.41	0.00
	Units in Math* Math score * SES	1077.11	18.00	59.84	2.85	0.00
4-way Effect						
	GED * Units in Math* Math score * SES	790.53	10.00	79.05	3.77	0.00
Error		192206.59	9156.00	20.99		

a. R Squared = .124 (Adjusted R Squared = .116)

Three of the six two way interactions, GED and Units in Math, GED and Math score, and GED and SES, showed no statistical significance ( $F[2, 9156] = 1.37, p = .25$ ;  $F[3, 9156] = .05, p = .98$ ;  $F[3, 9156] = .76, p = .52$ , respectively). The three other two-way interactions did show statistical significance: Units of Math and Math score ( $F[6, 9156] = 5.29, p = .00$ ); Units in Math and SES ( $F[6, 9156] = 3.61, p = .00$ ); and Math score and SES ( $F[9, 9156] = 2.30, p =$

.01). This means that differences in Post-secondary depend on the specific combinations of Units of Math and Math scores, SES and Math scores, and SES and Units of Math. The lack of interaction between GED and SES was unexpected and will be addressed in the Discussion.

The main effects of GED, Math score, and SES are significant ( $F [1, 9156] = 32.52, p = .00$ ;  $F [3, 9156] = 4.86, p = .00$ ;  $F [3, 9156] = 6.44, p = .00$ , respectively). The main effect of Units in Math, the variable on which the research question is based, is not statistically significant ( $F [2, 9156] = .59, p = .55$ ). However, as has been implied, it will be shown, there are significant interaction effects involving this variable.

The significant main effects of Math score, GED, and SES indicate that the main effect of Units in Math may be hidden. And, because of the 4-way effects, the 3-way interaction can be interpreted that the interaction between Units of Math, Math score, and SES is not consistent between GED and graduates. In other words, the 3-way interaction may be apparent for either GED or Graduates, but not both.

Additionally, the significant 3-way and 2-way interactions further indicate that the main effect of GED also needs examination because the effects of Math score and SES, Math score and Units of Math, and Units of Math and SES are inconsistent across the GED variable. In other words, the 2-way interaction may be apparent for either GED or graduates, but not both. All these observations suggest further exploration, including post hoc analyses.

The 4-way ANOVA can be thus summarized in terms of the research question of whether additional math classes are a proxy for post-secondary persistence with GEDs:

- 1) The 4-way interaction was significant meaning that a 3-way interaction depends on the levels of fourth factor – in this case, GED, Math score and SES depend on Units in Math.
- 2) The 3-way interactions were significant, meaning that the 2-way interactions depend on the level of the third factor – in these cases, Units in Math and Math score depend on GED, and Units in Math and Math score depend on SES.

- 3) Within the 3-way effect, the highest  $F$  value, 5.28, occurred for GED, Units in Math and Math score. For the 2-way effect, the highest  $F$  value, 5.29, occurred for Units in Math and Math score. Consequently, the study's focus was here, although all the 3-way interactions were investigated.

### **Detailed Examination of 3-Way Interactions**

**Math score, Units in Math and GED.** In a 3-way interaction, the 2-way interaction depends on the levels of the third factor. The plots associated with the 3-way interaction of Math Score, Units in Math and GED, are shown in Figure 4. It is graphically apparent that the interaction of Math score and Units in Math depend on the level of the third factor, GED. The graphs imply that months of Post-secondary outcomes for GED and Graduate are not different for Units in Math = 1 and Math score = 1 and show that as the Math score and units in Math increase, the gap in outcomes between GEDs and graduates increases.

The main effect of GED is illustrated by the separation of the lines. The main effect of Math score is shown by the rising slope as the Math score increases. The interaction effect between Units in Math and Math score on GED is indicated by the increasing difference between GED and Graduate as Math scores increase. The spikes at Math score = 3 for Units in Math = 1 and 3 were investigated and found inconclusive at Units in Math = 3 and puzzling at Units in Math = 1.

Because the results described above suggest that there is influence of Units of Math and Math score on GED at Units in Math = 1 and 3,  $t$ -tests were performed to compare outcomes. As shown in Table 9, GEDs were not different from Graduates on Post-secondary at Units in Math = 1 and Math score = 1 ( $p = .81$ ), Units of Math = 1 and Math score = 2 ( $p = .42$ ), and Units of Math = 1 and Math score = 4 ( $p = .60$ ). Only at Math score = 3 was there a statistically significant difference, where GEDs had lower means by 8.1. Because the GED sample size was so small at Math score = 4, it was impossible to make an inference of a trend.

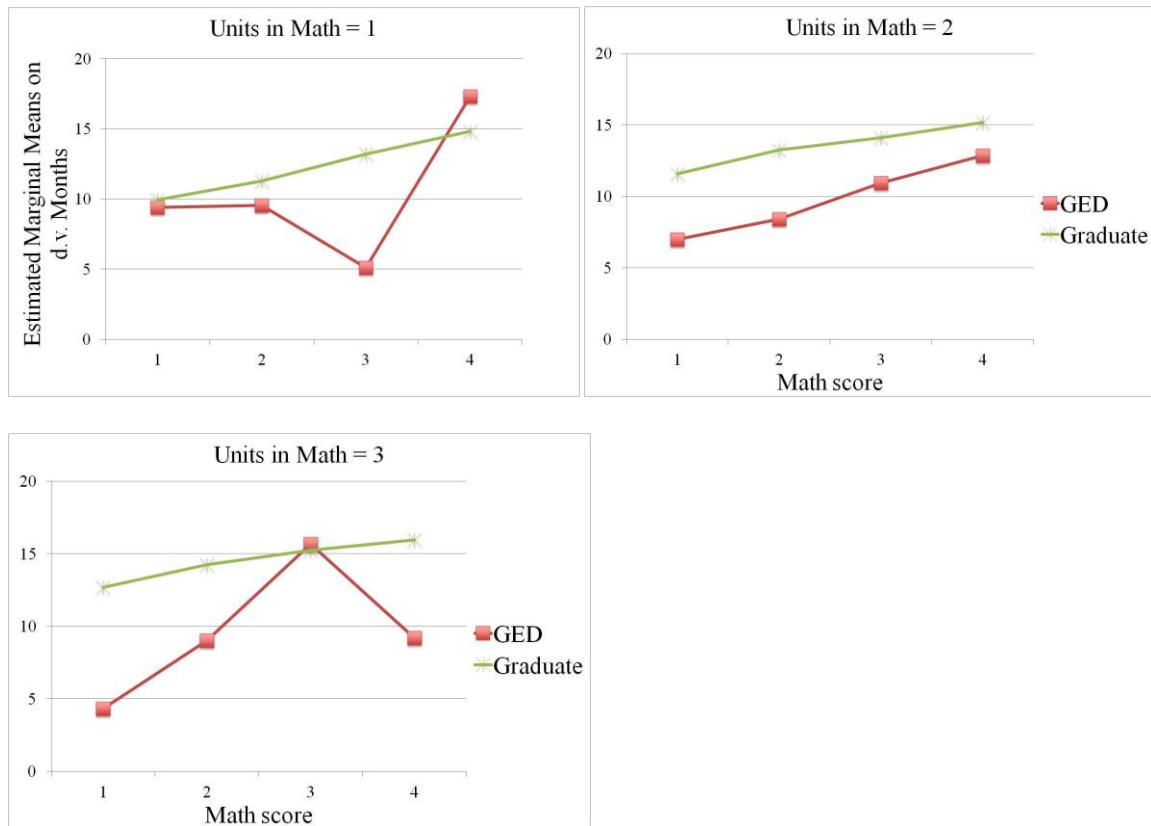


Figure 4. ANOVA Plot 1: Estimated marginal means of months enrolled in post-secondary schools for Math score, and Units in Math.

As shown in Table 10, GEDs were consistently lower than Graduates on Post-secondary at Units in Math = 2. However, the mean difference was significant only at Math score quartiles 1 and 2: Math score = 1, *Mean Difference* = 4.57,  $p = .00$ ; Math score = 2, *Mean Difference* = 4.86,  $p = .00$ . At Math score = 3 and 4, there was no statistically significant Mean Difference. Sample sizes for GEDs were consistent and ranged from 18 to 30. The mean differences declined as Math scores increased implying that GEDs with higher math scores had months of post-secondary enrollment that approached that of high school graduates.

Table 9

*Comparison of Post-secondary of GED and Graduates for Math score and Units in Math = 1*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
Math score = 1	Graduate	55	9.95	6.89	.24	65	.81	.53
	GED	12	9.41	7.63				
Math score = 2	Graduate	51	11.30	6.91	.82	62	.42	1.76
	GED	13	9.54	7.04				
Math score = 3	Graduate	42	13.21	5.01	4.57	49	.00	8.1
	GED	9	5.11	3.55				
Math score = 4	Graduate	17	14.82	6.78	-.53	18	.60	-2.51
	GED	3	17.33	11.50				

Table 10

*Comparison of Post-secondary of GED and Graduates for Math score and Units in Math = 2*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
Math score = 1	Graduate	719	11.57	5.81	3.31	735	.00	4.57
	GED	18	7.00	4.98				
Math score = 2	Graduate	1036	13.26	5.56	4.67	1064	.00	4.86
	GED	30	8.40	6.90				
Math score = 3	Graduate	1158	14.11	5.24	1.98 <sup>a</sup>	29.54 <sup>a</sup>	.06 <sup>a</sup>	3.18
	GED	30	10.93	8.76				
Math score = 4	Graduate	1035	15.16	4.63	1.15 <sup>a</sup>	22.23 <sup>a</sup>	.26 <sup>a</sup>	2.30
	GED	23	12.87	9.58				

<sup>a</sup>The t and df were adjusted because the variances were not equal

As shown in Table 11, GEDs statistically differed from graduates on Post-secondary only at Units in Math = 3 and Math score = 1 (*Mean Difference* = 8.43,  $p = .01$ ). GEDs did not differ statistically from Graduates on Post-secondary at Math score = 2, 3, and 4 ( $p = .05, .86, \text{ and } .05$ , respectively). However attention must be given to the very small N for the GED and any inferences made with great caution.

Table 11

*Comparison of Post-secondary of GED and Graduates for Math score and Units in Math = 3*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
Math score = 1	Graduate	390	12.70	5.44	2.68	391	.01	8.43
	GED	3	4.33	3.06				
Math score = 2	Graduate	854	14.24	4.50	2.09	855	.05	5.24
	GED	3	9.00	6.08				
Math score = 3	Graduate	1520	15.26	3.87	-.18	1521	.86	-.41
	GED	3	15.67	2.08				
Math score = 4	Graduate	2215	15.95	3.12	2.72 <sup>a</sup>	4.01 <sup>a</sup>	.05 <sup>a</sup>	6.75
	GED	5	9.20	5.54				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

The 4-way ANOVA, plots and *t*-tests consistently show statistically meaningful differences between GED and graduate Post-secondary enrollment only at certain levels of Units in Math and Math scores. And, statistically meaningful differences cannot be shown from the data at certain other levels of Units of Math and Math scores. In terms of practical conclusions, caution must be shown here. Because differences cannot be statistically shown does not mean that the outcomes were not different, especially in the case of Units in math = 3 where *N* for GED ranged only from 3 to 5. However, it should be emphasized that in the case of Units of Math = 1 and Math score = 1 and 2 that the *Mean Difference* between GEDs and graduates was not apparent. For Units in Math = 2, statistically significant Mean Differences between GEDs and graduates were shown for all Math scores.

**Math score, SES, and GED.** The plots associated with this 3-way interaction indicate that the 2-way interaction of Math score and SES depend on the level of the third factor, GED. The main effect of GED is shown by the separation of the lines. The main effect of Math score is shown by the rising data points as the SES increases. The interaction effect between Math score and SES is evident by the obvious non-parallel lines in the plot of Math score = 3 and 4 and SES = 3 and 4 as shown in Figure 5, while the lack of interaction is evident by the near parallel lines in the plot of Math score = 1 and 2. Because the results described above suggest that there is influence of SES on GED at Math score = 3 and 4, *t*-tests were performed to compare outcomes and they corroborated the implications of the plots, showing that this 3-way interaction really depends on the level of Math score.

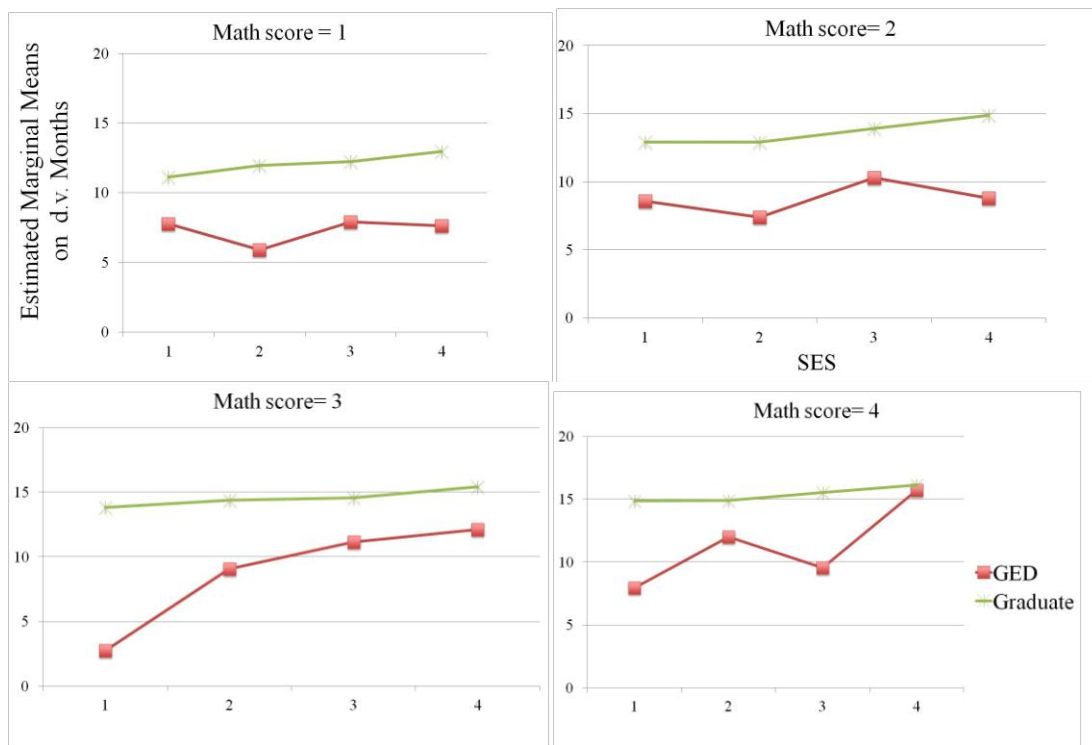


Figure 5. ANOVA Plot 2: Estimated marginal means of Post-secondary for Math score and SES.

At Math score = 3, as shown in Table 12, GED mean Post-secondary was not statistically different from Graduates at SES = 3 and 4 ( $p = .29$  and  $.15$ , respectively). Differences were

significant at SES = 1 and 2 (*Mean Difference* = 11.09 and 5.30 and  $p = .00$  and  $.02$ , respectively). The statistical inference is that SES does overcome the negative effect of GED on Post-secondary enrollment – but only at higher levels of math score and SES; the *Mean Differences* decline as SES increases. This is an important finding.

Table 12

*Comparison of Post-secondary of GED and Graduates for SES and Math score = 3*

Variable	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 1				20.24 <sup>a</sup>	5.15 <sup>a</sup>	.00 <sup>a</sup>	11.09
Graduate	372	13.84	5.14				
GED	4	2.75	.96				
SES = 2				2.65 <sup>a</sup>	13.27 <sup>a</sup>	.02 <sup>a</sup>	5.30
Graduate	574	14.37	4.84				
GED	14	9.07	7.44				
SES = 3				.115 <sup>a</sup>	7.04 <sup>a</sup>	.29 <sup>a</sup>	3.44
Graduate	796	14.57	4.68				
GED	8	11.13	8.39				
SES = 4				1.51 <sup>a</sup>	15.10 <sup>a</sup>	.15 <sup>a</sup>	3.32
Graduate	978	15.44	3.94				
GED	16	12.13	8.73				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

At Math score = 4, as indicated in Table 13, there were not statistically significant differences between GED and graduate Post-secondary at SES = 1, 2, and 4 ( $p = .16$ ,  $.75$  and  $.88$ , respectively). There was a significant difference at SES = 3 (*Mean Difference* = 5.98,  $p = .01$ ). Although this finding at first appears unexpected, a plausible explanation is that larger sample size at SES = 1 and 2 would have shown the *Mean Differences* to have been significant and that consequently, for high scoring students, the negative effect of GED could only be overcome by the highest level of SES. These findings, too, are consistent with the plots.

Table 13

*Comparison of Post-secondary of GED and Graduates for SES and Math score = 4*

Variable	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 1				1.41	245	.16	3.74
Graduate	244	14.76	4.66				
GED	3	11.00	7.94				
SES = 2				.36 <sup>a</sup>	2.00 <sup>a</sup>	.75 <sup>a</sup>	2.92
Graduate	489	14.91	4.49				
GED	3	12.00	13.89				

Table 13 (continued)

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 3					5.20 <sup>a</sup>	10.10 <sup>a</sup>	.01 <sup>a</sup>	5.98
	Graduate	835	15.52	3.75				
	GED	11	9.54	6.07				
SES = 4					.15 <sup>a</sup>	13.02 <sup>a</sup>	.88 <sup>a</sup>	.41
	Graduate	1699	16.13	3.19				
	GED	14	15.71	10.40				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

**Units in Math, SES, and GED.** The two way interaction of Units in Math and SES on the level of the third factor, GED, is evident in the plots as shown in Figure 6.

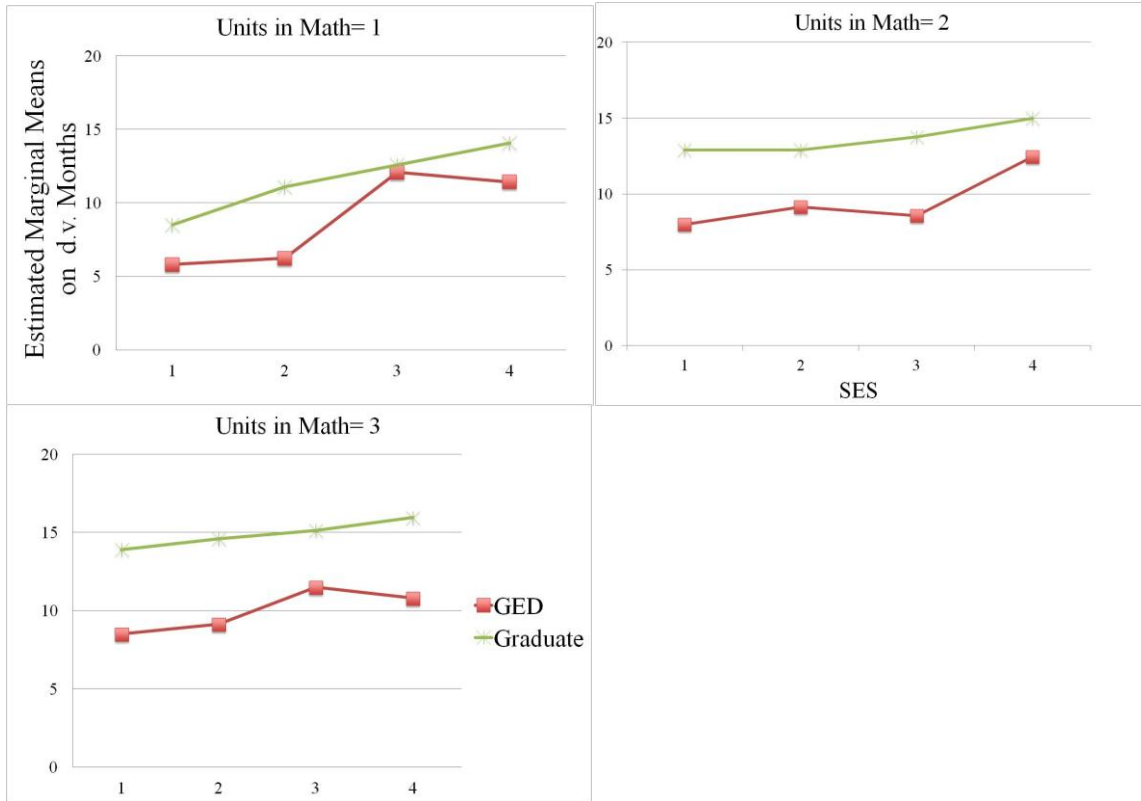


Figure 6. ANOVA Plot 3: Estimated marginal means of Post-secondary for Units in Math and SES.

At Units of Math = 1 and SES = 1, 3, and 4, there appeared to be little difference between GED and graduate. T-tests were performed, as shown in Table 14, that showed no statistically

significant difference ( $p = .29$ ,  $p = .84$ , and  $p = .57$ , respectively). At SES = 2, however, a difference was shown (Mean Difference = 4.84,  $p = .02$ ).

Table 14

*Comparison of Post-secondary of GED and Graduates for SES and Units in Math = 1*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 1					1.07	41	.29	2.70
	Graduate	38	8.50	5.46				
	GED	5	5.80	3.35				
SES = 2					2.54	51	.02	4.84
	Graduate	40	11.08	6.40				
	GED	13	6.23	5.40				
SES = 3					.21	50	.84	.49
	Graduate	40	12.58	7.32				
	GED	12	12.08	6.50				
SES = 4					.60 <sup>a</sup>	6.51 <sup>a</sup>	.57 <sup>a</sup>	2.64
	Graduate	47	14.06	6.04				
	GED	7	11.42	11.44				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

As listed in Table 15, at Units of Math = 2 and SES = 1, 2, and 3, statistical differences could be shown (Mean Difference = 4.48, 3.79, and 5.22;  $p = .29$ ,  $p = .00$ , .03, and .00, respectively). At SES = 4, however, a difference could not be shown ( $p = .13$ ). Again, high SES trumps.

Table 15

*Comparison of Post-secondary of GED and Graduates for SES and Units in Math = 2*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 1					2.88	746	.00	4.48
	Graduate	733	12.48	5.93				
	GED	15	8.00	6.72				
SES = 2					2.26 <sup>a</sup>	21.50 <sup>a</sup>	.03 <sup>a</sup>	3.79
	Graduate	953	12.92	5.59				
	GED	22	9.14	7.81				
SES = 3					4.16 <sup>a</sup>	30.00 <sup>a</sup>	.00 <sup>a</sup>	5.22
	Graduate	1053	13.78	5.20				
	GED	30	8.57	6.81				
SES = 4					1.56 <sup>a</sup>	33.50 <sup>a</sup>	.13 <sup>a</sup>	2.52
	Graduate	1209	14.99	4.86				
	GED	34	12.47	9.37				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

At Units of Math = 3, as shown in Table 16, a statistical difference could only be shown for SES = 2 (Mean Difference = 6.81,  $p = .01$ ). At SES = 1, 3, and 4, however, differences could not be shown statistically ( $p = .14, .18, \text{ and } .08$ , respectively). The very small N for GED, ranging from 2 to 5, precludes inferences.

Table 16

*Comparison of Post-secondary of GED and Graduates for SES and Units in Math = 3*

Variable		<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>Mean Difference</i>
SES = 1					1.48	680	.14	5.30
	Graduate	680	13.91	5.04				
	GED	2	8.50	10.60				
SES = 2					3.42	925	.00	6.81
	Graduate	922	14.61	4.43				
	GED	5	9.14	5.90				
SES = 3					1.34	1305	.18	3.64
	Graduate	1305	15.14	3.84				
	GED	2	11.50	6.36				
SES = 4					2.37 <sup>a</sup>	4.01 <sup>a</sup>	.08 <sup>a</sup>	5.15
	Graduate	2072	15.95	3.12				
	GED	5	10.80	4.87				

<sup>a</sup>The *t* and *df* were adjusted because the variances were not equal

**Math score, SES, and Units in Math.** The plots shown in Figure 7 associated with this 3-way interaction are consistent with the 3-way effect described earlier ( $F [18, 9156] = 2.85, p = .00$ ), indicating that the two way interaction of Units in Math and Math score depend on the levels of the third factor, SES. The apparent lack of interaction at Math score = 3 and 4 and the trend to similarity at SES = 3 and 4 suggest that the greatest interaction with Units of Math occurs at Math score = 1 and 2 and at SES = 1 and 2. One-way ANOVA of Units in Math at SES = 1 and Math score = 1 showed statistically significant differences in Post-secondary between students with 1, 2 and 3 Units in Math ( $F [2, 390] = 11.74, p = .00$ ), while at Math score = 1 and SES = 4, there were no statistically significant differences ( $F [2, 183] = 1.67, p = .19$ ). At Math score = 4, and SES = 1 and 2 the sample size for Units in Math = 1 was 1 and 3 respectively, and therefore inconclusive. The differences between outcomes of Units in Math at SES = 1 and Math score = 1 guided the study's post hoc analyses.

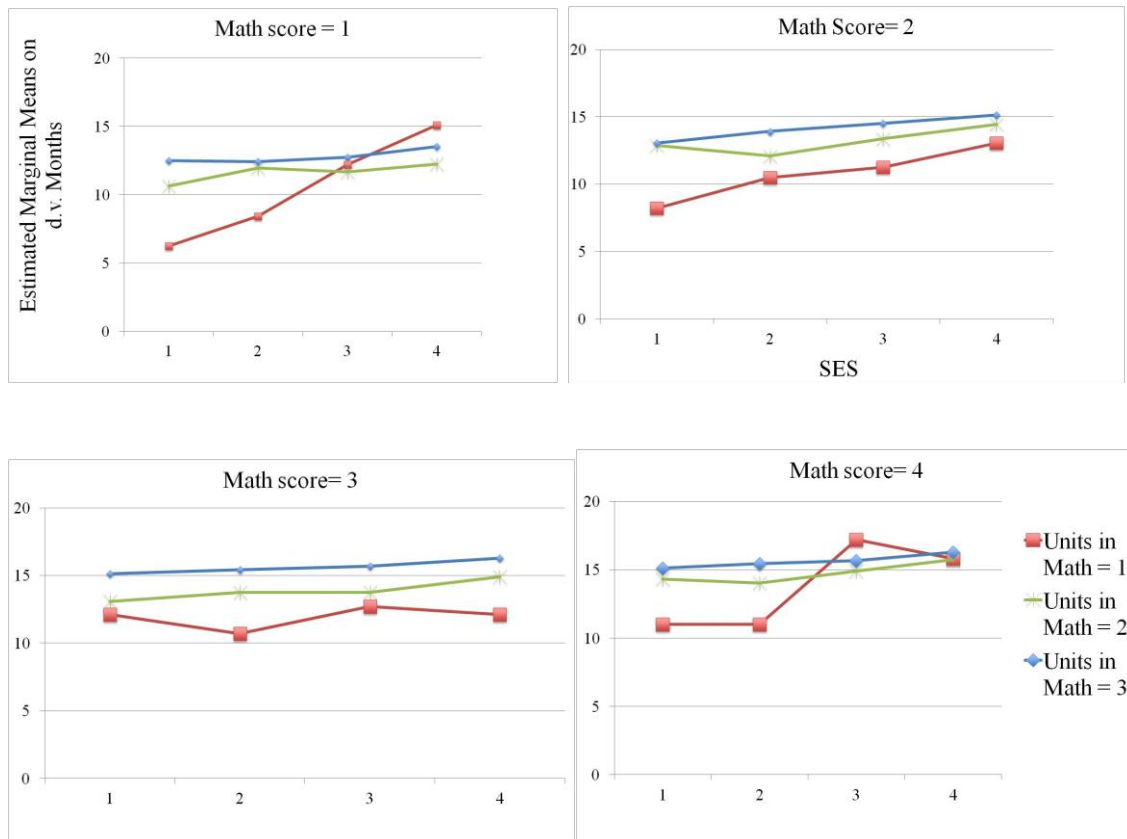


Figure 7. ANOVA Plot 4: Estimated marginal means of Post-secondary for Math score, SES, and Units in Math.

### Other Post Hoc Analyses

**Units in Math and graduates.** The lack of interaction between Units in Math and GED and the obvious main effect of Units in Math on graduates as shown in the plots begged further examination of Units in Math on Post-secondary for each level of SES. Consequently, four 1-way ANOVAs were run for each of the four levels of SES with Units in Math as the factor and Post-secondary as the dependent variable. The results are shown in Table 17 and Table 18. For all levels of SES, significant differences were found. This indicates that the Units in Math is positively related to the number of months of post-secondary school enrollment for each SES

subset of graduates. In other words, at each level of SES, there is a significant mean within group difference for Units in Math.

Table 17

*Post-secondary Means and Standard Deviations by Units in Math and SES for Graduates*

Units in Math	SES = 1			SES = 2			SES = 3			SES = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	38	8.50	5.46	40	11.08	6.40	40	12.56	7.32	47	14.06	6.04
2.00	733	12.48	5.93	953	12.92	5.59	1053	13.78	5.20	1209	14.99	4.86
3.00	680	13.81	5.04	922	14.61	4.43	1305	15.14	3.84	2072	15.95	3.12
Total	1451	13.00	5.60	1915	13.70	5.16	2398	14.50	4.61	3328	15.57	3.92

Table 18

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Units in Math by SES for Graduates*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
SES = 1				19.61	2	1448	.00
Between Groups	2 <sup>a</sup>	24.13 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	101.06 <sup>a</sup>						
SES = 2				2.52	2	1912	.00
Between Groups	2 <sup>a</sup>	29.96 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	104.27 <sup>a</sup>						
SES = 3				85.92	2	2395	.00
Between Groups	2 <sup>a</sup>	26.55 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	103.05 <sup>a</sup>						
SES = 4				112.08	2	3325	.00
Between Groups	2 <sup>a</sup>	20.99 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	120.73 <sup>a</sup>						

<sup>a</sup> The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Games-Howell post hoc tests were run because of the lack of homogeneity of variance and are shown in Table 19. For SES = 1, there were statistically significant differences in Post-secondary for graduates between Units in Math at all levels. As measure by Cohen's *d*, effect sizes of moving from Units in Math = 1 to 3 was 1.01 (much larger than typical), .70 (medium to

large) for moving from 1 to 2, and .24 (small) for moving from 2 to 3 (Leach et al., 2011). For SES = 2 there were only statistical differences between Units in Math = 1 and 3 and Units in Math = 2 and 3. The effect sizes were -.64 and -.34 respectively. For SES = 3, there was only a statistical difference between Units in Math = 2 and 3 with an effect size = -.30. For SES = 4, there was only a statistical difference between Units in Math = 2 and 3 with an effect size = -.24. It should be noted that the *Mean Differences* decrease as SES increases. The implications of this will be discussed.

Table 19

*Post Hoc Games Howell Analyses Comparing Post-secondary Units in Math by SES for Graduates*

<i>Compared</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d</i>	<i>95% Confidence Interval</i>	
					<i>Lower Bound</i>	<i>Upper Bound</i>
SES = 1						
1 to 2	-3.97	.91	.00	-.70	-6.19	-1.76
1 to 3	-5.31	.91	.00	-1.01	-7.52	-3.10
2 to 3	-1.33	.29	.00	-.24	-2.02	-.65
SES = 2						
1 to 2	-1.85	1.03	.18	-.31	-4.35	.65
1 to 3	-3.53	1.02	.00	-.64	-6.02	-1.04
2 to 3	-1.68	.232	.00	-.34	-2.23	-1.14
SES = 3						
1 to 2	-1.21	1.17	.56	-.19	-4.05	1.63
1 to 3	-2.57	1.16	.08	-.44	-5.40	.26
2 to 3	-1.36	.19	.00	-.30	-1.81	-.91
SES = 4						
1 to 2	-.92	.89	.56	-.17	-3.08	1.23
1 to 3	-1.89	.88	.09	-.39	-4.03	.25
2 to 3	-.97	.16	.00	-.24	-1.33	-.60

**Units in Math, SES, and GEDs.** However, the outcomes were quite different for the GED = 2, GEDs, as displayed in Tables 20 and 21. Four 1 – way ANOVAs were run for SES = 1, 2, 3, and 4 and they showed no statistical difference in Post-secondary for Units in Math:  $F(2, 19) = .24, p = .79$ ;  $F(2, 37) = .72, p = .49$ ;  $F(2, 41) = 1.25, p = .30$ ; and  $F(2, 43) = .09, p = .91$

respectively. This indicates that Units in Math is related to Post-secondary only for graduates and that there is no need for further statistical investigation GEDs and Units in Math in this data set. The implications of this will be discussed.

Table 20

*Means and Standard Deviations Comparing Units in Math and SES for GED*

Units in Math	SES = 1			SES = 2			SES = 3			SES = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	5	5.80	3.35	13	5.40	1.50	12	12.08	6.50	7	11.43	11.44
2.00	15	8.00	6.72	22	7.81	1.66	30	8.57	6.81	34	12.47	9.37
3.00	2	8.50	10.61	5	5.89	2.63	2	11.50	6.36	5	10.80	4.87
Total	22	7.55	6.21	40	6.87	1.08	44	9.66	6.76	46	12.13	9.18

Table 21

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Units in Math by SES for GED*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
SES = 1				2.52	2	19	.11
Between Groups	2	.24	.79				
Within Groups	19						
SES = 2				.98	2	37	.36
Between Groups	2	.72	.49				
Within Groups	37						
SES = 3				.11	2	41	.90
Between Groups	2	1.25	.30				
Within Groups	41						
Total	43						
SES = 4				1.50	2	43	.23
Between Groups	2	.09	.91				
Within Groups	43						

**Units in Math, Math score and graduates.** The lack of interaction between Units in Math and GED and its obvious main effect on graduates begged even further examination by holding Math score constant. Consequently, four 1-way ANOVAs were run for each of the four levels of

Math scores with Units in Math as the factor and Post-secondary as the dependent variable. The results are shown in Tables 22 and 23. There were statistically significant differences in Post-secondary for Math score = 1, 2, 3, and 4;  $F(2, 149.07) = 10.10, p = .00$ ;  $F(2, 157.07) = 14.7, p = .00$ ;  $F(2, 12.35) = 23.64, p = .00$ ;  $F(2, 44.96) = 13.07, p = .00$ , respectively.

Table 22

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	57	9.75	6.86	60	11.33	7.19	43	13.21	4.96	18	15.06	6.66
2.00	733	11.55	5.81	1085	13.26	5.58	1199	14.08	5.22	1067	15.15	4.63
3.00	406	12.84	5.41	893	14.24	4.55	1566	15.25	3.87	2281	15.95	3.12
Total	1451	11.90	5.78	2038	13.63	5.24	2808	14.72	4.55	3366	15.69	3.71

Table 23

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Math score by Units in Math for Graduates*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
Math score = 1				3.19	2	1193	.04
Between Groups	2 <sup>a</sup>	10.10 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	149.07 <sup>a</sup>						
Math score = 2				39.80	2	2035	.00
Between Groups	2 <sup>a</sup>	12.77 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	157.07 <sup>a</sup>						
Math score = 3				71.36	2	2805	.00
Between Groups	2 <sup>a</sup>	23.64 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	12.35 <sup>a</sup>						
Math score = 4				77.82	2	3363	.00
Between Groups	2 <sup>a</sup>	13.07 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	44.96 <sup>a</sup>						

<sup>a</sup>The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Games-Howell post hoc tests were run because of the lack of homogeneity of variance. The results are shown in Table 24. The greatest statistically significant difference was shown at Math score = 1, with comparisons of Units in Math 1 to 3 showing a *Mean Difference* of 3.09, with  $p = .01$  and  $d = .50$ . At Math score = 2, the magnitude of the difference was only slightly less, with a *Mean Difference* of 2.91,  $p = .01$ , and  $d = .48$ . At Math score = 3, the *Mean Difference* was 2.05,  $p = .01$ ,  $d = .46$ . At Math score = 4, there was no statistically significant Mean difference comparing Units of Math = 1 to 3. The implications of the greatest *Mean Difference* occurring at Math score = 1 comparing Units in Math = 1 to 3 will be discussed.

Table 24

*Post Hoc Games Howell Analyses Comparing Post-secondary Enrollment of Units in Math by Math score for Graduates*

<i>Compared</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d</i>	<i>95% Confidence Interval</i>	
					<i>Lower Bound</i>	<i>Upper Bound</i>
Math score = 1						
1 to 2	-1.80	.93	.14	-.28	-4.04	.45
1 to 3	-3.09	.95	.01	-.50	-5.36	-.81
2 to 3	-1.29	.34	.00	-.23	-2.10	-.48
Math score= 2						
1 to 2	-1.92	.94	.11	-.30	-4.19	.34
1 to 3	-2.91	.94	.01	-.48	-5.17	-.65
2 to 3	-.98	.23	.00	-.19	-1.52	-.45
Math score = 3						
1 to 2	-.87	.77	.43	-.17	-2.74	1.00
1 to 3	-2.05	.76	.01	-.46	-3.90	-.19
2 to 3	-1.17	.18	.00	-.25	-1.59	-.75
Math score = 4						
1 to 2	-.09	1.58	.99	-.02	-4.13	3.94
1 to 3	-.89	1.57	.84	-.17	-4.92	3.13
2 to 3	-.80	.16	.00	-.20	-1.17	-.43

**Units in Math, Math score and GEDs.** However, the outcomes were quite different for the GED = 2 (GEDs) group as displayed in Tables 25 and 26. At all levels of Math scores, there were

no statistically significant differences in Post-secondary related to Units in Math; therefore, no post hoc tests were run. Again, caution dictates against inferring that because there were no statistical differences, the group scores can be considered the same, especially with N sizes as small as 3. Appendix D clearly shows the limitations imposed by the small clusters.

Table 25

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Post-secondary for GED*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
1.00	13	11.15	9.63	15	8.80	6.81	9	5.11	3.55	3	17.33	11.5
2.00	18	7.00	4.98	33	8.82	6.80	31	11.10	8.66	23	12.87	9.58
3.00	3	4.33	3.06	3	9.00	6.08	3	15.67	2.08	5	9.20	5.54
Total	34	8.35	7.25	51	8.82	6.64	43	10.16	8.03	31	12.71	9.19

Table 26

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Math score by Units in Math on Post-secondary for GEDs*

	df	F	p	Test of Homogeneity of Variances			
				Levene Statistic	df1	df2	p
Math score = 1				3.36	2	31	.05
Between Groups	2	1.83	.18				
Within Groups	31						
Math score = 2				.07	2	48	.93
Between Groups	2	.00	1.00				
Within Groups	48						
Math score = 3				4.52	2	40	.02
Between Groups	2	18.48 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	10.34 <sup>a</sup>						
Math score = 4				.81	2	28	.457
Between Groups	2	.74	.49				
Within Groups	28						

<sup>a</sup>The F and the df were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

### Detailed Examination of 4-way Interaction

Finally, the significant 4-way interaction of SES, Math Score, Units of Math and GED and the now obvious lack of interaction of Units in Math on GED = 2 (GEDs) point to the three way interaction of SES, Math score and Units in Math depending on the level of the fourth factor, GED, suggesting further post hoc analysis on the interaction of Units in Math on GED = 1. As indicated in Tables 27 – 29, holding SES = 1 and varying Math scores from 1 to 4 showed that only at Math score = 1 and SES = 1 was there a statistically significant effect of Units in Math ( $F [2, 382] = 12.2, p = .00$ ). The *Mean Difference* between 1 and 2 Units in Math was 4.73 with  $p = .00$  and  $d = .87$ . The *Mean Difference* between 1 and 3 Units in Math was 6.48 with  $p = .00$  and  $d = 1.30$ . The *Mean Difference* between 2 and 3 Units in Math was 1.92 with  $p = .01$  and  $d = .33$ . It must not be overlooked that there were no statistically significant interactions at Math scores = 2, 3, and 4, just as it must be emphasized that the effect size of Units in Math at Math score = 1 and SES = 1 was very large (Leach, 2011).

Table 27

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 1*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	18	5.94	4.76	11	8.90	5.30	8	13.38	4.17	1	11.00	-
2.00	232	10.67	6.05	250	12.95	6.01	163	13.26	5.51	88	14.44	4.93
3.00	135	12.59	5.47	189	13.05	5.07	201	14.33	4.83	155	15.12	4.50
Total	385	11.12	5.97	450	12.89	5.64	372	13.84	5.14	244	14.86	4.66

Table 28

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 1*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
Math score = 1				1.79	2	382	.17
Between Groups	2	12.20	.00				
Within Groups	382						
Math score = 2				4.087	2	447	.02
Between Groups	2	3.13 <sup>a</sup>	.06 <sup>a</sup>				
Within Groups	27.44 <sup>a</sup>						
Math score = 3				4.07	2	369	.02
Between Groups	2	1.19 <sup>a</sup>	.17 <sup>a</sup>				
Within Groups	19.44						
Math score = 4				1.52	1	241	.219
Between Groups	2	.93	.40				
Within Groups	241						

<sup>a</sup>The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Table 29

*Post Hoc Tukey HSD Analyses Comparing Post-secondary Enrollment of Units in Math for SES = 1 and Math score = 1 for Graduates*

<i>Compared</i>	<i>Units in Math</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d<sup>a</sup></i>	95% Confidence Interval	
						<i>Lower Bound</i>	<i>Upper Bound</i>
	1 to 2	-4.73	1.42	.00	-.87	-8.07	-1.39
	1 to 3	-6.48	1.46	.00	-1.30	-10.07	-3.22
	2 to 3	-1.92	.63	.01	-.33	.340	-.44

As indicated in Tables 30 – 32, holding SES = 2 and varying Math scores from 1 to 4 only showed effects of Units of Math at Math score = 2 ( $F [2, 29.43] = 8.11, p = .00$ ) and there was no statistically significant effect of Units in Math at Math score = 1, 3, and 4 ( $F [2, 332] = 1.29, p = .28, F [2, 29.47] = 3.22, p = .05; F [2, 5.32] = 5.16, p = .06$ , respectively).

As shown in Table 32, there were only *Mean Difference* between 2 and 3 Units in Math and these occurred at Math score = 2. The *Mean Difference*, 1.74, was small as was the effect size,  $d$ , = .34.

Table 30

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 2*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	13	9.92	6.98	12	10.33	6.77	12	13.08	5.55	3	11	7.00
2.00	219	11.83	5.70	297	12.26	5.51	258	13.86	5.54	179	14.02	5.28
3.00	103	12.47	5.59	208	14.00	4.69	304	14.86	4.09	307	15.48	3.82
Total	335	11.94	5.72	517	12.92	5.30	574	14.37		489	14.92	4.49

Table 31

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 2*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
Math score = 1				.761	2	332	.47
Between Groups	2	1.29	.28				
Within Groups	332						
Math score = 2				8.69	2	514	.00
Between Groups	2	8.11 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	29.43 <sup>a</sup>						
Math score = 3				15.174	2	571	.00
Between Groups	2	3.22 <sup>a</sup>	.05 <sup>a</sup>				
Within Groups	29.47 <sup>a</sup>						
Math score = 4				14.05	2	486	.00
Between Groups	2	5.16 <sup>a</sup>	.06 <sup>a</sup>				
Within Groups	5.32						

<sup>a</sup> The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Table 32

*Post Hoc Games Howell Analyses Comparing Post-secondary Enrollment of Units in Math for SES = 2 and Math score = 2, 3, and 4 for Graduates.*

<i>Compared</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d<sup>a</sup></i>	<i>95% Confidence Interval</i>	
					<i>Lower Bound</i>	<i>Upper Bound</i>
Math score= 2						
1 to 2	-1.93	1.98	.61	-.31	-7.24	3.38
1 to 3	-3.67	1.98	.20	-.63	-8.98	1.64
2 to 3	-1.74	.46	.00	-.34	-2.81	-.67

\*Analyses were not performed for Math score = 1, 3, and 4 because the related ANOVA showed statistically insignificant differences.

At SES = 3, the *Mean Differences* that were noticeably smaller at SES = 2 shrink even further. This is shown in Table 33. At Math score = 1, as shown in Table 34, there was no statistically significant interaction with Units in Math ( $F [2, 261] = .66, p = .52$ ). At Math score = 2, there was a statistically significant interaction ( $F [2, 31.87] = 4.12, p = .03$ ), but the post hoc analysis showed a statistically significant difference but with a small effect size in Post-secondary between Units in Math = 2 and 3 (*Mean Difference* = -.99,  $p = .05, d = -.2$ ) which is shown in Table 35. At Math score = 3, there was a statistically significant interaction ( $F [2, 21.67] = 8.49, p = .00$ ), but the post hoc analysis showed only a small effect size in Post-secondary between Units in Math = 2 and 3 (*Mean Difference* = -1.39,  $p = .00, d = -.30$ ). At Math score = 4, the small group differences were nullified by the statistical insignificance of the post hoc test.

Table 33

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 3*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	15	12.40	6.63	13	10.54	7.38	9	13.00	6.80	3	21.00	9.54
2.00	162	11.93	5.40	266	13.54	5.20	355	13.82	5.29	270	15.09	4.57
3.00	87	12.74	5.04	224	14.53	4.24	432	15.21	3.88	562	15.71	3.21
Total	284	12.22	5.35	503	13.90	4.90	796	14.57	4.65	835	15.53	3.75

Table 34

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 3*

	<i>df</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
				<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
Math score = 1				.70	2	261	.50
Between Groups	2	.66	.52				
Within Groups	261						
Math score = 2				8.70	2	500	.00
Between Groups	2	4.12 <sup>a</sup>	.03 <sup>a</sup>				
Within Groups	31.87 <sup>a</sup>						
Math score = 3				25.46	2	793	.00
Between Groups	2	8.49 <sup>a</sup>	.00 <sup>a</sup>				
Within Groups	21.67 <sup>a</sup>						
Math score = 4				20.26	2	832	.00
Between Groups	2	2.21 <sup>a</sup>	.20 <sup>a</sup>				
Within Groups	5.31 <sup>a</sup>						

<sup>a</sup> The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Table 35

*Post Hoc Games Howell Analyses Comparing Post-secondary Enrollment of Units in Math for SES = 3 and Math score = 2, 3, and 4 for Graduates*

<i>Compared</i>	<i>Units in Math</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d<sup>a</sup></i>	95% Confidence Interval	
						<i>Lower Bound</i>	<i>Upper Bound</i>
Math score= 2							
	1 to 2	-3.00	2.07	.35	-.47		
	1 to 3	-3.99	2.07	.17	-.66		
	2 to 3	-.99	.43	.05	-.20		
Math score = 3							
	1 to 2	-.82	2.28	.932	-.13	-7.31	5.66
	1 to 3	-2.21	2.27	.61	-.40	-8.69	4.27
	2 to 3	-1.39	.34	.00	-.30	-2.18	-.59

Analyses were not performed for Math score = 1 and 4 because the related ANOVA showed statistically insignificant differences.

Confidence intervals were not calculated for Math score = 2 and 4 because the related *p* showed statistically insignificant difference.

At SES = 4, the *Mean Differences* between Units in Math and Math scores, as displayed in Table 34 at each of the aggregated levels were statistically insignificant. The 1-way ANOVA, displayed in Table 37, for the comparison of Units in Math with Math score = 1 and 2 produced *p* values of .41 and .44. Although the 1 – way ANOVA for Math Score = 3 and 4 and Units in Math produced *p* values of .00 and .00, the post hoc analysis shown in Table 38 showed no significant *Mean Differences* at Math score = 3 and 4.

Table 36

*Means and Standard Deviations Comparing Post-secondary Enrollment of Units in Math and Math score for Graduates at SES = 4*

Units in Math	Math score = 1			Math score = 2			Math score = 3			Math score = 4		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1.00	9	13.89	7.6	15	14.47	7.17	13	13.38	4.09	10	14.5	5.60
2.00	106	12.47	5.91	223	14.60	5.31	382	14.92	4.76	498	15.75	4.25
3.00	65	13.64	5.70	233	15.14	3.86	583	15.83	3.24	1191	16.30	2.56
Total	180	12.97	5.92	471	14.86	4.72	978	15.44	3.94	1699	16.13	3.19

Table 37

*One way Analysis of Variance Summary Table Comparing Post-secondary Enrollment by Units in Math and Math score for Graduates at SES = 4*

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	Test of Homogeneity of Variances			
						<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>p</i>
Math score = 1						.62	2	177	.54
Between Groups	2	63.63	31.82	.907	.41				
Within Groups	177	6208.17	35.07						
Math score = 2						12.00	2	468	.00
Between Groups	2			.80 <sup>a</sup>	.46 <sup>a</sup>				
Within Groups	36.93 <sup>a</sup>		22.27						
Math score = 3						26.70	2	975	.00
Between Groups	2			7.00 <sup>a</sup>	.00				
Within Groups	32.04 <sup>a</sup>								
Math score = 4						33.73	2	1696	.00
Between Groups	2			4.07 <sup>a</sup>	.03 <sup>a</sup>				
Within Groups	23.75 <sup>a</sup>								

<sup>a</sup> The *F* and the *df* were adjusted by means of the Welch Analysis because the homogeneity of variance assumption is likely violated.

Table 38

*Post Hoc Games Howell Analyses Comparing Post-secondary Enrollment of Units in Math for SES = 4 and Math score = 3 and 4 for Graduates*

<i>Compared</i>	<i>Units in Math</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>p</i>	<i>d<sup>a</sup></i>	<i>95% Confidence Interval</i>	
						<i>Lower Bound</i>	<i>Upper Bound</i>
Math score = 3							
	1 to 2	-1.54	1.16	.41	-.35	-4.60	1.52
	1 to 3	-2.44	1.14	.12	-.66	-5.48	.60
	2 to 3	-.90	.28	.00	-.22	-1.55	-.24
Math score = 4							
	1 to 2	-1.25	1.78	.77	-.25	-6.20	3.71
	1 to 3	-1.80	1.77	.59	-.41	-6.75	3.15
	2 to 3	-.55	.20	.02	-.16	-1.03	-.07

Analyses were not performed for Math score = 1 and 2 because the related ANOVA showed statistically insignificant differences.

## CHAPTER IV

### DISCUSSION

#### Summary of Results

The results of this study were generally consistent with prior researchers' findings described in the Introduction section. SES, Math Score and GED showed main effects on the dependent variable, months enrolled in Post-secondary. The main research question, however, examined the relationship of Units in Math and Post-secondary monthly enrollment of GEDs and graduates – if SES and Math score were held constant – and the study's hypotheses were: (a) the number of math classes taken in high school is related to the months of attendance in post-secondary educational institution, (b) GEDs and graduates similarly blocked for SES, 10<sup>th</sup> grade math scores, and number of math classes taken in high school would show the same number of months attended in a post-secondary institution, and (c) the number of months in a post-secondary institution is a function of the nested cognitive and non cognitive skills acquired from succeeding at additional math classes in high school – Units in Math is a proxy for post-secondary persistence in GEDs. The further expectation was that there would be little difference in outcomes between GEDs and graduates with three units of math at some combination of SES and Math score.

The data with respect to GEDs seemed initially ambiguous, obscured mainly by very small sample sizes that limited generalization of the results. The *N* values were simply too small for factoring by SES, Math score and Units in Math which produced 48 cells spread between the 152 data values for comparison. Although the bar graphs in Figure 3 that were introduced as descriptives in the methodology section suggested that as Math score and SES increased, post-secondary attendance increased, inferential statistics were unable to show differences. The 3-way ANOVA shown in Appendix F shows lack of 3-way effect, lack of any 2-way effect and no main effects for Math score, SES and Units of Math. This is an important finding in spite of the limitations imposed by the small *N*.

The data with respect to Graduates were clearer; larger  $N$  values allowed comparisons. For certain Graduates, Units in Math showed significant effect on Post-secondary enrollment, but with an unexpected twist—although graduates whose Units in Math = 3 showed significantly more Post-secondary enrollment than those with fewer Units in Math, graduates whose Units in Math = 1 and Math score = 1 had Post-secondary that, for the most part, could not be differentiated statistically from GEDs as a group. The mean Post-secondary months enrolled for this Graduate group was 9.75 with  $sd = 6.86$  and  $N = 57$ . The mean Post-secondary enrollment for GEDs collectively was 9.67 with  $sd = 7.67$  and  $N = 152$ . The  $t$ -test comparison was unable to show a difference ( $t [205] = .23, p = .82$ ). In fact, the study could have asked: How does the lack of difficult math classes relate to post-secondary outcomes for high school graduates?

Specifically, the research question asked: How does the difference in post-secondary attendance by month vary between GEDs and graduates based on the additional number of math classes controlling for SES and 10<sup>th</sup>-grade test scores? Analyses of the data produced the following findings:

- 1) There was no statistically significant difference in Post-secondary enrollment between GED and Graduates for the following cases holding 15 categories:
  - A) Units in Math = 1 and Math scores = 1, 2, and 4;
  - B) Units in Math = 1 and SES = 1, 3, and 4;
  - C) Units in Math = 2 and SES = 4;
  - D) Units in Math = 2 and Math score = 3 and 4;
  - E) Units in Math = 3 and Math score = 2, 3, and 4;
  - F) Units in Math = 3 and SES = 1, 3, and 4;
- 2) There were statistically significant differences in Post-secondary between GED and Graduates for the following cases holding 9 categories:
  - A) Units in Math = 1 and Math score = 3;
  - B) Units in Math = 1 and SES = 2;

- C) Units in Math = 2 for Math score = 1 and 2;
  - D) Units in Math = 2 for SES = 1, 2, and 3;
  - E) Units in Math = 3 for Math score = 1;
  - F) Units in Math = 3 for SES = 2.
- 3) The greatest interactions with Units in Math and GED variables occurred at Units in Math = 1 and Math score = 1 and 2 with  $N$  GED = 12 and 13 and  $N$  graduate = 55 and 51 respectively. In these cases, there was no statistical difference in the mean Post-secondary enrollment. For Units in Math = 2, the  $N$  GED = 18 and 30 and the  $N$  graduate was 719 and 1,036 respectively. In these cases there was a significant statistical difference in mean Post-secondary enrollment. The post hoc analyses determined that the additional Unit in Math for this subset were related to significantly more Post-secondary enrollment. The conclusion was that because there was no meaningful difference in Post-secondary enrollment at Units in Math = 1 and there was a difference at Units in Math = 2, graduates at Units in Math = 1 and Math score = 1 were more like GEDs in terms of persistence than graduates.
- 4) Units in Math were more closely related to Post-secondary for graduates than for GEDs.
- A) Graduates whose Units in Math = 1 and SES = 1 and  $N = 38$ , showed a mean difference of 5.31 fewer months enrollment compared to similar graduates whose Units in Math = 3 and whose  $N = 680$ . The effect size is 1.01 which is considered large.
  - B) Graduates whose Units in Math = 1 and Math score = 1 and  $N = 57$  showed a mean difference of 3.09 fewer months enrollment compared to similar graduates whose Units in Math = 3 and whose  $N = 406$ . The effect size is .50 which is considered moderate.
  - C) Graduates whose Math score = 1, SES = 1, and Units in Math = 1 and  $N = 18$  showed a mean difference of 6.55 fewer months enrollment compared to similar

graduates whose Units in Math = 3 and whose  $N = 135$ . The effect size is 1.3, which is considered very large (Leach, 2011).

- D) GEDs showed no significant between group differences comparing Post-secondary enrollment based on Units in Math by SES.

### **Limitations**

**Small sample sizes of GED group.** Further caution must be exercised with regard to GED. This sample consisted of 192 GED Option from the larger sample of 612—these were the 10<sup>th</sup> graders in 2002 who earned the GED before June 2004 *and* continued to a post-secondary educational institution. The conclusions and inferences apply to this group only, keeping in mind the Cameron and Heckman (1993) observations noted in the introduction that the top 10% of GEDs were indistinguishable from high school graduates (1993) and that 8<sup>th</sup> grade dropouts who earned the GED after a struggle showed economic benefits from the GED (Trebino, 2008).

Related to the small sample size was the non response bias. Of the 192 GED Option students who attended post-secondary education, 36 were missing information in Units in Math, 3 in Math score, and 13 in SES. Because of the intersections of the subsets, 46, or 24%, were not included in the analyses. Of the 10,183 graduates, 676 were missing information in Units in Math, 107 in Math score, and 470 in SES. Because of the subset intersections, 1,091, or 11%, were not included in the analyses. Because the variable, Units in Math, is based on the restricted data based on transcript information, access to the restricted data would not improve this information and it would be speculative to anticipate whether the information would mitigate the apparent inconsistencies in the results.

**Math score construct.** The variable, Math score is based on a composite of NAEP, PISA, and the assessment used in the National Educational Longitudinal Survey of 1988 and was intended to provide a cognitive baseline (Ingels, 2007). This study assumes that the scores indeed do provide a baseline that assures all students of the same score have the same abilities to accomplish Units in Math. The studies of Tyler and Lofstrom's (2010) and the Ezzelle and Chu

(2007) described in the introduction, provide the logic for the necessity of an adequate baseline. However, test taking stamina is a considerable element of any test score and as a construct in its own right may be related to persistence. Additionally, because the test measures math skills acquired before the end of the 10<sup>th</sup> grade, it can be considered an indicator of proficiency in a number of specific math skills learned, which in turn is not dissimilar conceptually to the construct of Units in Math.

**Null hypothesis testing.** Morgan noted (2003) that "...Failure to reject the null hypothesis means that chance cannot be discounted as a reason for observed differences...." (p.210). The great limitation to this study is that although it can be stated with statistical certainty that GEDs and graduates do not differ in certain areas, it cannot be stated that therefore GEDs are similar to graduates.

### **Findings**

The challenges faced by the study are summarized by the overall differences between GEDs and graduates that are shown in Table 38. There was little difference in SES status between the two groups which contradicts the prior literature and most GEDs in this group were in the highest SES. Based on the data in Appendices C and D, 30% of the GEDs were in the highest SES quartile, 29% in the third, 26% in the second and 14% in the lowest. The corresponding percentages for graduates were 37%, 26%, 21% and 16%. But, graduates showed many more post-secondary months of enrollment, a finding that was consistent with prior literature. Median and mean Math scores showed moderate differences consistent with the expectation that GEDs have cognitive skills similar to graduates. Units in Math, however, were far more likely to be taken by graduates, indicating consistency with the logic of the argument that Units in Math were a proxy for persistence in post-secondary enrollment. The issue for the study was to determine how the post-secondary outcomes were distributed within the subgroups composed of the combinations of Units in Math, Math score, and SES and organize the findings in a way that, if

implemented, will increase the average number of months of Post-secondary enrollment for both GEDs and graduates.

Table 39

*Comparison of Descriptive Statistics of GEDs and Graduates*

Variable	median			mean		
	GED	Graduate	% difference	GED	Graduate	% difference
SES	3	3	0	2.69	2.84	6
Math score	2	3	50	2.42	2.89	19
Units in Math	2	3	50	1.85	2.53	37
Post-secondary	7	16	129	9.97	14.45	48

Initially, the study intended a between-group comparison of GED and Graduate by means of a 4 – way ANOVA. However, the generally over-riding negative effect of the GED, perhaps characterized by the seeking of the easy way out, precluded meaningful comparisons in outcomes based on Units in Math. But, in the absence of the GED factor, graduates showed an effect of Units in Math that varied considerably based on Math Scores and SES.

**Between groups – GED variable.** The differences in Post-secondary months’ enrollment between GEDs and graduates depended on how they were grouped and the *N* size for the GED. GEDs grouped by SES and Math scores always had significantly lower Post-secondary if the Math scores were in the lowest quartiles. GEDS grouped by Units in Math and SES generally were not statistically un-alike when the students had only 1 Unit of Math. With 2 Units of math, they were statistically un-alike, except at the highest SES quartile. With 3 Units in Math, the analyses could not show statistically significant differences at three SES quartiles. These data corroborate the more general observation from the 4-way ANOVA that Units in math interact with the GED.

**Within groups – GED variable.** The results also indicated strong connections between Units in Math and Post-secondary, but only for certain groupings of graduates in the sample. Post hoc analyses showed significant differences in outcomes between low SES, low Math score

Graduates who take additional math classes and similar Graduates who did not take more math. The *Mean Difference* was 6.65 with an effect size of 1.3 which is considered very large (Leach, 2011).

Units in Math was not related to Post-secondary for GEDs. At all levels there was no difference in Post-secondary outcomes between GEDs who had more Units in Math than those who did not, indicating that the negative GED component trumped whatever persistence may have been associated with the Units in Math.

**SES.** The literature showed that GEDs generally are of lower SES than graduates (Guison-Dowdy and Patterson, 2011), but the descriptive statistics of this study show a near similar SES for GEDs and graduates and an SES distribution skewed to the higher quartiles. Of all the variables, Units in Math showed the greatest interaction with SES. The lowest SES quartile of graduates showed the greatest differences in outcomes between students who had 1 Unit in Math and 3 Units in Math.

### **Practical Implications**

These are the implications for decision makers at the high school level: Low SES students with low math scores should be targeted for substantial math interventions and the GED Option should only be the choice for kids whose life circumstances indicate benefit (no chance of graduating). Math electives should be suggested over conventional elective offerings like music appreciation or ceramics. Math score indicates presence of skills acquired before the 10<sup>th</sup> grade. Therefore, focus should be on math skills taught and learned in middle school.

**GED Option.** Currently, the GED Option is available as a seductive temptation for sixteen, seventeen and eighteen year olds behind in credits, probably requiring an additional year to graduate. On the one hand, the student is faced with an additional year of high school and parental supervision; on the other hand, the freedom of post-secondary education.

Duckworth (2007), in her paper on perseverance, notes that the of the Big Five model, conscientiousness is closely related to job performance. To further describe this phenomenon, she

has developed a term, grit, defined as "...perseverance and a passion for long term goals..." (p. 1087). Additionally, because adolescence is time in human development when conscientiousness shows its steepest acquisition (Soto, 2010), presenting challenging math classes to low SES students with low math scores is an obvious recommendation for improving post-secondary attendance as well as bettering other life skills related to persistence.

This academic pathway must be used cautiously, especially in the case of higher SES students looking for a quick exit from high school to enter a post-secondary institution.

**40 – 40 – 20.** The current Oregon policy goals of 40% of high school graduates with bachelors and advanced degrees, 40% with two year degrees, and 20% with high school diplomas or the equivalent will place a great deal of pressure on teachers and administrators to choose the easiest pathway for students at-risk of graduating from high school, thus depriving them not only of training in mathematics but reducing their development of persistence. This pressure will be especially poignant in the cases of academically capable at-risk students with objectionable behavior – by shunting these students into a GED program, high school administrators can obtain a positive graduation outcome while ridding themselves of a difficult and time consuming student. Clearly, additional math classes for low SES, low Math score students will require more effort for this population. However, without credible advocacy for greater emphasis in this area, lower SES students will not receive the services concomitant with the intent of 40-40-20.

**Credit by proficiency.** At Math score = 1, Units in Math = 1, graduates' Post-secondary attendance was more like those of the GEDs. An inference from this is that high school was too easy for these students and they did not learn persistence as a result. High SES students learn persistence and conscientiousness at home by example. Low SES students learn it by means of deliverables like homework. The current pressure on high school building administrators for graduation rate outcomes induces the awarding of credits to students who have failed classes because of poor attendance and late or incomplete homework assignments. It is common practice to award English 9 and 10, Biology and Physical Science, Algebra and Geometry credits to

seniors who have passed the related OAKS tests if they have failed the classes without having recovered them. At its worst, graduating by means of credit by proficiency is GED by another name, disproportionately neglecting the cultivation of persistence in lower SES students.

### **Future Research**

**Teacher interaction variable.** Committee member Dr. Charles Martinez asked for a variable related to teacher interaction with students to contrast successful students from unsuccessful. The variables exist in ELS 2002: *Teacher expects student to succeed* and *Student believes teacher cares about success*. A short study correlating the results of this study to those variables could be easily accomplished, yielding further strategies for improving post-secondary outcomes.

**3<sup>rd</sup> Follow-up to ELS 2002.** This continuation of the ELS 2002, on which this study is based, will show post-secondary monthly attendance through 2010. Presumably this will include additional GEDs and additional Post-secondary attendance outcomes, particularly for GEDs, thus minimizing the current limitations of the small sample size.

### **Conclusion**

In addition to the GED being described by the characteristic it lacks, persistence, there is also some negative characteristic of the GED that appears to override commitment, persistence and conscientiousness and it is related to the seeking of an easier way. The GED is someone who was unable to complete the basic task of finishing public education. If the reason for failure is that the student has chosen the easiest pathway, then the negative GED attribute may over-ride any relationship with academic course work and this idea fits neatly into the conceptual model introduced in the in the Research Purpose section of the Introduction as shown as Figure 8.

Graduates blocked for test-scores and SES

Post-secondary Attendance = f [(Post 10<sup>th</sup> grade math classes and related skill acquisition) + (non cognitive skills related to graduation)]

GEDs blocked for test-scores and SES

Post-secondary Attendance = f [(Post 10<sup>th</sup> grade math classes and related skill acquisition) + (*the negative non cognitive attributes associated with the GED*)]

*Figure 8: Revised Post-secondary Success Model*

To paraphrase Tolstoy: All high school graduates are more alike than different. GEDs are different, each in their own way. With this in mind, policy makers must not lose sight of the variety of reasons for the failure and the GED must continue to be offered as a second chance for students whose life circumstances, not a lack of persistence, has prevented their graduation.

## APPENDIX A

### DEPENDENT VARIABLES THAT COMPRISE THE D.V.: MONTHS ENROLLED IN POST-SECONDARY

Variable Name	Variable Label	Type	Additional Description
F2SPR_4	Number of months of post-secondary enrollment before January 2004	categorical	Public use version of the restricted use variable F2PRPRE4. Categories indicate 1-3 months, 4-6 months, or more than 7 months.
F2PS0401	Enrolled in post-secondary institution in January 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0402	Enrolled in post-secondary institution in February 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0403	Enrolled in post-secondary institution in March 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0404	Enrolled in post-secondary institution in April 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0405	Enrolled in post-secondary institution in May 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0406	Enrolled in post-secondary institution in June 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0407	Enrolled in post-secondary institution in July 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0408	Enrolled in post-secondary institution in August 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0409	Enrolled in post-secondary institution in September 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0410	Enrolled in post-secondary institution in October 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0411	Enrolled in post-secondary institution in November 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0412	Enrolled in post-secondary institution in December 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0501	Enrolled in post-secondary institution in January 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.

	Variable Label	Type	Additional Description
F2PS0502	Enrolled in post-secondary institution in February 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0503	Enrolled in post-secondary institution in March 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0504	Enrolled in post-secondary institution in April 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0505	Enrolled in post-secondary institution in May 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0506	Enrolled in post-secondary institution in June 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0507	Enrolled in post-secondary institution in July 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0508	Enrolled in post-secondary institution in August 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0509	Enrolled in post-secondary institution in September 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0510	Enrolled in post-secondary institution in October 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0511	Enrolled in post-secondary institution in November 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0512	Enrolled in post-secondary institution in December 2005	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0508	Enrolled in post-secondary institution in January 2006	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0509	Enrolled in post-secondary institution in January 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0510	Enrolled in post-secondary institution in February 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0511	Enrolled in post-secondary institution in March 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0512	Enrolled in post-secondary institution in April 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.
F2PS0601	Enrolled in post-secondary institution in May 2004	categorical	Enrolled in 4-yr, 2-yr, less than 2-year, or unknown institution level.

## APPENDIX B

### RECODING VARIABLES

#### Independent Variables

The study needed to categorize the student as either a high school graduate or a GED by the time of the second follow-up. BYF2STU (high school completion status) lists ten categories: 1) Fall 2003 - Summer 2004 graduate, 2) Post-summer 2004 graduate, 3) Pre-fall 2003 graduate, 4) Graduation date unknown, 5) Received certificate of attendance, 6) Received GED or other equivalency, 7) Still enrolled in high school, 8) Working towards GED or equivalent, 9) No diploma, not in HS, not pursuing GED, 10) Status cannot be determined. Categories 1 – 4 were recoded as 1, graduated from high school, and the rest as 0, not graduated from high school. BYF2EVRGED (ever earned the GED or equivalent) lists two categories: 0) No evidence of receiving a GED or equivalent, and 1) Evidence of receiving a GED or equivalent. This variable did not need recoding.

A new variable, GED/Grad, was created that added the new value of BYF2STU to BYF2EVRGED to produce values of 0, 1, or 2. However, there were 25 students, whose value was 3, indicating both a GED and a Diploma. One explanation for this duality is that Pennsylvania, Florida, and New Jersey issue high school diplomas to GED recipients (New Jersey Department of Education; Pennsylvania Department of Education; Palka, 2010). These were recoded these as 2, GED, based on program experience that students obtaining both the GED and Diploma are more likely to exhibit characteristics of GEDs than of Diplomas (COIC, 2010).

FIRMAT\_P (Carnegie units of math) had eight categories of Carnegie units of math taken: 0 for 0 units, 1 for between 0 and 1.99; 2 for between 2 and 2.99; 3 for between 3 and 3.99; 4 for between 4 and 4.99; 5 for between 5 and 5.99; 6 for six or more units; and -4 for non-respondent. -4 was recoded to 0. Because of the limitations of small sample size, this variable was recoded to three groups; a new variable was created, revFIRMAT\_P, in which 0 - 1 to

become 1, 2 – 3 became 2, and 4 – 6 to become 3. Among GEDs, 36 out of 192, or 19%, were missing data. Among Graduates, 676 out of 10,183, or 7% were missing data.

BYTXMQU (quartile score based on the math test score of the variable BYTXMSTD), besides having 1 through 4 quartile values with 1 being the lowest, also had the -8 for skipped data. These values were noted in the SPSS program as missing. Among GEDs, 13 out of 192, or 7%, were missing data. Among Graduates, 107 out of 10,183, or 1%, were missing data.

### **Dependent Variable**

F2PSPR\_4 (number of months of post-secondary prior to January, 2004) had eight categories: 0 for 0 months enrolled; 1 for 1 – 3 months enrolled; 2 for 4 – 6 months enrolled; 4 for 7 or more months enrolled; -3 for legitimate skip; -4 for non-respondent; -8 for item component legitimate skip; and -9 for missing. A new variable, revF2PSR, was created that recoded category 1 as 2 months, category 2 as 5 months, and category 3 as 7 months.

The variables F2PS0401 (January 2004) through F2PS0601 (January 2006) had nine categories: 0 for not enrolled; 1 for enrolled in a 4 year institution; 2 for enrolled in a 2-year institution; 3 for enrolled in less than a 2 year institution; 4 for enrolled in level unknown; -3 legitimate skip; -4 non-respondent; -8 survey component legitimate skip; -9 missing. By means of SPSS, 0 through -10 were considered as missing for these variables, and new variables were created -- revF2PS0401 through revF2PS0601 with categories 1 – 4 given the value of 1 month.

Finally, the values in revF2PSR and revF2PS0401 through revF2PS0601 were summed in a new variable, revTotpsec. This produced the total number of months enrolled in any post-secondary institution for each student in the ELS 2002 sample.

**APPENDIX C**

**GRADUATES' DESCRIPTIVE STATISTICS: UNITS IN MATH, MATH SCORE, AND  
SES**

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Dependent Variable: Post-secondary months enrolled

Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
1	1	Lowest quartile	5.94	4.76	18
		Second quartile	9.92	6.98	13
		Third quartile	12.40	6.63	15
		Highest quartile	13.89	7.61	9
		Total	9.95	6.89	55
1	2	Lowest quartile	8.91	5.30	11
		Second quartile	10.33	6.77	12
		Third quartile	10.54	7.38	13
		Highest quartile	14.47	7.17	15
		Total	11.29	6.91	51
1	3	Lowest quartile	13.38	4.17	8
		Second quartile	13.08	5.55	12
		Third quartile	13.00	6.80	9
		Highest quartile	13.38	4.09	13
		Total	13.21	5.02	42
1	4	Lowest quartile	11.00	.	1
		Second quartile	11.00	7.00	3
		Third quartile	21.00	9.54	3
		Highest quartile	14.50	5.60	10
		Total	14.82	6.78	17
1	Total	Lowest quartile	8.50	5.46	38
		Second quartile	11.08	6.40	40
		Third quartile	12.58	7.32	40
		Highest quartile	14.06	6.04	47
		Total	11.70	6.61	165

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Dependent Variable: Post-secondary					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
2	1	Lowest quartile	10.67	6.05	232
		Second quartile	11.83	5.70	219
		Third quartile	11.93	5.40	162
		Highest quartile	12.47	5.91	106
		Total	11.57	5.81	719
		2	2	Lowest quartile	12.95
Second quartile	12.26			5.51	297
Third quartile	13.54			5.20	266
Highest quartile	14.60			5.31	223
Total	13.26			5.58	1036
2	3			Lowest quartile	13.26
		Second quartile	13.86	5.54	258
		Third quartile	13.82	5.29	355
		Highest quartile	14.93	4.76	382
		Total	14.12	5.24	1158
		2	4	Lowest quartile	14.44
Second quartile	14.02			5.28	179
Third quartile	15.09			4.57	270
Highest quartile	15.75			4.25	498
Total	15.17			4.63	1035
2	Total			Lowest quartile	12.48
		Second quartile	12.92	5.59	953
		Third quartile	13.78	5.20	1053
		Highest quartile	14.99	4.86	1209
		Total	13.70	5.43	3948
		3	1	Lowest quartile	12.59
Second quartile	12.47			5.59	103
Third quartile	12.74			5.04	87
Highest quartile	13.65			5.70	65
Total	12.77			5.44	390

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Dependent Variable: Post-secondary					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
3	2	Lowest quartile	13.05	5.07	189
		Second quartile	14.00	4.69	208
		Third quartile	14.53	4.24	224
		Highest quartile	15.14	3.86	233
		Total	14.24	4.51	854
		3	3	Lowest quartile	14.33
Second quartile	14.86			4.09	304
Third quartile	15.21			3.88	432
Highest quartile	15.83			3.24	583
Total	15.26			3.87	1520
3	4			Lowest quartile	15.12
		Second quartile	15.48	3.82	307
		Third quartile	15.71	3.21	562
		Highest quartile	16.30	2.56	1191
		Total	15.95	3.12	2215
		3	Total	Lowest quartile	13.81
Second quartile	14.61			4.43	922
Third quartile	15.14			3.84	1305
Highest quartile	15.95			3.12	2072
Total	15.20			3.94	4979
Total	1			Lowest quartile	11.12
		Second quartile	11.95	5.72	335
		Third quartile	12.22	5.35	264
		Highest quartile	12.97	5.92	180
		Total	11.90	5.78	1164
		Total	2	Lowest quartile	12.89
Second quartile	12.92			5.30	517
Third quartile	13.90			4.91	503
Highest quartile	14.86			4.72	471
Total	13.64			5.21	1941

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Dependent Variable: Post-secondary					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
Total	3				
		Lowest quartile	13.84	5.14	372
		Second quartile	14.37	4.85	574
		Third quartile	14.57	4.65	796
		Highest quartile	15.44	3.94	978
		Total	14.74	4.56	2720
Total	4				
		Lowest quartile	14.86	5.66	244
		Second quartile	14.92	4.49	489
		Third quartile	15.53	3.75	835
		Highest quartile	16.13	3.19	1699
		Total	15.70	3.71	3267
Total	Total				
		Lowest quartile	13.00	5.60	1451
		Second quartile	13.70	5.16	1915
		Third quartile	14.50	4.61	2398
		Highest quartile	15.58	3.92	3328
		Total	14.49	4.77	9092

**APPENDIX D**

**TESTS BETWEEN-SUBJECTS EFFECTS FOR GRADUATES: SES, MATH SCORE,  
AND UNITS IN MATH**

Dependent Variable: Post-secondary						
Source		<i>Type III Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>p</i>
Main Effect						
	SES	792.47	3	264.16	12.85	0.00
	Math score	1341.17	3	447.06	21.74	0.00
	Units in Math	1708.89	2	854.45	41.55	0.00
2-way Effect						
	SES*Math score	416.29	9	46.25	2.25	0.02
	SES*Units in Math	205.41	6	34.23	1.66	0.13
	Math score*Units in Math	87.99	6	14.67	0.71	0.64
3-way Effect						
	SES*Math score*Units in Math	674.59	18	37.48	1.82	0.02
Error		185979.20	9044	20.56		

**APPENDIX E**

**GEDS' DESCRIPTIVE STATISTICS: UNITS IN MATH, MATH SCORE, AND SES**

Dependent Variable: Post-secondary months enrolled					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
1	1	Lowest quartile <sup>a</sup>	9.00	1.41	2
		Second quartile	4.60	5.86	5
		Third quartile	11.50	5.57	4
		Highest quartile	26.00	.	1
		Total	9.42	7.63	12
1	2	Lowest quartile	4.50	2.12	2
		Second quartile	11.00	4.55	4
		Third quartile	13.20	8.64	5
		Highest quartile	2.50	2.12	2
		Total	9.54	7.04	13
1	3	Lowest quartile	2.00	.	1
		Second quartile	3.50	2.38	4
		Third quartile	10.00	.	1
		Highest quartile	6.67	4.04	3
		Total	5.11	3.55	9
1	4	Third quartile	11.50	7.78	2
		Highest quartile	29.00	.	1
		Total	17.33	11.50	3
1	Total	Lowest quartile	5.8	3.35	5
		Second quartile	6.23	5.40	13
		Third quartile	12.08	6.50	12
		Highest quartile	11.43	11.44	7
		Total	9.05	7.36	37
2	1	Lowest quartile	8.60	5.32	5
		Second quartile	8.50	10.61	2
		Third quartile	5.86	4.88	7
		Highest quartile	6.25	2.87	4
		Total			

Dependent Variable: Post-secondary					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
		Total	7.00	4.98	18
2	2	Lowest quartile	8.75	9.74	4
		Second quartile	6.22	5.24	9
		Third quartile	8.67	6.75	9
		Highest quartile	10.38	7.89	8
		Total	8.40	6.90	30
2	3	Lowest quartile	3.00	1.00	3
		Second quartile	10.56	7.75	9
		Third quartile	11.29	9.05	7
		Highest quartile	13.18	10.03	11
		Total	10.93	8.76	30
2	4	Lowest quartile	11.00	7.94	3
		Second quartile	16.50	16.26	2
		Third quartile	8.43	6.37	7
		Highest quartile	15.55	10.63	11
		Total	12.87	9.58	23
2	Total	Lowest quartile	8.00	6.72	15
		Second quartile	9.14	7.81	22
		Third quartile	8.57	6.81	30
		Highest quartile	12.47	9.37	34
		Total	9.92	8.06	101
3	1	Lowest quartile	1.00	.	1
		Second quartile	7.00	.	1
		Highest quartile	5.00	.	1
		Total	4.33	3.06	3
3	2	Lowest quartile	16.00	.	1
		Second quartile	5.50	0.71	2
		Total	9.00	6.08	3

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Dependent Variable: Post-secondary					
Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
3	3	Second quartile	18.00	.	1
		Highest quartile	14.50	0.71	2
		Total	15.67	2.08	3
3	4	Second quartile	3.00	.	1
		Third quartile	11.50	6.36	2
		Highest quartile	10.00	5.66	2
		Total	9.20	5.54	5
3	Total	Lowest quartile	8.50	10.61	2
		Second quartile	7.80	5.89	5
		Third quartile	11.50	6.36	2
		Highest quartile	10.80	4.87	5
		Total	9.50	5.68	14
Total	1	Lowest quartile	7.75	4.89	8
		Second quartile	5.88	6.24	8
		Third quartile	7.91	5.63	11
		Highest quartile	9.33	8.48	6
		Total	7.64	6.02	33
Total	2	Lowest quartile	8.57	7.93	7
		Second quartile	7.40	5.03	15
		Third quartile	10.29	7.49	14
		Highest quartile	8.8	7.74	10
		Total	8.76	6.77	46
Total	3	Lowest quartile	2.75	.96	4
		Second quartile	9.07	7.45	14
		Third quartile	11.13	8.39	8
		Highest quartile	12.13	8.76	16
		Total	10.02	8.07	42

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Dependent Variable: Post-secondary

Units in Math	Math score quartile	SES	<i>M</i>	<i>SD</i>	<i>N</i>
Total	4				
		Lowest quartile	11.00	7.94	3
		Second quartile	12.00	13.89	3
		Third quartile	9.55	6.07	11
		Highest quartile	15.71	10.40	14
		Total	12.71	9.19	31
Total	Total				
		Lowest quartile	7.55	6.21	22
		Second quartile	8.03	6.87	40
		Third quartile	9.66	6.76	44
		Highest quartile	12.13	9.18	46
		Total	9.67	7.67	152

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**APPENDIX F**

**TESTS OF BETWEEN-SUBJECTS EFFECTS FOR GEDS: SES, MATH SCORE, AND  
UNITS IN MATH**

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Dependent Variable: Post-secondary

Source		<i>Type III Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>p</i>
Main Effect						
	BYSES2QU	160.77	3.00	53.59	0.96	0.41
	BYTXMQU	106.21	3.00	35.40	0.64	0.59
	revF1RMAT_P	21.31	2.00	10.66	0.19	0.83
2-way Effect						
	SES * Math Score	619.57	9.00	68.84	1.24	0.28
	SES * Units in Math	338.14	6.00	56.36	1.01	0.42
	Math score * Units in Math	716.04	6.00	119.34	2.15	0.05
3-Way Effect						
	SES * Math Score * Units in Math	762.77	10.00	76.28	1.37	0.20
Error		6227.38	112.00	55.60		

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a. R Squared = .300 (Adjusted R Squared = .056)

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