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Academic Growth Patterns of First-Generation College Students in Grades 8 to 12

Dina Bassiri, PhD

Dina Bassiri is a senior research scientist in Statistical and Applied Research at ACT, specializing in educational outcomes research and student growth models.

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Abstract

Many college students are first-generation (i.e., their parents do not have postsecondary educations). As is well known, first-generation college students tend to have lower college admission test scores and to be less successful in completing their postsecondary programs than students whose parents have gone to college. This study investigated the extent to which gaps in their test scores might begin in middle school. Using longitudinal data of approximately 282,000 students who took ACT Explore®, ACT Plan®, and the ACT® test (in grades 8, 10, and 11/12, respectively), I examined growth patterns by parent education level from grade 8 to 10, grade 10 to 11/12, and grade 8 to 11/12. About 20% of the students were first-generation college students, 67% were non-first-generation, and 13% did not report their parents' education level.

First-generation students experienced less-than-expected growth in all four subject areas (English, reading, mathematics, and science), whereas students with a parent who had at least a bachelor's degree experienced above-average expected growth. Most of the growth differences, while statistically significant, were small in magnitude.

I also examined growth patterns of gender and racial/ethnic subgroups within parent education groups. In general, male students consistently experienced at or above-average expected growth in mathematics and science and female students typically experienced less-than-expected growth in both subject areas. Female students typically experienced higher growth in English and reading among students whose parent had at least a bachelor's degree. Results for race/ethnicity were generally mixed, except that African American students consistently had the least growth. Notably, Asian students demonstrated significantly higher growth than the other racial/ethnic subgroups in mathematics and science; in English and reading, Asian students whose parent had at least a bachelor's degree generally experienced higher growth than the other subgroups.

Introduction

As postsecondary education is becoming more crucial for career placement in the twenty-first century's fast-changing economy, more students with diverse backgrounds are seeking a higher education. Access to college has increased substantially over the last 50 years, although student success—defined as the combination of academic success and degree or certificate completion—is unevenly distributed by socioeconomic status (Turner, 2004). That being said, first-generation students still remain underrepresented among college students. Specifically, a 2001 National Center for Education Statistics (NCES) study found that although 82% of non-first-generation students enrolled in college immediately after finishing high school, only 54% of students whose parents had completed high school and 36% of students whose parents had less than a high school diploma did so (Choy, 2001).

Many first-generation students come from educationally disadvantaged and/or low-income backgrounds. Disparities in educational outcomes widen when focusing on more distal outcomes such as degree completion. For example, young adults from high-income families are 10 times more likely than those from low-income families to earn bachelor's degrees by age 24 (82% vs. 8%) (Mortenson, 2007).

A substantial body of research has been conducted on first-generation college students to identify factors that distinguish them from their peers regarding their academic preparation, transition to postsecondary education, and progress toward degree attainment (Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996; Choy, 2001; Engle, 2007; Saenz, 2007; Tym, McMillion, Barone, & Webster, 2004). For example, many students begin college but do not attain a degree (Choy, 2002; Engle & Tinto, 2008). Factors that have been shown to affect completion rates are students' race and ethnicity, as well as first-generation status (Richardson & Skinner, 1992; Choy, 2002; Engle & Tinto, 2008).

Studies have shown that first-generation students have poor pre-college preparation, lower career aspirations, lack of family support, lack of faculty and peer support, fear of the college environment, and poor study skills or habits (Billson & Terry, 1982; York-Anderson & Bowman, 1991; Terenzini et al., 1996). These factors inhibit the success of first-generation students and decrease their chances of attaining a college degree (Billson & Terry, 1982; Warburton, Bugarin, & Nunez, 2001). The results show that such students are at a distinct disadvantage in gaining access to postsecondary education. Even those who overcome the barriers and do enroll have difficulty remaining enrolled and attaining a degree (Horn & Nunez, 2000; Nunez & Cuccaro-Alamin, 1998; Warburton et al., 2001). As with all students, it is imperative that first-generation students receive appropriate support in and out of the classroom in order to successfully navigate the educational pathway.

A good deal of research supports the idea that the path to college and career readiness begins well before high school, and the achievement level that students attain by middle school is a crucial element in deriving subsequent achievements (e.g., ACT, 2008; Sawyer, 2008). Learning gaps are likely to widen over time because of "Matthew effects"—those who start out ahead are at a relative advantage in acquiring new knowledge. Surprisingly, little is known about the academic growth patterns of first-generation college students from middle school to high school. Using longitudinal datasets, the goal of the current study was to examine the growth differences across parent education levels for three grade spans (grade 8 to 10, grade 10 to 11/12, and grade 8 to 11/12).

First-Generation College Students

The US Department of Education defines a first-generation college student as one whose parents do not have more than a high school education (US Department of Education, 2009). These students typically face additional financial, social, emotional, and academic barriers that their peers with college-educated parents do not face.

The majority of research available on first-generation college students generally falls into three categories (Terenzini et al., 1996). First, there are several studies that typically compare demographic characteristics, secondary school preparation, the college choice process, and college expectations between first-generation students and their peers (see, for example, Berkner & Chavez, 1997; Horn & Nunez, 2000; Hossler, Schmit, & Vesper, 1999; Kojaku & Nunez, 1998; Pratt & Skaggs, 1989; Stage & Hossler, 1989; Warburton et al., 2001; York-Anderson & Bowman, 1991). Much of the evidence from these studies shows that when compared to their peers, first-generation college students tend to be at a distinct disadvantage with respect to basic knowledge about postsecondary education (e.g., costs and application process), level of family income and support, educational degree expectations and plans, and academic preparation in high school. A disproportionate number of first-generation students come from lower socio-economic classes, are Hispanic, are foreign born, and come from households where English is not the primary language spoken (Warburton et al., 2001). First-generation students are less likely to have taken college entrance exams such as the SAT and ACT and less likely than their peers to complete advanced mathematics classes in high school (Warburton et al., 2001). Compared to others, first-generation students take fewer academic hours and take less challenging courses (Warburton et al., 2001). However, first-generation students who took rigorous high school coursework or who scored in the highest percentiles of their class showed little difference in academic ability from their non-first-generation peers (Warburton et al., 2001; ACT, 2014a).

The second set of studies about first-generation college students attempts to examine various aspects of the transition from high school to postsecondary education (e.g., Lara, 1992; Rendon, 1992; Rendon, Hope, & Associates, 1996; Terenzini, Rendon, Upcraft, Millar, Allison, Gregg, & Jalomo, 1994; Weis, 1992). As summarized by Terenzini et al. (1996), the evidence is reasonably clear that first-generation students as a group have a more difficult transition from secondary school to college than their peers. Similar to their peers, first-generation students must cope with the anxieties, dislocations, and difficulties associated with making the transition to college, while going through substantial cultural, social, and academic transitions. Large class sizes and lack of opportunity for faculty interaction provide a great risk for first-generation students, who are often less prepared to cope with such challenges (Richardson & Skinner, 1992).

About 50% of all first-generation college students in the US are from low-income families, compared to one-third of students whose parents have had at least some college experience (Horn & Nunez, 2000). These students are also more likely to be a member of a racial/ethnic minority subgroup. Wright (1987) found that racial/ethnic minority students arrive on campus with naive perceptions regarding their life plans and future careers. According to Richardson and Skinner (1992), students from racial/ethnic minority subgroups frequently indicated dissatisfaction with their social and emotional environment as a reason for leaving college or earning poor grades, regardless of academic ability or parent educational level. Institutions that are successful in retaining minority students can help to facilitate their academic, social, and personal development (Wright, 1987).

The third category of studies on first-generation college students assesses their persistence in college attendance, degree attainment, and level of success during early career labor market participation (e.g., Attinasi, 1989; Berkner, Horn, & Clune, 2000; Billson & Terry, 1982; Choy, 2000; Horn, 1998; Nunez & Cuccaro-Alamin, 1998; Richardson & Skinner, 1992; Warburton et al., 2001). Most of the above-mentioned studies consistently indicate that, when compared to their peers whose parents are college graduates, first-generation students are less likely to be successful in college based on a variety of outcomes. For example, first-generation students are more likely to leave a four-year institution at the end of the first year, less likely to be on track to a bachelor's degree after three years (i.e., remain enrolled in a four-year institution), and less likely to stay enrolled or attain a bachelor's degree after five years. Even among those qualified for college, first-generation students were less likely to enroll in four-year institutions (Horn & Nunez, 2000). Independent of other relevant demographic, enrollment, and college involvement factors, first-generation status was also found to be negatively associated with students' persistence and degree attainment (Nunez & Cuccaro-Alamin, 1998). In addition, first-generation incoming college students tend to be less likely than students whose parents have college degrees to enroll in a graduate or professional program four to five years after high school graduation. However, there appears to be little difference in the early career earnings between first-generation graduates and their peers when degree attainment is taken into account.

The current study belongs to the first category and compares growth differences in secondary educational performance by parent education levels; it does not attempt to address the other two categories.

Data and Methodology

To examine growth differences between first-generation students and other students across the three grade level spans (8 to 10, 10 to 11/12, and 8 to 11/12), this study used longitudinal data from approximately 282,000 students who took ACT Explore in 8th grade, ACT Plan in 10th grade, and the ACT in 11th or 12th grade.[1,2] Data collected as part of the assessment programs were used to classify students into subgroups and to measure growth between grade 8 and grade 11/12.

To estimate growth, I developed models to predict ACT Plan (or ACT) test scores for each student. I developed multiple-predictor models for each of the four subject areas (English, reading, mathematics, and science) that included student's prior achievement ACT Explore (or ACT Plan) scores in all four subject areas, the number of months elapsed between the two tests, and the prior subject-specific mean achievement scores for each high school.

[1] Until 2015, the ACT college and career readiness system of assessment included ACT Explore (for 8th graders), ACT Plan (for 10th graders), and the ACT (for 11th and 12th graders). (The ACT Aspire® assessment system has replaced ACT Explore and ACT Plan.) The three assessments shared a common score scale, with different score ceilings. ACT Explore scores ranged from 1–25, ACT Plan scores ranged from 1–32, and ACT scores range from 1–36. ACT Explore and ACT Plan contained multiple-choice tests in English, mathematics, reading, and science, as the ACT does. For each assessment, the Composite score is calculated as the mean of the four subject area scores. All three assessments measure academic skills necessary for education and work after high school, respective to the curriculum of the grade level for which it is intended, and use a common score scale.

[2] For students who took the ACT more than once, the last ACT score was used.

There are significant differences among high schools in their students' average test scores (Noble & Schnelker, 2007), even after accounting for differences in their students' characteristics (Sawyer, 2008). These differences potentially confound inferences about students' growth across all high schools. To account for high school effects, I estimated random intercept models. The random intercept model adjusts the predicted scores for unobserved school effects on student growth, so that residual scores are not confounded by school effects. Residual scores are defined as the difference between students' actual and predicted scores. This residual describes a student's growth in terms of how much he or she performed above expected, given prior scores. As described in Castellano and Ho's *A Practitioner's Guide to Growth Models* (2013), this approach is known as the residual gain model according to their taxonomy. A group's mean residual score then describes how much higher or lower than expected students score, on average, and can be used to support group value-added interpretations. The one-sample t-test can be used to test whether the mean residual is different from 0 for each group. This approach has produced group effect estimates that are highly correlated (e.g., $r > 0.985$) with those produced by t he mean Student Growth Percentile (Castellano & Ho, 2015)—another frequently used model.

I aggregated residual scores by subgroup to form a measure of aggregate growth for each. This was done separately for each subject area (English, mathematics, reading, and science), and for each grade level span (8 to 10, 10 to 11/12, and 8 to 11/12). By definition, the mean residual score across all students in the study sample is zero. For each subgroup mean residual score, I tested whether the mean was significantly different than zero. Statistical tests with p-values less than 0.01 were considered significant.

Subgroup Definitions

Many definitions of first-generation students exist; the current study used ACT's definition of first- and non-first-generation to classify students into subgroups.[3] Included in the Student Profile Section of the ACT registration form are two questions regarding parental education:

- *What is the educational level of your mother/guardian 1?*
- *What is the educational level of your father/guardian 2?*

The response options for these questions are: (1) Less than high school, (2) High school graduate/GED, (3) Business/technical school or certificate program, (4) Some college, no degree or certificate, (5) Associate's degree (2 years), (6) Bachelor's degree (4 years), (7) One or two years of graduate study (MA, MBA, etc.), and (8) Doctorate or professional degree (PhD, MD, JD, etc.). Based on self-reported data provided by students (students' responses to these two questions), I identified four groups of students for analysis: students whose parents have no college experience (first-generation); and students with at least one parent with, respectively, some college experience[4], a bachelor's degree, or graduate degree. The latter three groups are also referred to as non-first-generation.

[3] The term "first-generation student" is defined differently by a number of organizations, often differing in the extent of exposure to postsecondary education (e.g., enrolled, attended, or completed) as experienced by disparate combinations of parent/guardian arrangements (e.g., highest extent of exposure for one parent/guardian or both parents/guardians). The definition used in this report's analysis is consistent with that used by NCES.

[4] This includes students whose parents had some college experience but earned no degree as well as those who earned an associate's degree.

Students also reported their demographic information. I considered gender and used five racial/ethnic subgroups for analysis: African American, Hispanic, White, Asian, and Other (American Indian, two or more races, and prefer not to respond).

Predicted Test Scores

I modeled ACT test scores for each student, using as predictors the student's prior ACT Explore scores in all four subject areas, the number of months that passed between the two tests, and the prior subject-specific mean ACT Explore score for the high school. To account for unobserved high school effects, a random intercept model was used. Equation 1 describes the model for predicted ACT test scores:

$$\hat{Y}_{ij} = \hat{\beta}_0 + \sum_{p=1}^{4} \hat{\beta}_p X_{ijp} + \hat{\beta}_5 X_{ij5} + \hat{\beta}_6 \overline{X}_j + \hat{\tau}_j \qquad (1)$$

where

- $\hat{Y}_{ij}$ is the predicted ACT score for the i^{th} student from the j^{th} high school,
- $\hat{\beta}_0$ is the estimate for the overall intercept term,
- X_{ijp} (p = 1,2,3,4) are the prior ACT Explore scores in the four subject areas for the i^{th} student from the j^{th} high school,
- $\hat{\beta}_p$ (p = 1,2,3,4) are the estimated regression coefficients for the four prior test scores,
- X_{ij5} is the number of months between ACT Explore to ACT for the i^{th} student from the j^{th} high school,
- $\hat{\beta}_5$ is the estimated regression coefficient for the number of months between tests,
- $\overline{X}_j$ is the mean prior test score in the subject area of interest for the j^{th} high school,
- $\hat{\beta}_6$ is the estimated regression coefficient for the school mean prior test score, and
- $\hat{\tau}_j$ is the estimated school-specific intercept (a random variable assumed to be normally distributed with mean 0 and variance τ_{00}).

The model is a special case of a hierarchical linear model (Raudenbush & Bryk, 2002) and can be fit using statistical software packages such as HLM or SAS. I estimated analogous models to predict ACT Plan scores from ACT Explore scores and to predict ACT scores from ACT Plan scores.

By using the amount of time between tests as a covariate (Allen, Bassiri, & Noble, 2009), the predicted scores accommodate varying time spans between tests, as more growth is expected as more time passes. Additionally, because of possible peer effects (Angrist & Lang, 2002), the predicted scores also take into account the subject-specific prior mean achievement observed in each high school.[5]

[5] There are two kinds of peer effects: exogenous/contextual effects and endogenous/spillover effects. Contextual effects refer to how students' scores are affected by the average characteristics of their peers. A positive estimate indicates that average peer characteristics are positively correlated with a student's exam scores. Endogenous effects refer to how students' academic performance is affected by the average academic performance of their peers. A positive estimate indicates that peers are more likely to have similar scores, because their scores positively affect each other. While contextual effects capture peer effects generated from predetermined observable characteristics of peers, the spillover effect captures peer effects, which do not go through any observable characteristics in the model (Manski, 1993; & Lam, n.d.).

Results

The sample sizes, gender, and racial/ethnic breakdowns for the four parent education level groups, the total sample, and the 2013 ACT-tested high school graduating class are presented in Table 1. Of the original 281,854 students, 56,162 were first-generation students (20%), 187,712 were non-first-generation students (67%), and 13% did not report their parent's education level. Students who did not report their parent's education level were excluded from the study. Of non-first-generation students, 41% of students had at least one parent with some college experience, 35% with at least one parent holding a bachelor's degree, and 24% with at least one parent holding a graduate degree.

Students' demographic characteristics are summarized in Table 1. Note that the gender and racial/ethnic breakdowns of the total sample are similar to that for the 2013 ACT-tested high school graduating class. Most of the students were female (53%), and White students were slightly overrepresented in the sample (63% vs. 58%). Of first-generation students, 16% were African American, 22% were Hispanic, and 52% were White. As parental education increased, the percentage of African American and Hispanic students decreased, while the percentage of White students increased (from 52% to 74%). It is worth noting that the study sample is highly representative of the entire ACT-tested population who also took ACT Explore in grade 8 and ACT Plan in grade 10. Among the national 2013 ACT-tested graduating class, about 18% (335,711) were potential first-generation college students (ACT, 2013a). Furthermore, the entire ACT-tested population is fairly representative of all first-year college students in the nation. In particular, about 69% of 2013 ACT-tested graduates (1,238,375) enrolled in a postsecondary institution in the fall 2013 (ACT, 2013b), compared to 63% of all 2008 US high school graduates. Considering that the demand for postsecondary education increased from 59% in 2004 to 63% in 2008 (Western Interstate Commission for Higher Education [WICHE], 2012), it is likely that by 2013 the college-going rate of all US high school graduates will be close to 69%.

Table 1. Demographics of Study Sample

		Gender		Race/Ethnicity				
Group	N	Female	Male	African American	Hispanic	White	Asian	Other
Parental Education								
No College	56,162	57%	43%	16%	22%	52%	3%	7%
Some College	76,265	56%	44%	16%	9%	66%	2%	8%
Bachelor's Degree	65,493	52%	48%	10%	6%	75%	2%	8%
Graduate Degree	45,954	51%	49%	8%	5%	74%	5%	8%
Sample Total	281,854	53%	47%	13%	11%	63%	3%	8%
ACT-Tested Graduating Class of 2013	1,799,243	53%	46%	13%	14%	58%	4%	10%

Note: Of the total sample of 281,854 students, 37,980 students (13%) didn't report their parent's education level. Percentages do not sum to 100 due to non-response to gender or race/ethnicity questions.

Achievement Differences

Table 2 contains summary statistics of the three test scores for each of the four subgroups of students. Across subject areas, the average ACT Explore, ACT Plan, and ACT scores increased with parent education level. For example, the average ACT score difference between first- and non-first-generation students whose parents had some college experience, bachelor's degree, or graduate degree were, respectively, 1.0, 2.3, and 3.2, in English; 0.8, 2.0, and 2.8 in mathematics; 0.9, 2.1, and 2.9 in reading; and 0.8, 1.9, and 2.5 in science. To provide some indication of the practical significance of these differences, it would be helpful to express the differences in standard deviation (SD) units. Considering that the 2013 average ACT scores nationwide in English, mathematics, reading, and science were 20.2, 20.9, 21.1, and 20.7, respectively (ACT, 2013b), the average English, mathematics, reading, and science scores of first-generation students were, respectively, 0.35, 0.64, 0.54, and 0.43 standard deviations lower than those of national ACT scores. However, the corresponding averages for non-first-generation students whose parents had at least a bachelor's degree were, respectively, 0.52, 0.24, 0.33, and 0.45 standard deviations higher than those of national ACT scores.

Table 2. Summary Statistics of ACT Explore, ACT Plan, and ACT Scores

			Subject Area			
			English	Mathematics	Reading	Science
Group	N	Test	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Parental Education						
No College	56,162	ACT Explore	14.7 (1.6)	15.4 (1.4)	14.4 (1.3)	16.6 (1.1)
		ACT Plan	16.6 (1.7)	17.8 (1.9)	17.0 (1.8)	18.0 (1.6)
		ACT	19.3 (2.6)	19.5 (2.2)	19.8 (2.4)	19.8 (2.1)
Some College	76,265	ACT Explore	15.3 (1.5)	15.8 (1.4)	14.9 (1.3)	16.9 (1.1)
		ACT Plan	17.2 (1.6)	18.4 (1.9)	17.7 (1.7)	18.6 (1.5)
		ACT	20.3 (2.6)	20.3 (2.3)	20.7 (2.4)	20.6 (2.1)
Bachelor's Degree	65,493	ACT Explore	16.0 (1.5)	16.4 (1.3)	15.4 (1.3)	17.4 (1.1)
		ACT Plan	18.0 (1.6)	19.3 (2.0)	18.5 (1.7)	19.3 (1.5)
		ACT	21.6 (2.7)	21.5 (2.5)	21.9 (2.4)	21.7 (2.2)
Graduate Degree	45,954	ACT Explore	16.4 (1.5)	16.7 (1.3)	15.7 (1.3)	17.7 (1.1)
		ACT Plan	18.4 (1.6)	19.9 (2.0)	18.9 (1.7)	19.8 (1.6)
		ACT	22.5 (2.8)	22.3 (2.5)	22.7 (2.5)	22.3 (2.2)

Hierarchical Modeling Results

We now examine results from the two-level linear regression model (Equation 1) used to generate the predicted and residual scores. Twelve models were fit—one for each combination of subject area (English, mathematics, reading, and science) and grade level span (8 to 10, 10 to 11/12, and 8 to 11/12). Tables in Appendix A contain the parameter estimates from these twelve models.

Tables A1 and A3 show intra-class correlation coefficients (ICCs), which measure the level of homogeneity of score outcomes within schools. The ICCs for the ACT Explore-to-ACT models range from 0.05 to 0.11, and are slightly larger than the corresponding ICCs for the ACT Explore-to-ACT Plan or the ACT Plan-to-ACT models. A potential explanation for this result is that schooling has a longer time to affect growth between ACT Explore and the ACT than between the other two pairings of tests (Bassiri, 2015). Another potential explanation is that there is less similarity between ACT Explore and the ACT in the constructs they measure. In any case, the low estimated ICCs across models suggest that the proportion of the variance in later test scores is much higher within the schools than between the schools, indicating that the majority of overall variance in later test scores is due to student characteristics (particularly, student's initial test scores).

Tables A1–A3 also show that across models, all regression coefficients for prior test scores, time between tests, and school subject-specific mean prior test scores are positive and statistically significant (p-value < 0.01). The only exception was that ACT Plan scores in reading were not predictive of ACT mathematics test scores (Table A2). These results suggest that prior test scores, time between tests, and mean prior test scores are all predictive of later test scores, and that predicted later scores increase with increasing prior test scores, more time in between tests, and higher performing schools. As expected, the same-subject regression coefficients of prior test scores were the largest across all models. It is also apparent that the second largest regression coefficients tend to be for the subject test that is next most similar in content (English with reading, mathematics with science).

The multiple correlations of the models (denoted as *R* at the bottom of Tables A1–A3) ranged from 0.76 to 0.87. Multiple *R* reflects the strength of the relationships between predicted and actual later test scores. The multiple *R*s for the models ranged from 0.76 to 0.87, indicating strong relationships. In sum, the results in Tables A1–A3 signify the importance of prior achievement, number of months between tests, and school mean prior test scores in predicting later test scores. Notice that *R*s for predicting ACT scores from ACT Plan (Table A3) are larger than *R*s for predicting ACT scores from ACT Explore (Table A1) and *R*s for predicting ACT Plan scores from ACT Explore (Table 2). One likely reason for this result is that students who were tested in grades 10 and 11/12 most likely were from the same high school, whereas students who were tested in grades 8 and 10 or 11/12 were in transition from middle school to high school.

Growth Differences

Results from the two-level linear regression models are used to generate the predicted and residual scores. Averaging residual scores by subgroup provides a measure of each subgroup's average relative growth (for each subject area and for each grade level span). The mean residual scores and their standard errors for all four subject areas are given in Table 3 for grade span 8 to 1/12, in Table 4 for grade span 8 to 10, and in Table 5 for grade span 10 to 11/12. From Tables 3–5, we see that first-generation students across all grade spans experienced less-than-expected growth in all subject areas, ranging from -0.52 to -0.18 in English; -0.39 to -0.15 in reading; -0.34 to -0.19 in mathematics; and -0.35 to -0.15 in science. Similarly, students whose parent had only some college experienced less-than-expected growth in all subject areas and across all grade periods. However, students whose parent had at least a bachelor's degree had statistically significant (p-value < 0.01) and positive mean residual scores (ranging from 0.09 to 0.79 in English, 0.08 to 0.63 in reading, 0.13 to 0.71 in mathematics, and 0.08 to 0.53 in science). Note that first-generation students and students whose parent had some college experience both had statistically significant (p-value < 0.01) and negative mean residual scores in all subject areas across all grade spans. Yet, the difference between their mean residual scores ranged from 0.02 to 0.07 in mathematics; 0.14 to 0.34 in English; 0.11 to 0.26 in reading; and 0.11 to 0.23 in science. This shows that the difference between first-generation students and students whose parent had some college experience were smallest in mathematics.

Table 3. Mean Residual Scores (and Standard Errors) for Grade 8 to 11/12 Growth Period by Parental Education

	Parental Education				Parental Education			
	No College	Some College	Bachelor's Degree	Graduate Degree	No College	Some College	Bachelor's Degree	Graduate Degree
Group	English				Reading			
All Students	-0.52 (0.01)	-0.18 (0.01)	0.31 (0.01)	0.79 (0.02)	-0.39 (0.01)	-0.13 (0.01)	0.19 (0.01)	0.63 (0.02)
Gender								
Female	-0.47 (0.02)	-0.07 (0.02)	0.43 (0.02)	0.95 (0.02)	-0.39 (0.02)	-0.14 (0.02)	0.14 (0.02)	0.61 (0.02)
Male	-0.57 (0.02)	-0.32 (0.02)	0.17 (0.02)	0.62 (0.02)	-0.39 (0.02)	-0.10 (0.02)	0.24 (0.02)	0.65 (0.03)
Race/Ethnicity								
African American	-0.71 (0.03)	-0.48 (0.03)	**-0.05** (0.04)	**0.09** (0.06)	-0.54 (0.04)	-0.47 (0.03)	-0.29 (0.05)	-0.16 (0.06)
Hispanic	-0.59 (0.03)	-0.32 (0.04)	**0.09** (0.06)	0.52 (0.07)	-0.46 (0.03)	-0.20 (0.05)	**0.09** (0.06)	0.40 (0.08)
White	-0.46 (0.02)	-0.10 (0.02)	0.35 (0.02)	0.81 (0.02)	-0.34 (0.02)	**-0.05** (0.02)	0.24 (0.02)	0.66 (0.02)
Asian	**-0.05** (0.08)	0.37 (0.10)	1.02 (0.09)	1.74 (0.08)	**-0.11** (0.09)	**0.08** (0.11)	0.59 (0.10)	1.31 (0.08)
Other	-0.41 (0.06)	-0.16 (0.04)	0.35 (0.05)	0.97 (0.06)	-0.18 (0.06)	**0.01** (0.05)	0.30 (0.05)	0.91 (0.06)
Group	Mathematics				Science			
All Students	-0.34 (0.01)	-0.27 (0.01)	0.22 (0.01)	0.71 (0.01)	-0.35 (0.01)	-0.12 (0.01)	0.21 (0.01)	0.53 (0.02)
Gender								
Female	-0.64 (0.01)	-0.61 (0.01)	-0.20 (0.02)	0.27 (0.02)	-0.66 (0.02)	-0.50 (0.01)	-0.28 (0.02)	**0.02** (0.02)
Male	0.07 (0.02)	0.17 (0.02)	0.68 (0.02)	1.17 (0.02)	**0.06** (0.02)	0.37 (0.02)	0.75 (0.02)	1.06 (0.02)
Race/Ethnicity								
African American	-0.31 (0.03)	-0.41 (0.02)	-0.35 (0.03)	-0.23 (0.05)	-0.52 (0.03)	-0.47 (0.03)	-0.32 (0.04)	-0.28 (0.05)
Hispanic	-0.22 (0.03)	-0.36 (0.04)	**-0.09** (0.05)	0.26 (0.07)	-0.36 (0.03)	-0.23 (0.04)	**-0.08** (0.05)	**0.13** (0.07)
White	-0.45 (0.02)	-0.24 (0.01)	0.29 (0.01)	0.72 (0.02)	-0.33 (0.02)	**-0.03** (0.01)	0.30 (0.01)	0.58 (0.02)
Asian	0.98 (0.08)	1.10 (0.10)	1.66 (0.09)	2.50 (0.07)	0.46 (0.08)	0.41 (0.09)	0.78 (0.08)	1.33 (0.07)
Other	-0.43 (0.05)	-0.37 (0.04)	**0.13** (0.04)	0.78 (0.05)	-0.33 (0.05)	-0.12 (0.04)	0.16 (0.05)	0.62 (0.05)

Note: Means in **bold** are not statistically significant. All others are statistically significant at $p < .01$.

Table 4. Mean Residual Scores (and Standard Errors) for Grade 8 to 10 Growth Period by Parental Education

	Parental Education				Parental Education			
	No College	Some College	Bachelor's Degree	Graduate Degree	No College	Some College	Bachelor's Degree	Graduate Degree
Group	English				Reading			
All Students	-0.18 (0.01)	-0.04 (0.01)	0.09 (0.01)	0.30 (0.01)	-0.15 (0.01)	-0.04 (0.01)	0.08 (0.01)	0.27 (0.01)
Gender								
Female	-0.08 (0.01)	0.09 (0.01)	0.27 (0.01)	0.50 (0.02)	**-0.03** (0.02)	0.09 (0.01)	0.20 (0.02)	0.38 (0.02)
Male	-0.31 (0.02)	-0.21 (0.01)	-0.12 (0.01)	0.09 (0.02)	-0.30 (0.02)	-0.19 (0.02)	**-0.05** (0.02)	0.17 (0.02)
Race/Ethnicity								
African American	-0.44 (0.03)	-0.30 (0.02)	-0.15 (0.03)	**-0.09** (0.04)	-0.39 (0.03)	-0.40 (0.03)	-0.28 (0.04)	-0.30 (0.05)
Hispanic	-0.27 (0.02)	-0.11 (0.03)	**-0.02** (0.04)	0.14 (0.05)	-0.18 (0.03)	**-0.04** (0.04)	**0.01** (0.05)	**0.16** (0.07)
White	-0.06 (0.01)	**0.02** (0.01)	0.12 (0.01)	0.31 (0.01)	-0.07 (0.02)	0.05 (0.01)	0.13 (0.01)	0.32 (0.02)
Asian	-0.26 (0.06)	**-0.16** (0.07)	0.24 (0.06)	0.78 (0.06)	**-0.14** (0.07)	**-0.18** (0.08)	**0.06** (0.07)	0.42 (0.07)
Other	-0.12 (0.04)	**0.01** (0.03)	0.12 (0.03)	0.44 (0.04)	**-0.12** (0.05)	**0.03** (0.04)	**0.10** (0.04)	0.39 (0.05)
Group	Mathematics				Science			
All Students	-0.19 (0.01)	-0.17 (0.01)	0.13 (0.01)	0.46 (0.01)	-0.15 (0.01)	-0.04 (0.01)	0.08 (0.01)	0.27 (0.01)
Gender								
Female	-0.44 (0.01)	-0.48 (0.01)	-0.25 (0.02)	**0.04** (0.02)	-0.37 (0.01)	-0.37 (0.01)	-0.31 (0.01)	-0.12 (0.02)
Male	0.14 (0.02)	0.23 (0.02)	0.55 (0.02)	0.90 (0.02)	0.14 (0.02)	0.26 (0.01)	0.48 (0.02)	0.79 (0.02)
Race/Ethnicity								
African American	-0.18 (0.03)	-0.23 (0.02)	-0.22 (0.03)	-0.17 (0.05)	-0.22 (0.02)	-0.30 (0.02)	-0.32 (0.03)	-0.33 (0.04)
Hispanic	-0.12 (0.02)	-0.20 (0.03)	**-0.09** (0.05)	**0.12** (0.07)	-0.21 (0.02)	-0.20 (0.03)	**-0.10** (0.04)	**0.03** (0.06)
White	-0.26 (0.02)	-0.17 (0.01)	0.16 (0.01)	0.47 (0.02)	-0.11 (0.01)	**-0.03** (0.01)	0.12 (0.01)	0.37 (0.02)
Asian	0.77 (0.07)	0.87 (0.09)	1.27 (0.08)	1.74 (0.07)	**0.02** (0.06)	**0.00** (0.07)	0.35 (0.07)	0.79 (0.06)
Other	-0.27 (0.05)	-0.19 (0.04)	**0.11** (0.04)	0.52 (0.05)	-0.14 (0.04)	**-0.05** (0.03)	**0.10** (0.04)	0.49 (0.04)

Note: Means in **bold** are not statistically significant. All others are statistically significant at $p < .01$.

Table 5. Mean Residual Scores (and Standard Errors) for Grade 10 to 11/12 Growth Period by Parental Education

	Parental Education				Parental Education			
	No College	Some College	Bachelor's Degree	Graduate Degree	No College	Some College	Bachelor's Degree	Graduate Degree
Group	English				Reading			
All Students	-0.45 (0.01)	-0.13 (0.01)	0.27 (0.01)	0.58 (0.01)	-0.32 (0.01)	-0.09 (0.01)	0.15 (0.01)	0.45 (0.02)
Gender								
Female	-0.35 (0.02)	0.05 (0.01)	0.47 (0.02)	0.82 (0.02)	-0.28 (0.02)	**-0.04** (0.02)	0.18 (0.02)	0.53 (0.02)
Male	-0.56 (0.02)	-0.34 (0.02)	0.06 (0.02)	0.33 (0.02)	-0.38 (0.02)	-0.14 (0.02)	0.11 (0.02)	0.36 (0.02)
Race/Ethnicity								
African American	-0.49 (0.03)	-0.23 (0.03)	**0.09** (0.04)	0.24 (0.05)	-0.32 (0.03)	-0.21 (0.03)	-0.13 (0.04)	**0.03** (0.06)
Hispanic	-0.47 (0.03)	-0.24 (0.04)	0.16 (0.05)	0.50 (0.07)	-0.33 (0.03)	**-0.11** (0.04)	**0.14** (0.06)	0.39 (0.08)
White	-0.45 (0.02)	-0.09 (0.01)	0.30 (0.01)	0.60 (0.02)	-0.34 (0.02)	-0.06 (0.02)	0.17 (0.02)	0.47 (0.02)
Asian	**-0.13** (0.07)	0.29 (0.09)	0.58 (0.08)	0.90 (0.07)	**-0.16** (0.08)	**0.06** (0.10)	0.26 (0.09)	0.65 (0.08)
Other	-0.37 (0.05)	-0.16 (0.04)	0.28 (0.05)	0.59 (0.05)	**-0.11** (0.06)	**0.01** (0.05)	0.24 (0.05)	0.60 (0.06)

Group	Mathematics				Science			
All Students	-0.24 (0.01)	-0.17 (0.01)	0.16 (0.01)	0.44 (0.01)	-0.26 (0.01)	-0.04 (0.01)	0.17 (0.01)	0.30 (0.01)
Gender								
Female	-0.41 (0.01)	-0.33 (0.01)	**-0.04** (0.01)	0.25 (0.02)	-0.46 (0.02)	-0.29 (0.01)	-0.16 (0.02)	**0.00** (0.02)
Male	**-0.02** (0.02)	0.04 (0.01)	0.38 (0.02)	0.64 (0.02)	**0.00** (0.02)	0.27 (0.02)	0.52 (0.02)	0.62 (0.02)
Race/Ethnicity								
African American	-0.25 (0.02)	-0.27 (0.02)	-0.22 (0.03)	**-0.11** (0.04)	-0.41 (0.03)	-0.29 (0.03)	-0.17 (0.04)	**-0.12** (0.05)
Hispanic	-0.10 (0.03)	-0.22 (0.02)	**0.01** (0.03)	0.22 (0.04)	-0.23 (0.03)	-0.10 (0.04)	**-0.01** (0.05)	**0.11** (0.06)
White	-0.34 (0.01)	-0.14 (0.01)	0.21 (0.01)	0.45 (0.02)	-0.26 (0.02)	**0.03** (0.01)	0.23 (0.01)	0.34 (0.02)
Asian	0.65 (0.07)	0.76 (0.09)	0.98 (0.07)	1.53 (0.06)	0.31 (0.07)	0.26 (0.09)	0.31 (0.08)	0.58 (0.07)
Other	-0.32 (0.04)	-0.29 (0.03)	**0.05** (0.04)	0.43 (0.04)	-0.24 (0.05)	**-0.07** (0.04)	**0.09** (0.04)	0.29 (0.05)

Note: Means in **bold** are not statistically significant. All others are statistically significant at $p < .01$.

Figure 1 presents the mean residual scores from ACT Explore to the ACT by subgroup. Figure 1 displays 99% confidence intervals (error bands) around each mean residual score. Similar trends were observed for the other two growth periods (see Figures B1 and B2 in Appendix B).

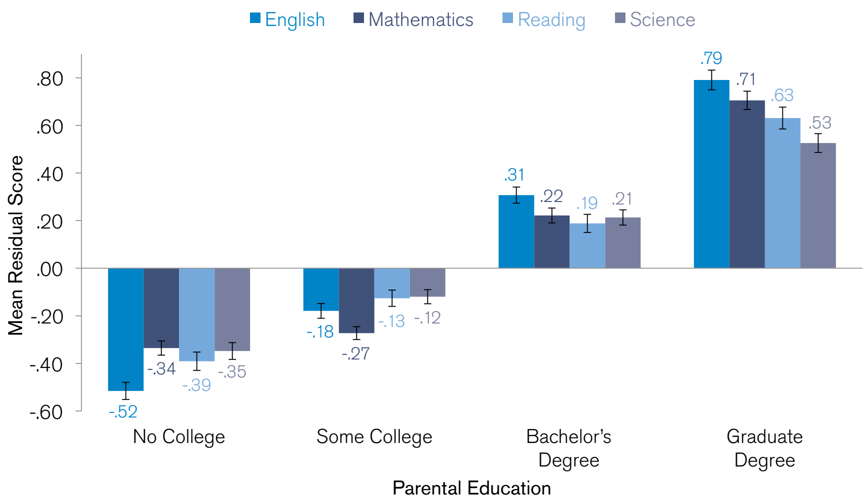

Figure 1. Mean residual scores[6] for grade 8 to 11/12 growth period by parental education

While many of the growth differences were not statistically significant, or were statistically significant but small in magnitude, some general trends are apparent. In general, male students consistently experienced at or above-average expected growth in mathematics and science, while female students typically experienced less-than-expected growth in both subject areas. The only exception was in mathematics from grade 10 to 11/12 and 8 to 11/12 where female students whose parent had a graduate degree had above-average expected growth. Among students whose parent had at least a bachelor's degree, both males and females experienced above-average expected growth in English and reading. The only exception was from grade 8 to 10 where only male students whose parents had a graduate degree had above-average expected growth. However, the growth in English and reading tended to be higher for females as compared to males (with the exception of 8 to 11/12 growth in reading for males) (Tables 3–5). Mean residuals by parent education level and gender are presented in Figures B3–B5 in Appendix B.

African American students consistently had less-than-expected growth and showed the least growth among the racial/ethnic subgroups. The only exception was in English from grade 10 to 11/12: African American students whose parent had a graduate degree had greater-than-expected growth. In general, Hispanic students whose parent had a graduate degree experienced above-average expected growth in all subject areas from grade 10 to 11/12 and 8 to 11/12, except in science. White students whose parents had at least a bachelor's degree experienced above-average expected growth in all subject areas. Other students whose parent had at least a bachelor's degree experienced above-average expected growth in English and reading; in mathematics and science, however, only those whose parent had a graduate degree experienced above-average expected growth. Notably, in mathematics and to a lesser degree in science, Asian students demonstrated significantly higher growth than other subgroups; in English and reading, those whose parent had at

[6] The mean residual scores represent deviations in average actual and predicted ACT scores for the total group.

least a bachelor's degree experienced higher growth than other subgroups. The only exception was in reading from grade 8 to 10 among Asian students whose parent had a bachelor's degree (see Tables 3–5).

Discussion

As the results of the current study and others suggest (Choy, 2002; Terenzini et al., 1996), the unadjusted differences in average achievement across parent education levels are striking. As shown in Table 2, first-generation students had lower ACT Explore, ACT Plan, and ACT scores in all subject areas.

Moreover, first-generation students grow less academically from late middle school to late high school than non-first-generation students do. The statistically adjusted growth measures presented in Tables 3–5 reveal that first-generation students across all grade spans consistently experienced below-average expected growth in all subject areas than students whose parent had only some college experience. The growth measures for students whose parents had at least a bachelor's degree were positive and above average in all subject areas. In Tables 3–5, we see that across all grade spans, the difference between first-generation students and students whose parent had some college experience was smallest in mathematics. Terenzini et al. (1996) reported that there were no differences between first-generation and non-first-generation gains in mathematics and critical thinking abilities. However, first-generation students made fewer gains in reading comprehension than their non-first-generation peers.

In cases where a subgroup's mean growth was significantly above or below average, it is important to understand the practical magnitude of the difference. For example, differences in group residual scores (between students whose parent had a bachelor's degree and first-generation students) shown in Table 3 may be compared to average annual growth between the ACT Explore and ACT tests in standard deviation units (ACT, 2012)[7] using the average of the ACT Explore and ACT standard deviations.[8] For the grade 8 to grade 11/12 growth period, the mean English residual for students whose parent had a bachelor's degree was 0.83 (0.31+0.52) ACT score points higher than the mean English residual for first-generation students (Table 3). This is a difference of 0.13 (0.83/6.5) standard deviation units on the ACT English scale. To put this difference into context, the average annual growth from ACT Explore to the ACT is approximately 0.26 standard deviation units; therefore, the difference between students whose parent had a bachelor's degree and first-generation students is comparable to a half-year of average growth. Comparing the mean growth of these two subgroups helps place the 0.83 score point growth difference in context, letting us see that a half-year of average growth difference arguably is large enough in magnitude to be of practical significance. Similarly, the mean mathematics, reading, and science residuals for students whose parent had a bachelor's degree was 0.56, 0.58, and 0.56 ACT score points higher than those for first-generation students (Table 3). These are differences of 0.11 (0.56/5.3), 0.09 (0.58/6.3), and 0.11 (0.56/5.3) standard deviation units on the corresponding ACT scales. Alternatively, differences between the mean residual scores for female and male students whose parent had a

[7] The annual growth from ACT Explore to the ACT is approximately 0.26 (1.4/ ((4.2+6.5)/2)) standard deviation units in English, .27 (1.2/ ((3.5+5.3)/2)) in mathematics, .31 (1.6/ ((3.9+6.3)/2)) in reading, and .23 (1.0/ ((3.3+5.3)/2)) in science. (ACT 2012, Table 2).

[8] Standard deviations on the ACT Explore tests were 4.2 points in English, 3.5 in mathematics, 3.9 in reading, and 3.3 in science (ACT 2013c, Table 4.11). Standard deviations on the ACT were 6.5 in English, 5.3 in mathematics, 6.3 in reading, and 5.3 in science (ACT 2014b, Table 5.4).

bachelor's degree may be compared with average annual growth from ACT Explore to the ACT of 0.26 standard deviations in English, 0.27 in mathematics, 0.31 in reading, and 0.23 in science. For the grade 8 to grade 11/12 growth period, the mean mathematics and science residuals for male students whose parent had a bachelor's degree were, respectively, 0.88 and 1.03 ACT score points higher than the mean mathematics and science residuals for female students whose parent had a bachelor's degree. These are differences of 0.17 (0.88/5.3) and 0.19 (1.03/5.3) standard deviation units on the ACT mathematics and science scales, indicating that the differences between male and female students whose parent had a bachelor's degree exceed a half-year of average growth in mathematics and science.

Although many of the growth differences were small in magnitude, some differences were more striking. In all subject areas, students whose parent had at least a bachelor's degree grew 0.56 to 1.31 points more between grade 8 and grade 11/12, on average, than first-generation students. More growth is expected as more time passes, and subgroup differences tend to become larger over more time. Prior studies have suggested that raising the achievement level of students before they enter high school is likely to be more effective in improving college readiness than other interventions and that lower-achieving 8th graders tend to grow less during high school (Sawyer, 2008; Bassiri, 2014). Thus, it is important to understand why pre-high school achievement gaps exist between first- and non-first-generation students and to adopt policies that close those gaps.

This study contributes to the existing literature on first-generation students by evaluating their growth in achievement from grade 8 to grade 11/12. Policymakers, researchers, educators, and parents alike want to know how to best assess the academic progress of all students, including first-generation students. The results of the current study demonstrate the potential of assessing the achievement growth of first-generation students relative to their peers using the residual gain model.

Study Limitations and Future Research

One limitation of the study is that in examining growth differences between grades 8 and 12 (ACT Explore to ACT Plan, ACT Plan to the ACT, or ACT Explore to the ACT), the analysis did not take into account (or control for) potential interactions between subgroup membership and prior test scores when predicting later test scores. In the ACT Explore-to-ACT Plan models, for example, the coefficients for ACT Explore tests might be different for the first- and non-first-generation students. Such differences could affect the resulting mean residual scores and assessment of relative growth differences.

Future studies in reporting on grade 8 to 12 growth patterns by parent education levels, should examine potential causes of the growth differences, such as low-income status and type of high school coursework. Past research has shown that high school grades and specific high school coursework are related to standardized achievement scores and together account for nearly half of the variability in ACT Composite scores (Noble, Davenport, Schiel, & Pommerich, 1999a, 1999b). Noble et al. (1999a, 1999b) also found that noncognitive characteristics affect ACT scores directly as well as through their impact on high school grade point average (HSGPA). Prior studies also have found substantial variability among schools in the academic achievement levels (as measured by ACT scores) of their students, even after accounting for differences in their students' characteristics (Sawyer, 2008). Building upon the work of Noble et al. (1999a, 1999b), a recent study by McNeish, Radunzel, and Sanchez (2015) examined the contributions of students' noncognitive characteristics toward explaining performance on the ACT over and above traditional predictors such as HSGPA, coursework taken, and school characteristics. Results from this study suggest that differential performance on the ACT among student demographic groups is largely attributable to differential academic preparation. Additionally, differences in ACT scores among racial/ethnic, family income, and parental education level groups were substantially reduced when students' academic preparation and achievement levels were taken into account (McNeish et al., 2015). Moreover, the smaller growth might be due to first-generation students being less likely to take college-preparatory or core curriculum in high school (Radunzel, 2015). Thus, the observed growth differences between first- and non-first-generation students might have been partially or fully explained by these other cognitive factors.

Policy Implications

Academic preparation gaps between first- and non-first-generation students appear long before high school. These gaps are likely to widen over time because of "Matthew effects"—those who start out ahead are at a relative advantage in acquiring new knowledge. Therefore, it is critically important to identify any learning deficiencies as early as possible. The implications of this study are similar to those outlined by Sawyer (2008) and Bassiri (2014). First, student progress must be monitored, and interventions should start before kindergarten and continue through the primary grades. Second, lead educators and policymakers should focus on the importance of an early start and an emphasis on prevention over remediation. Third, high school counselors and teachers can provide first-generation students with the support and resources they need to improve their academic skills, offer them academic and social support by engaging faculty and peers for mentoring, aid them with beginning the college planning process earlier, and help them cope with the transition to college.[9] College administrators should also develop additional programs to better facilitate retention and, ultimately, degree attainment for first-generation students as well as non-first-generation students. Successful retention programs need to involve coordinated efforts of student affairs and counseling professionals as well as admissions officers. Different interventions may be needed to retain first-generation students and non-first-generation students. Early identification of first-generation students should assist student affairs professionals with understanding the needs of these students and provide them with special attention during the first year of college. ■

[9] There are a growing number of college access and success programs across the country that target low-income, minority, and first-generation test-takers. The most well known and longstanding are the federally funded TRIO and GEAR UP programs. Other programs include the Talent Search, Upward Bound, Student Support Services, and McNair Scholars programs. These programs provide services that aim to increase college awareness and preparation, counseling, tutoring, mentoring, and information regarding the college admissions process. Evaluation data of these programs have generally demonstrated a positive impact on the educational outcomes of low-income and first-generation test takers (Engle, 2007).

References

ACT. (2008). *The forgotten middle: Ensuring that all students are on target for college and career readiness before high school.* Iowa City, IA: ACT.

ACT. (2012). *Principles for measuring growth towards college and career readiness.* Iowa City, IA: ACT. Retrieved from www.act.org/content/dam/act/unsecured/documents/GrowthModelingReport.pdf.

ACT. (2013a). *The Condition of College & Career Readiness 2013: First-Generation Students.* Iowa City, IA: ACT. Retrieved from www.act.org/newsroom/data/2013/states/pdf/FirstGeneration.pdf.

ACT. (2013b). *ACT profile report—national: Graduating class 2013—national*. Iowa City, IA: ACT. Retrieved from www.act.org/content/dam/act/unsecured/documents/Natl-Scores-2013-National2013.pdf.

ACT. (2013c). *ACT Explore Technical Manual*. Iowa City, IA: ACT. Retrieved from www.act.org/content/dam/act/unsecured/documents/Explore-TechManual.pdf.

ACT. (2014a). *The Condition of College & Career Readiness 2014: First-Generation Students.* Iowa City, IA: Author. Retrieved from www.act.org/newsroom/data/2014/states/firstgeneration.html.

ACT. (2014b). *The ACT Technical Manual*. Iowa City, IA: Author. www.act.org/aap/pdf/ACT_Technical_Manual.pdf.

Allen, J., Bassiri, D., & Noble, J. (2009). *Statistical properties of accountability measures based on ACT's educational planning and assessment system* (ACT Research Report 2009-1). Iowa City, IA: ACT.

Angrist, J., & Lang, K. (2002). "How Important Are Classroom Peer Effects? Evidence from Boston's Metco Program." NBER Working Paper 9263, National Bureau of Economic Research, Cambridge, MA. Retrieved from www.nber.org/papers/w9263.

Attinasi, L. (1989). Getting in: Mexican Americans' perceptions of university attendance and the implications for freshman-year persistence. *Journal of Higher Education*, *60*(3), 247–277.

Bassiri, D. (2014). *Research study: The forgotten middle*. (ACT Policy Brief, September 2014). Iowa City, IA: ACT.

Bassiri, D. (2015). *Statistical properties of school value-added scores based on assessments of college readiness* (ACT Research Report 2015-5). Iowa City, IA: ACT.

Berkner, L., & Chavez, L. (1997). *Access to postsecondary education for the 1992 high school graduates* (NCES 98-105). National Center for Education Statistics. Washington, DC: US Department of Education.

Berkner, L., Horn, L., & Clune, M. (2000). *Descriptive summary of 1995–96 beginning postsecondary students: Three years later, with an essay on students who start at less-than-4-year institutions* (NCES 2000-188). National Center for Education Statistics. Washington, DC: US Department of Education.

Billson, J., & Terry, B. (1982). In search of the silken purse: Factors in attrition among first-generation students. *College and University*, *58*, 57–75.

Castellano, K. E., & Ho, A. D. (2013). *A practitioner's guide to growth models*. Washington, DC: Council of Chief State School Officers.

Castellano, K. E., & Ho, A. D. (2015). Practical differences among aggregate-level conditional status metrics: From median student growth percentiles to value-added models. *Journal of Educational and Behavioral Statistics*, *40*(1), 35–68.

Choy, S. (2000). *Debt burden four years after college* (NCES 2000-188). National Center for Education Statistics. Washington, DC: US Department of Education.

Choy, S. (2001). Students whose parents did not go to college: Postsecondary access, persistence, and attainment. Essay in J. Wirt et al. (Eds.), *The condition of education 2001* (pp. XVIII–XLIII). National Center for Education Statistics. Washington, DC: US Department of Education.

Choy, S. P. (2002). *Access and persistence: Findings from 10 years of longitudinal research on students.* American Council on Education, Center for Policy Analysis. Washington, DC: American Council on Education.

Engle, J. (2007). Postsecondary access and success for first-generation college students. *American Academic, 3,* 25–48.

Engle, J., & Tinto, V. (2008). *Moving beyond access: College success for low-income, first-generation students*. Washington, DC: The Pell Institute for the Study of Opportunity in Higher Education. Retrieved from files.eric.ed.gov/fulltext/ED504448.pdf.

Horn, L. (1998). *Stopouts or stayouts? Undergraduates who leave college in their first year* (NCES 1999–087). National Center for Education Statistics. Washington, DC: US Department of Education.

Horn, L., & Nunez, A. (2000). *Mapping the road to college: First-generation students' math track, planning strategies, and context of support* (NCES 2000-153). National Center for Education Statistics. Washington, DC: US Department of Education.

Hossler, D., Schmit, J., & Vesper, N. (1999). *Going to college: How social, economic, and educational factors influence the decisions students make*. Baltimore, MD: Johns Hopkins University Press.

Kojaku, L., & Nunez, A. (1998). *Descriptive summary of 1995–96 beginning postsecondary students, with profiles of students entering 2- and 4-year institutions* (NCES 1999–030). National Center for Education Statistics. Washington, DC: US Department of Education.

Lam, C. T. (n.d.). *Estimating Various Kinds of Peer Effects on Academic Performance*. Department of Economics, University of Chicago. Retrieved from www.albany.edu/economics/research/seminar/files/chungsang.pdf.

Lara, J. (1992). Reflections: Bridging cultures. In L. Zwerling & H. London (Eds.), *First-generation students: Confronting the cultural issues* (pp. 65–70). New Directions for Community Colleges, No. 80. San Francisco, CA: Jossey-Bass.

Manski, C. F. (1993). Identification of endogenous social effects: The reflection problem. *The Review of Economic Studies, 60*(3), 531–542.

McNeish, D. M., Radunzel, J., & Sanchez, E. (2015). *A multidimensional perspective of college readiness: Relating student and school characteristics to performance on the ACT.* (ACT Research Report 2015-6). Iowa City, IA: ACT.

Mortenson, T. (2007). *Bachelor's Degree Attainment by Age 24 by Family Income Quartiles, 1970 to 2005.* Oskaloosa, IA: Postsecondary Education Opportunity. Pell Institute for the Study of Opportunity in Higher Education, Washington, DC. Retrieved from www.postsecondary.org/default.asp.

Noble, J., Davenport, M., Schiel, J., & Pommerich, M. (1999a). *Relationships between the noncognitive characteristics, high school course work and grades, and test scores of ACT-tested students* (ACT Research Report 99-4). Iowa City, IA: ACT.

Noble, J., Davenport, M., Schiel, J., & Pommerich, M. (1999b). *High school academic and noncognitive variables related to the ACT scores of racial/ethnic and gender groups.* (ACT Research Report 99-6). Iowa City, IA: ACT.

Noble, J., & Schnelker, D. (2007). *Using hierarchical modeling to examine course work and ACT score relationships across high schools* (ACT Research Report 2007-2). Iowa City, IA: ACT.

Nunez, A., & Cuccaro-Alamin, S. (1998). *First-generation students: Undergraduates whose parents never enrolled in postsecondary education* (NCES 98-082). National Center for Education Statistics. Washington, DC: US Department of Education.

Pratt, P., & Skaggs, C. (1989). First-generation college students: Are they at greater risk for attrition than their peers? *Research in Rural Education*, *6*(2), 31–34.

Radunzel, J. (2015). *Informing Educational Planning and Advising for Students from At-Risk Demographic Groups.* Iowa City, IA: ACT. Retrieved from www.act.org/research/policymakers/pdf/Informing-Ed-Planning-Report.pdf.

Raudenbush, S. W. & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods.* Thousand Oaks, CA: Sage Publications.

Rendon, L. (1992). From the barrio to the academy: Revelations of a Mexican American "scholarship girl." In L. Zwerling & H. London (Eds.), *First-generation students: Confronting the cultural issues* (pp. 55–64). New Directions for Community Colleges, No. 80. San Francisco, CA: Jossey-Bass.

Rendon, L., Hope, R., & Associates. (1996). *Educating a new majority: Transforming America's educational system for diversity.* San Francisco, CA: Jossey-Bass.

Richardson, R., & Skinner, E. (1992). Helping first-generation minority students achieve degrees. In L. Zwerling & H. London (Eds.), *First-generation students: Confronting the cultural issues* (pp. 29–43). New Directions for Community Colleges, No. 80. San Francisco, CA: Jossey-Bass.

Saenz, V. B., Hurtado, S., Barrera, D., Wolf, D., & Yeung, F. (2007). *First in my family: A profile of first-generation college students at four-year institutions since 1971.* Los Angeles, CA: Higher Education Research Institute.

Sawyer, R. (2008). *Benefits of additional high school course work and improved course performance in preparing students for college* (ACT Research Report 2008-1) Iowa City, IA: ACT.

Stage, F., & Hossler, D. (1989). Differences in family influences on college attendance plans for male and female ninth graders. *Research in Higher Education*, *30*, 301–315.

Terenzini, P., Rendon, L., Upcraft, M., Millar, S., Allison, K., Gregg, P., & Jalomo, R. (1994). The transition to college: Diverse students, diverse stories. *Research in Higher Education*, *35*, 57–73.

Terenzini, P., Springer, L., Yaeger, P., Pascarella, E., & Nora, A. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education*, *37*, 1–22.

Turner, S. (2004). Going to college and finishing college: Explaining different educational outcomes. In C. Hoxby (Ed.), *College Choices: The Economics of Where to Go, When to Go, and How to Pay for It.* Chicago, IL: University of Chicago Press.

Tym, C., McMillion, R., Barone, S., & Webster, J. (2004). *First-generation college students: A literature review.* Austin, TX: TG Research and Analytical Services. Retrieved from www.tgslc.org/pdf/first_generation.pdf.

US Department of Education (2009). Projections of education statistics to 2018. (NCES 2009-062). Washington DC: Institute of Education Studies, National Center for Education Statistics.

Warburton, E., Bugarin, R., & Nunez, A. (2001). *Bridging the gap: Academic preparation and postsecondary success of first-generation students* (NCES 2001-153). National Center for Education Statistics. Washington, DC: US Department of Education.

Weis, L. (1992). Discordant voices in the urban community college. In L. Zwerling & H. London (Eds.), *First-generation students: Confronting the cultural issues* (pp. 13–27). New Directions for Community Colleges, No. 80. San Francisco, CA: Jossey-Bass.

Western Interstate Commission for Higher Education (WICHE). (2012). *Knocking at the college door: Projection of high school graduates.* Boulder, CO: WICHE.

Wright, D. J. (1987). Minority students: Developmental beginnings. In D. J. Wright (Ed.), *Responding to the needs of today's minority students* (pp. 5–22). New Directions for Student Services, No. 38. San Francisco, CA: Jossey-Bass.

York-Anderson, D., & Bowman, S. (1991). Assessing the college knowledge of first-generation and second-generation students. *Journal of College Student Development*, *32*, 116–122.

Appendix A

Table A1. Parameter Estimates for Predicting ACT Scores from ACT Explore

	Subject Area			
	English	Math	Reading	Science
Effect	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept $(\hat{\beta}_0)$	-10.26 (0.17)	-3.71 (0.19)	-6.74 (0.18)	-4.64 (0.22)
ACT Explore Test				
English	0.67 (< 0.01)	0.21 (< 0.01)	0.41 (< 0.01)	0.22 (< 0.01)
Mathematics	0.30 (< 0.01)	0.60 (< 0.01)	0.19 (< 0.01)	0.41 (< 0.01)
Reading	0.31 (< 0.01)	0.08 (< 0.01)	0.55 (< 0.01)	0.21 (< 0.01)
Science	0.21 (< 0.01)	0.31 (< 0.01)	0.25 (< 0.01)	0.34 (< 0.01)
Subject-Specific Mean ACT Explore	0.23 (<0.01)	0.25 (0.01)	0.24 (0.01)	0.30 (0.01)
Time Span	0.08 (< 0.01)	0.02 (< 0.01)	0.05 (< 0.01)	0.03 (< 0.01)
Variance of Intercept, $(\hat{\tau}_{00})$	1.20	1.17	0.72	0.74
Intra-class Correlation Coefficient (ICC)	0.09	0.11	0.05	0.06
Multiple R	0.84	0.81	0.79	0.77

Note. All regression coefficients are statistically significant at $p < 0.01$.

Table A2. Parameter Estimates for Predicting ACT Plan Scores from ACT Explore

	Subject Area			
	English	Math	Reading	Science
Effect	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept $(\hat{\beta}_0)$	-2.81 (0.14)	-5.16 (0.20)	-3.11 (0.18)	-1.44 (0.18)
ACT Explore Test				
English	0.46 (< 0.01)	0.18 (< 0.01)	0.29 (< 0.01)	0.16 (< 0.01)
Mathematics	0.19 (< 0.01)	0.56 (< 0.01)	0.11 (< 0.01)	0.27 (< 0.01)
Reading	0.20 (< 0.01)	0.08 (< 0.01)	0.44 (< 0.01)	0.22 (< 0.01)
Science	0.14 (< 0.01)	0.29 (< 0.01)	0.19 (< 0.01)	0.29 (< 0.01)
Subject-Specific Mean ACT Explore	0.14 (< 0.01)	0.21 (< 0.01)	0.17 (< 0.01)	0.19 (< 0.01)
Time Span	0.10 (< 0.01)	0.11 (< 0.01)	0.10 (< 0.01)	0.08 (< 0.01)
Variance of Intercept, $(\hat{\tau}_{00})$	0.32	0.56	0.34	0.29
Intra-class Correlation Coefficient (ICC)	0.05	0.06	0.03	0.04
Multiple R	0.82	0.79	0.76	0.77

Note. All regression coefficients are statistically significant at $p < 0.01$.

Table A3. Parameter Estimates for Predicting ACT Scores from ACT Plan

	Subject Area			
	English	Math	Reading	Science
Effect	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept $(\hat{\beta}_0)$	-8.40 (0.13)	-1.88 (0.12)	-4.95 (0.12)	-2.18 (0.14)
ACT Plan Test				
English	0.75 (< 0.01)	0.19 (< 0.01)	0.42 (< 0.01)	0.21 (< 0.01)
Mathematics	0.20 (< 0.01)	0.56 (< 0.01)	0.10 (< 0.01)	0.32 (< 0.01)
Reading	0.22 (< 0.01)	0.00 (< 0.01) ^{ns}	0.44 (< 0.01)	0.12 (< 0.01)
Science	0.16 (< 0.01)	0.25 (< 0.01)	0.27 (< 0.01)	0.36 (< 0.01)
Subject-Specific Mean ACT Plan	0.19 (< 0.01)	0.18 (< 0.01)	0.14 (< 0.01)	0.19 (< 0.01)
Time Span	0.09 (< 0.01)	0.03 (< 0.01)	0.06 (< 0.01)	0.04 (< 0.01)
Variance of Intercept, $(\hat{\tau}_{00})$	0.65	0.57	0.41	0.42
Intra-class Correlation Coefficient (ICC)	0.06	0.08	0.03	0.04
Multiple R	0.87	0.86	0.82	0.81

Note: Statistically nonsignificant coefficients ($p > 0.05$) are marked as 'ns.' All other coefficients are statistically significant at $p < 0.01$.

Appendix B

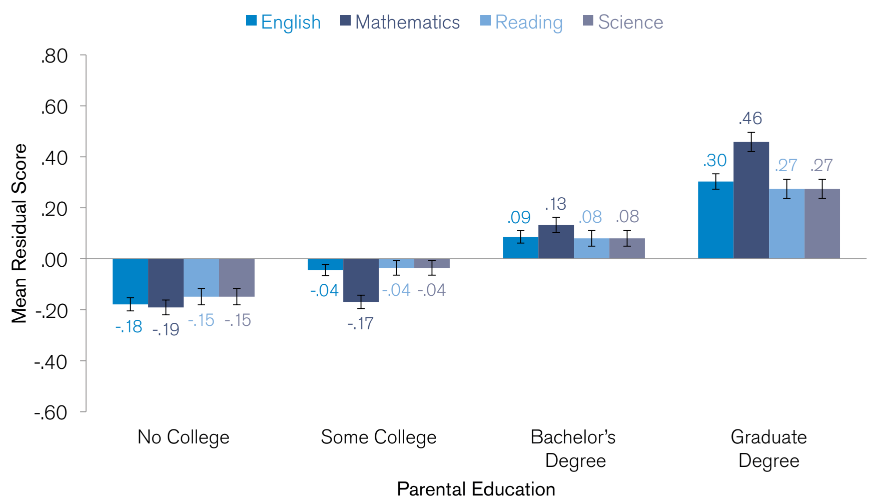

Figure B1. Mean residual scores for grades 8 to 10 growth period by parental education

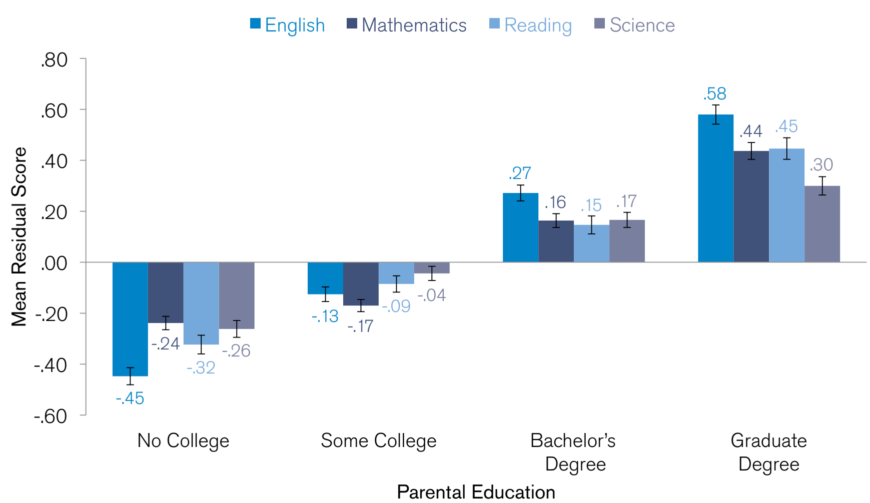

Figure B2. Mean residual scores for grades 10 to 11/12 growth period by parental education

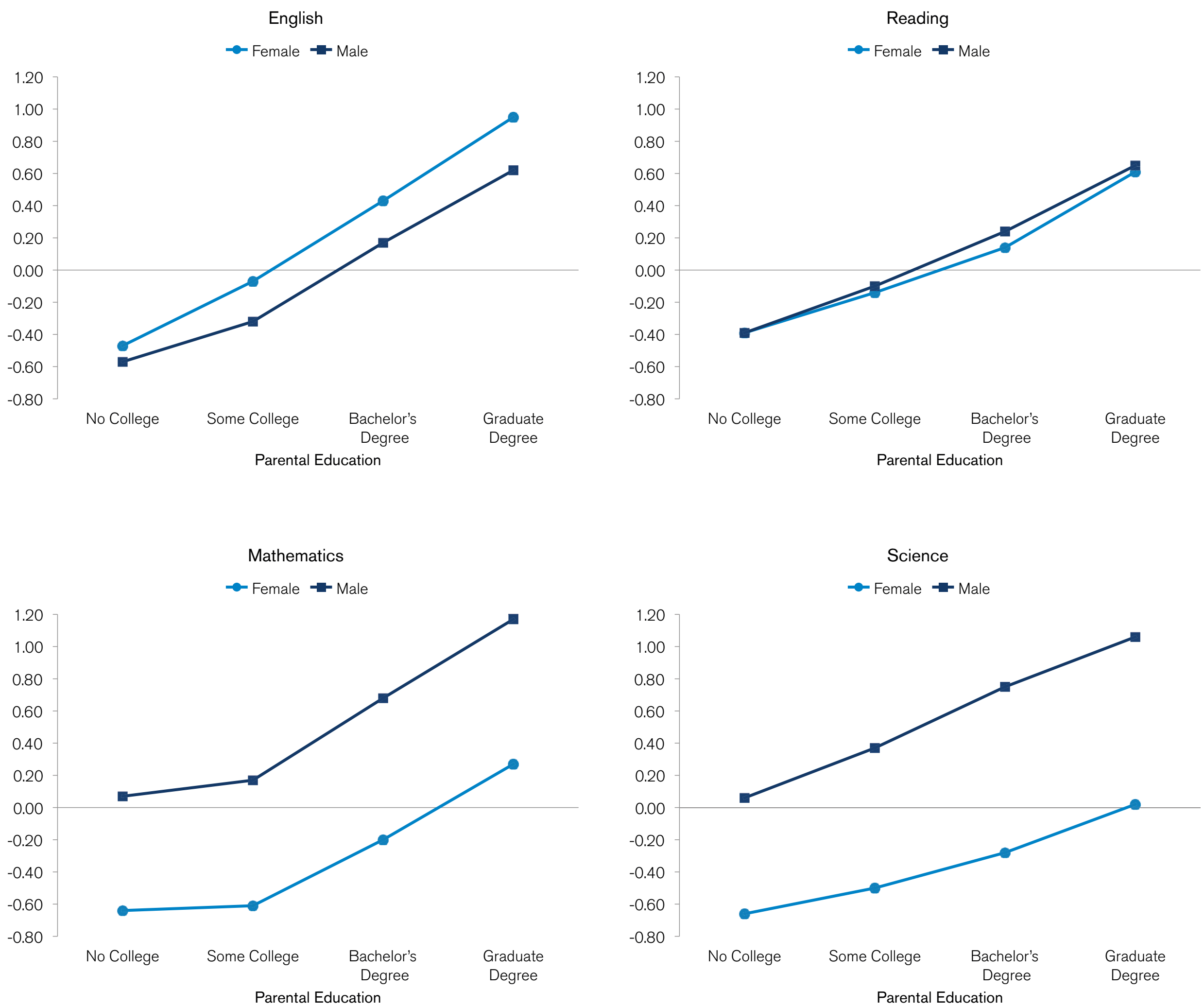

Figure B3. Mean residual scores from ACT Explore to the ACT

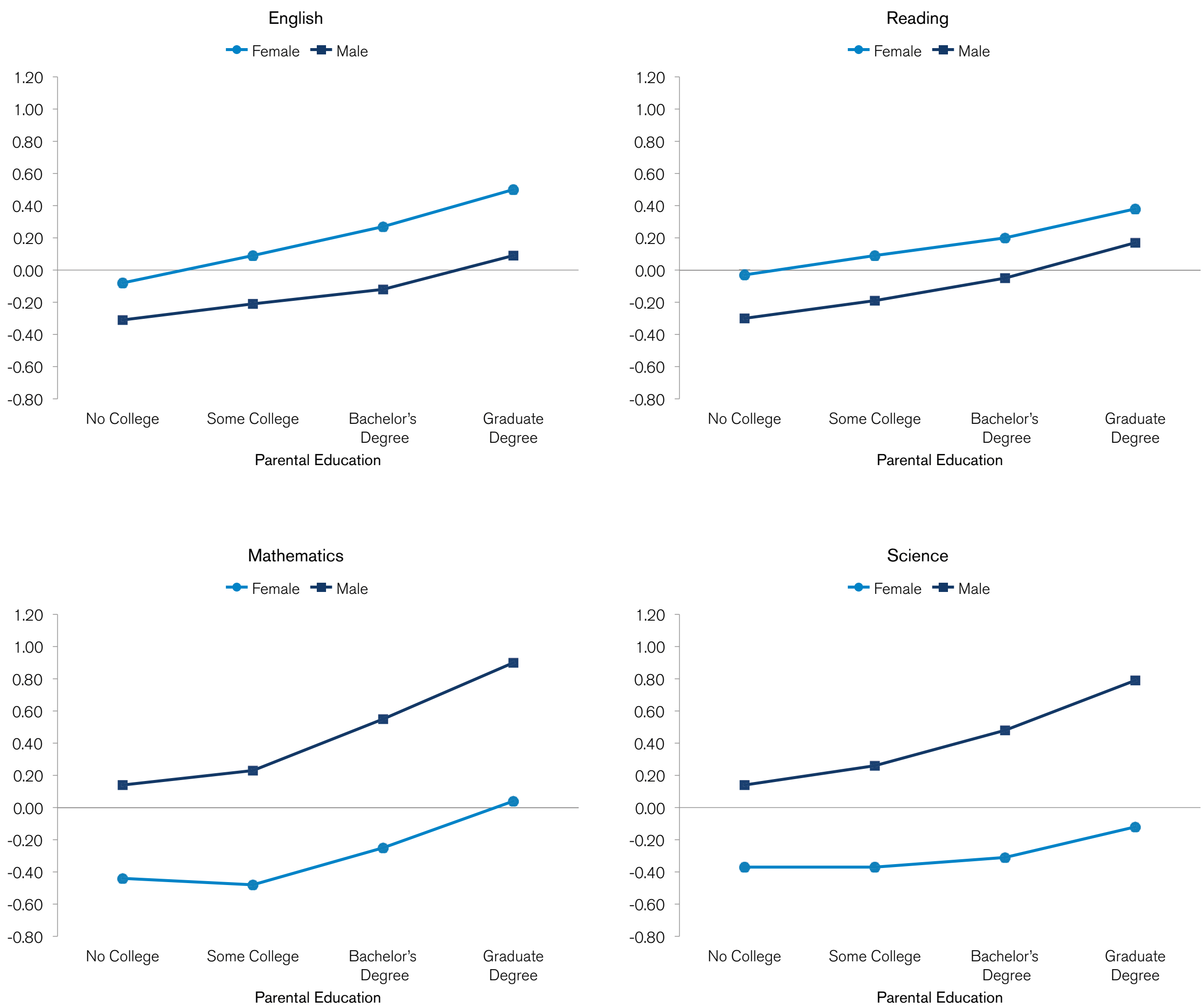

Figure B4. Mean residual scores from ACT Explore to ACT Plan

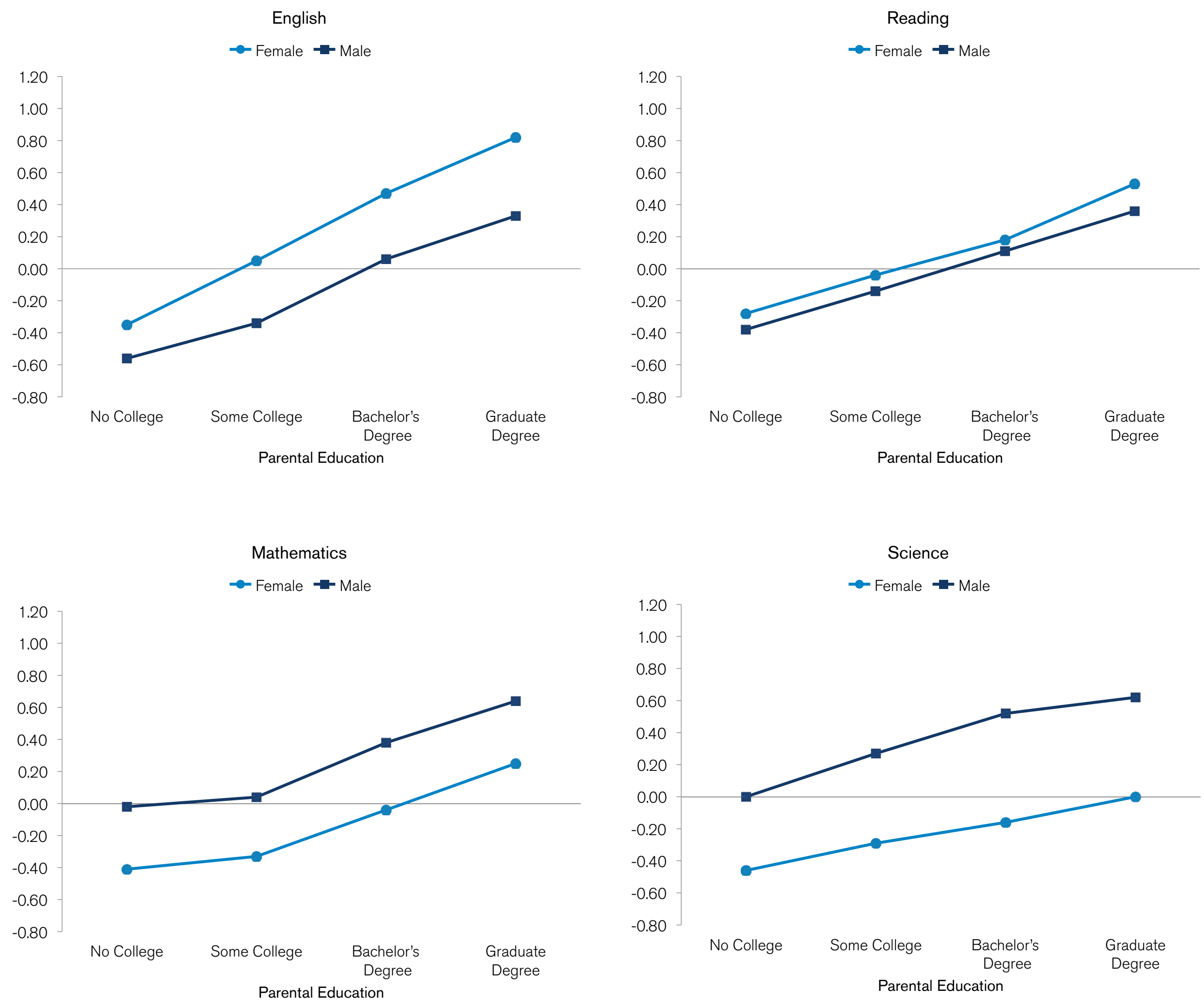

Figure B5. Mean residual scores from ACT Plan to the ACT

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