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Profiles of Persisting Fourth-Year STEM Majors

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Abstract

Using data from 120,612 students at 26 four-year institutions, this report provides a description of STEM majors entering four-year postsecondary institutions and those who persist through four years of study. The results indicate that persisting STEM majors enter college with very high levels of pre-college academic achievement as measured by the ACT® test, and they have distinct interests as measured by the ACT Interest Inventory. Meta-analyses of 26 institutional studies indicate that these patterns are rather consistent across colleges.

Within institutions, STEM majors enter college with higher levels of pre-college academic achievement than non-STEM majors; the largest differences are seen on ACT mathematics and ACT science scores. Furthermore, the gaps between the STEM majors and non-STEM majors generally become larger over four years of study. STEM majors also differ from non-STEM majors in regard to their measured interests. The creation of two STEM categories, STEM-Biological and STEM-Quantitative, was supported by the differences seen in their ACT mathematics and science scores and their measured interests.

More young students are being encouraged to enter STEM fields. Although this trend is commendable, it is important for students to understand the high levels of academic achievement that persisting STEM majors achieve before entering college and the alignment of their interests with their choice of major.

Introduction

Interest in science, technology, engineering, and mathematics (STEM) education has grown in recent years, with leaders in government, academics, and industry expressing concern that the United States is falling behind other countries in the STEM fields and, consequently, economic strength (Langdon, McKittrick, Beede, Khan, & Doms, 2011; National Academy of Science, 2007; National Governors Association, 2007; National Research Council, 2013; National Science Board [NSB], 2007). Following World War II, the United States held a sizable advantage over other countries in educational attainment, but this advantage in educational attainment has diminished in recent years (NSB, 2014). Countries such as China, Russia, Japan, India, and Ukraine produce more engineering graduates than does the United States, and the United States annually produces roughly one out of the eleven science engineering graduates produced in in the world (NSB, 2014). While some researchers question whether the United States faces a STEM shortage (Anft, 2013; Benderly, 2010; Salzman, 2013; Salzman, Kuehn, & Lowell, 2013; Teitelbaum, 2014), calls for stronger STEM education and more STEM majors continue in the face of rising global competition (Executive Office of the President, President's Council of Advisors on Science and Technology, 2012; Langdon et al., 2011; US Department of Labor, 2007).

These calls to increase the size of the STEM pipeline, however, must also be considered in conjunction with research on the "leaks" along the pipeline. ACT recently reported that 49% of ACT-tested high school graduates (class of 2014) had an expressed or a measured interest in STEM programs of study or occupations (ACT, 2014a). However, fewer than 25% of college students start as STEM majors or later become STEM majors (Chen, 2009), and only 37% of the students who start college as STEM majors earn a degree or certificate within six years (Chen, 2013).

Given the interest in STEM, information on the pre-college achievement levels of persisting STEM majors and their measured interests—a STEM profile—may be useful for identifying future STEM majors and identifying current STEM majors who may be at risk of leaving the STEM pipeline. This study aims to provide descriptive profiles of persisting STEM majors based on their ACT scores, high school grade point average (HSGPA), and their measured career-related interests.

Previous STEM Research

Researchers have conducted numerous studies on college students' enrollment patterns, persistence within a major, and differential grading across fields of study. Some of these studies have focused on STEM majors and how they compare with non-STEM majors. One of the common themes in this research is that STEM majors enter college with higher mean ACT/SAT scores and HSGPAs than their non-STEM peers (Astin & Astin, 1992; Bridgeman, Pollack, & Burton, 2008; Burnham & Hewitt, 1972; Chen, 2009; Goldman & Hewitt, 1975; Goldman & Widawski, 1976; Green, 1989; Kokkelenberg & Sinha, 2010; Mendez, Buskirk, Lohr, & Haag, 2008; Strenta & Elliot, 1987; Westrick, 2012; Whalen & Shelley, 2010). Some of these researchers drew attention to differences in mathematics scores for STEM and non-STEM majors (Elliott & Strenta, 1988; Goldman & Hewitt, 1975; Goldman & Widawski, 1976; Strenta & Elliot, 1987; Strenta, Elliott, Adair, Matier, & Scott, 1994), and some argued that students with insufficient mathematics ability have no choice but to go into non-STEM programs of study (Burnham & Hewitt, 1972).

Researchers have also tried to predict STEM enrollment and persistence using not only cognitive measures such as admission test scores and HSGPA, but also using students' expressed and measured interests. Leuwerke, Robbins, Sawyer, and Hovland (2004) found that mathematics ability predicted engineering students' retention on campus and in engineering, and they found that the congruence between engineering students' interests and engineering tasks predicted retention at the institution to the second year in any academic major. More recently, Shaw and Barbuti (2010) found that students with higher levels of pre-college academic achievement and who had an interest in engineering and technology were more likely to persist in engineering. Le, Robbins, and Westrick (2014) found that academic-ability fit and interest fit were both related to choosing a STEM major and persisting in it.

Most of the previous STEM research has disaggregated students by major (e.g., Goldman & Widawski, 1976). However, Pennock-Román's (1994) research on differential grading suggested that collapsing academic majors into larger groups was more parsimonious and provided similar results to analyses conducted at the student major level. She concluded that simply dichotomizing academic majors as quantitative and non-quantitative was insufficient because the grading standards in the biological sciences did not fit neatly into either category. More recent studies (Westrick, 2012, 2015) have collapsed STEM students into two STEM groupings—STEM-Quantitative and STEM-Biological. In those studies, the mean test scores from the descriptive statistics indicated that the two STEM groups had different mean ACT scores and HSGPAs than a non-STEM group, but in neither study were direct comparisons made between the two STEM groups in regard to their ACT scores and HSGPAs.

Aside from differential grading, differences in gender representation in STEM-Quantitative and STEM-Biological fields provide another reason for dichotomizing STEM majors. The STEM-Biological fields tend to have a fairly equal balance of males and females, but males outnumber females in the STEM-Quantitative fields by a wide margin. For example, approximately 6.3% of female students versus 8.0% of male students enroll in biological science fields, whereas approximately 2.7% of female students versus 15.1% of male students enroll in engineering (Chen, 2009). Another important distinction is that although all STEM fields require mathematics/quantitative skills, the importance associated with these skills differ across fields (Kimura, 2007; Mattern, Radunzel, & Westrick, 2015). Furthermore, males and females differ in their measured interests in regard to "people" and "things," with females more on the "people" end of the scales and males more on the "things" end of the scale (Lippa, 1998; Su, Rounds, & Armstrong, 2009).

While differences in admission tests scores, high-school rank (HSR), and/or HSGPA have been emphasized in much of the STEM literature, differences in measured interests have also been studied (Le et al., 2014). To a large degree measured interest profiles already exist for a number of STEM fields. Research conducted by ACT has indicated that students in different academic majors differ in their measured interests (ACT, 1995, 2009), and ACT advocates using ACT Interest Inventory scores (2015a) to guide students' choices of academic majors and careers. The ACT World-of-Work Map (2015b) has been included on the ACT Student Report (2015c), the ACT High School Report (2015d), and the ACT College Report (2015e), and it provides a bridge between students' ACT Interest Inventory scores and a wide variety of academic majors and occupations. The map has 26 career areas, and what could be considered STEM fields are spread out over multiple areas. Placing all STEM majors into one category may mask important differences between different STEM fields.

While these interest profiles of various STEM majors are readily available, the pre-college academic achievement profiles of STEM majors are less clear.[1] All the studies noted above included some combination of ACT/SAT scores, high school grades (or HSR), and interests as predictor variables in their analyses. Using the descriptive statistics for these measures, one could construct a "pre-college profile" of STEM majors. Unfortunately, many of the previous studies included one or two types of measures, not all three. Furthermore, many used data from a single institution. While a profile of STEM majors at a single institution may be helpful for students enrolled at or considering enrolling at that institution, that profile may differ from the profile for STEM majors at other institutions.

Recent research efforts have increased our knowledge about enrollment, persistence, and performance in the STEM fields. However, profiles of persisting STEM majors with regard to their pre-college academic achievement levels and measured interests could inform decisions about entering a STEM major—clearly a value to both high school students and their counselors. Aggregating data from thousands of students across multiple institutions would provide a range of STEM profiles that could be quite informative; it would also provide support for past research findings that STEM majors have higher levels of pre-college academic achievement than non-STEM majors have.

Purpose/Research Questions

The primary purpose of this report is to provide, by institution, pre-college academic achievement and measured interest profiles of students who succeeded in STEM majors. Profiles are also provided for students who succeeded in non-STEM majors, for all entering first-year STEM majors, and for all entering first-year non-STEM majors. The profiles include means and interquartile ranges (IQRs) for HSGPA, ACT test scores, and ACT Interest Inventory scores. As each institution has its own profile, so this report also provides the medians and IQRs of the institutional means.

In addition to the profiles, meta-analytic techniques are used to examine the standardized mean differences between STEM majors and non-STEM majors, and between STEM-Quantitative and

[1] The Profiles for Success are very broad and cover occupations that do not require postsecondary education.

STEM-Biological majors, in regard to their ACT scores, HSGPAs, and measured interests. These meta-analyses aim to answer the following questions:

- In regard to students' ACT test scores, HSGPAs, and ACT Interest Inventory scores, are the standardized mean differences between STEM majors (STEM-Biological and STEM-Quantitative) and non-STEM majors of practical significance?
- In regard to students' ACT test scores, HSGPAs, and ACT Interest Inventory scores, are the standardized mean differences between the STEM-Quantitative majors and STEM-Biological majors of practical significance?

The results provide a rationale for further research on the student profiles of a multitude of academic majors (not just STEM majors), which will benefit high school students searching for college majors that match their interest and ability profiles.

Methods

Data

Data for this study came from 26 four-year institutions that participated in various ACT research services or partnerships. Up to six cohorts (years 2000–2005) at each institution were included. Institutions were required to have four years of follow-up data. Institutions self-reported their admission selectivity levels on the ACT Institutional Data Questionnaire (IDQ). There are five levels in the scale, summarized in Table 1. Of the 26 institutions, one institution self-identified as highly selective; nine self-identified as selective; 15 self-identified as traditional; none self-identified as liberal; and one self-identified as open. Of the 26 institutions, 23 were public and three were private.

Table 1. Typical Range of ACT Composite Scores and Class Ranks by Institution Admission Selectivity

Institution Selectivity Level	ACT Composite Scores Middle 50%	Definition
1. Highly Selective	25–30	Majority admitted from top 10% of high school class
2. Selective	21–26	Majority admitted from top 25% of high school class
3. Traditional	18–24	Majority admitted from top 50% of high school class
4. Liberal	17–22	Majority admitted from bottom 50% of high school class
5. Open	16–21	Generally open to all with high school diploma or equivalent

Note: ACT Composite score scale ranges from 1 to 36. Adapted from *National Collegiate Retention and Persistence to Degree Rates* (ACT, 2013).

To be included in this study, institutions also had to offer academic majors in both the quantitative sciences and the biological sciences. At an institution with academic majors in both quantitative sciences and biological sciences, a student may declare an academic major in a STEM field where the profiles of persisting students are similar to the student's profile, or the student may have initially declared another major, but later declared a STEM major. In contrast, if a student enrolled at a college that did not offer the student's preferred STEM major, and that student majored in a field where the profile of persisting students was dissimilar in some way to the profile of the student, the student may very well have dropped out or transferred. Thus, including institutions that did not offer both quantitative science majors and biological science majors could have distorted the results.

For students, data inclusion required a complete set of ACT scores, ACT Interest Inventory scores, self-reported high school grades, semester grade point average (GPA), and a classification of instructional program (CIP) code (National Center for Education Statistics [NCES], 2002), described in the next section. Students who transferred into an institution after the first semester were excluded. Overall, approximately 57% of the students in the first semester and 59% of the students in the eighth semester were females.

A subset of this data set has been used in previous ACT research on STEM majors who had been continuously enrolled for eight consecutive semesters in the same general field of study (Westrick, 2012, 2015). As in the previous research, transfer students from other institutions were excluded. However, this study sought to be more inclusive, starting with all students who enrolled in the first semester with decreasing numbers of persisting students across eight consecutive semesters of study. Persisting students were allowed to move in and out of academic majors, and students who had not decided on an academic major were included in the overall analyses but excluded from the group comparisons.

Classification of Academic Majors

Each student in this study had a CIP code (NCES, 2002) that identifies his or her declared major. There are six-, four-, and two-digit CIP codes, with the six-digit code being the most specific and the two-digit code being the most general. For example, the six-digit CIP code 14.0701 represents Chemical Engineering, and the two-digit CIP code 14 represents Engineering. In this study, the two-digit CIP code was used to classify academic majors.

There are multiple definitions of STEM and lists of STEM programs of study. The National Science Foundation (NSF) has a list, as does Immigration and Customs Enforcement within the US Department of Homeland Security. Various non-government organizations also have their own definitions and lists. Consistent with previous STEM research using a portion of this data set (Westrick, 2012, 2015), two STEM categories were created: STEM-Quantitative and STEM-Biological. The STEM-Quantitative category consisted of the following academic majors (with applicable CIP code): Computer Sciences (11), Engineering (14), Mathematics & Statistics (27), and Physical Sciences (40). The STEM-Biological category consisted on only one two-digit CIP code grouping: Biological/Biomedical Sciences (26). All other academic majors were classified as non-STEM majors, with the exception of those who had been coded as "undecided." This categorization of students into three student major categories (SMCs) was used in all the analyses. In the first semester, 67%, 26%, and 61% of the STEM-Biological, STEM-Quantitative, and non-STEM majors were female, respectively. In the eighth semester, the corresponding figures were 62%, 27%, and 63%.

Measures

The ACT

The ACT test is a battery of four tests—English, mathematics, reading, and science—with a Composite score that is the average score of the four tests. All scores are reported on a scale from 1 to 36. Table 2 contains descriptive statistics for the ACT test administered between 1999 and 2005. Reliability estimates for the ACT test are as follows: Composite, .96; English, .91; mathematics, .91; reading, .85; and science, .80 (ACT, 2014b). Additional information about the test content, reliability, and validity of the ACT test can be found in the *ACT Technical Manual* (ACT, 2014b).

Table 2. Reference Populations' Means, Standard Deviations, and Correlations between Pre-College Academic Predictors, ACT National Data, 1999–2005

Measure	*N*	*Mean*	*SD*	ACTC	ACTE	ACTM	ACTR	ACTS
ACT Composite	6,783,762	20.9	4.8					
ACT English	6,783,762	20.4	5.8	.91				
ACT Mathematics	6,783,762	20.7	5.0	.86	.72			
ACT Reading	6,783,762	21.3	6.1	.90	.79	.65		
ACT Science	6,783,762	20.9	4.6	.89	.73	.76	.72	
High School GPA	5,718,341	3.21	0.61	.58	.54	.56	.48	.50

Note: Overall figures include examinees who did not identify their gender. All correlations are significant at p <.0001. GPA = grade point average.

High School Grade Point Average

The measure of HSGPA in this study is based on students' self-reported high schools grades in the four core subject areas: English, mathematics, social science, and natural science. Although students report grades on up to 30 high school courses, only grades earned for the first 23 specific high school courses in English, mathematics, social studies, and science were used in calculating HSGPA. ACT research found that the median correlation between self-reported high school grades and actual grades on transcripts was .79 (Schiel & Noble, 1991). This median correlation was used as the reliability estimate of self-reported high school GPA.[2]

ACT Interest Inventory

The ACT Interest Inventory is a wideband measure intended for use in career exploration. It provides scores on six basic types of vocational interests paralleling six career types in Holland's (1997) theory of careers. The six vocational interests, with Holland's types in parentheses, are: Science & Technology (Investigative), Arts (Artistic), Social Service (Social), Administration & Sales (Enterprising), Business Operations (Conventional), and Technical (Realistic). ACT Interest Inventory scale scores range from 20 to 80. Table 3 contains descriptive statistics for the ACT Interest Inventory administered between 1999 and 2005. Reliability estimates for the ACT Interest Inventory scales are as follows: Science & Technology, .92; Arts, .88; Social Service, .87; Administration & Sales, .88; Business Operations, .92; and Technical, .89 (ACT, 2009). Information on the validity of the ACT Interest Inventory can be found in the *ACT Interest Inventory Technical Manual* (ACT, 2009).

Table 3. Reference Populations' Means, Standard Deviations, and Correlations between Pre-College ACT Interest Inventory Scale Scores, ACT National Data, 1999–2005

Measure	*N*	*Mean*	*SD*	Science & Technology	Arts	Social Services	Administration & Sales	Business Operations
Science & Technology	5,968,806	52.4	9.1					
Arts	5,968,806	52.0	9.5	.33				
Social Service	5,968,806	51.3	10.8	.34	.40			
Administration & Sales	5,968,806	51.1	9.9	.19	.29	.60		
Business Operations	5,968,806	50.6	8.8	.19	.09	.32	.54	
Technical	5,968,806	51.7	9.7	.44	.39	.33	.23	.42

Note: All correlations are significant at p < .0001.

[2] This estimate comes from a restricted sample and was used for each institutional study.

The relationships among the six scales can be represented as a hexagon, as seen in Figure 1. Note that based on the locations of the scales on the hexagon, it would be reasonable to expect that STEM interests would be located in the lower right quadrant. Research has shown (ACT, 2009) that two dimensions (Data/Ideas and People/Things) underlie job analysis ratings and measured interests of Holland-type career groups. ACT Interest Inventory scores can be converted to Data/Ideas (DI) and People/Things (PT) scores in several ways. The approach used here involves inserting scores directly into formulas based on the Cartesian coordinates of a hexagon. While not the operational approach for locating persons on DI and PT space, this method has been used by others (e.g., Leuwerke et al., 2004) and involves substituting the scores for Holland types in the following formulas:

$$\begin{aligned} DI = {} & 0.00\,(\text{Technical}) - 1.73\,(\text{Science \& Technology}) - 1.73\,(\text{Arts}) + 0.00\,(\text{Social Service}) \\ & + 1.73\,(\text{Administration \& Sales}) + 1.73\,(\text{Business Operations}) \end{aligned} \tag{1}$$

$$\begin{aligned} PT = {} & 2.00\,(\text{Technical}) + 1.00\,(\text{Science \& Technology}) - 1.00\,(\text{Arts}) - 2.00\,(\text{Social Service}) \\ & - 1.00\,(\text{Administration \& Sales}) + 1.00\,(\text{Business Operations}) \end{aligned} \tag{2}$$

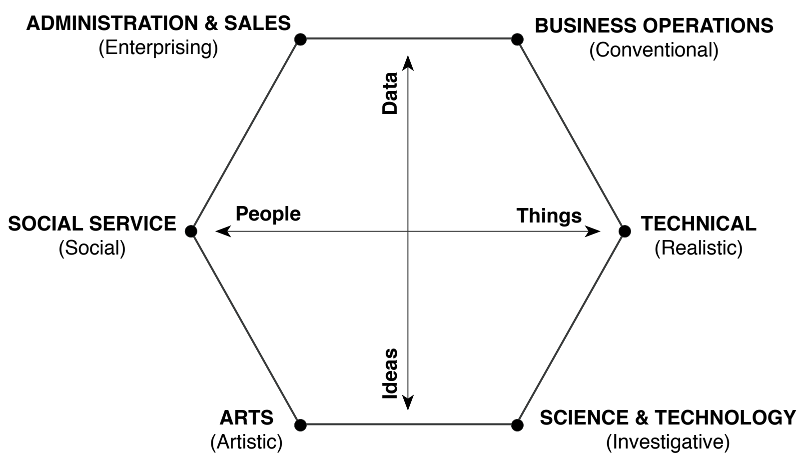

Figure 1. Relationship between ACT Interest Inventory scales and the Data/Ideas and People/Things work task dimensions (Holland types corresponding to the ACT Interest Inventory scales shown in parentheses)

Statistical Analyses

For all differences between group means for ACT scores, HSGPA, and ACT Interest Inventory scores, standardized mean differences, Cohen's (1988) *d*, was calculated within each institution. Cohen's *d* is calculated by subtracting the mean (*M*) for group 2 from the mean for group 1 and dividing the difference by the pooled (*p*) standard deviation (*SD*) for groups 1 and 2.

$$d = (M_1 - M_2)/SD_p \tag{3}$$

According to Cohen's (1988) guidelines, *d*s greater than or equal |0.20| and less than |0.50| are small effect sizes; *d*s in the |0.50| to |0.79| range are considered medium; and any d greater than or equal to |0.80| is a large effect size. In the computation of *d*s, means for the non-STEM group were subtracted from the means for the STEM groups, the reference groups. Hence, a positive effect size indicated that the STEM group had a higher mean score on the ACT measure or had a higher mean HSGPA. For the STEM-Quantitative and STEM-Biological comparisons, the means for the STEM-Biological majors were subtracted from the means for the STEM-Quantitative majors.

The effect sizes were then meta-analyzed using standard formulas (Schmidt & Hunter, 2014). Means and standard deviations were calculated in SAS and the meta-analyses were conducted in Microsoft Excel.[3] First, bare-bones meta-analyses—meta-analyses of the observed institutional effect sizes corrected only for sampling error—were conducted. Next, meta-analyses that corrected for sampling error, range restriction, and measurement error were conducted. While observed effect sizes pertain to the mean differences in observed scores from the sample, effect sizes corrected for measurement error pertain to the mean differences in the underlying constructs that the instruments are designed to measure in the population. The reliability estimates of the scores, however, are influenced by the variability of the group (Thorndike, 1951). The reliability estimate for a measure obtained from a restricted sample will be lower than the estimate obtained with the total population, hence the need to make corrections for range restriction at the institutional level. (As no reliability estimates were available for the DI and PT work task dimensions, only corrections for sampling error and range restriction were made in the meta-analyses of the DI and PT work task dimensions.)

Corrections for range restriction required a reference population, which was all ACT test examinees (Table 2) and ACT Interest Inventory respondents (Table 3) tested between 1999 and 2005. For a particular institution, the ratio of the observed standard deviation from the restricted sample (SD_i) and the unrestricted standard deviation from the reference population (SD) is referred to as u_x (Thorndike, 1949). The subscript *i* denotes the restricted sample for each institutional study, and the subscript *x* denotes the measure (e.g., ACT Composite score):

$$u_x = SD_i/SD \tag{4}$$

The reciprocal of this ratio,

$$U_x = 1/u_x \tag{5}$$

was then used to estimate the reliability of the measures within each comparison grouping within each institution.

$$r_{yyi} = 1 - [U_x{}^2(1\text{-}r_{yy})] \tag{6}$$

where r_{yyi} is the reliability estimate for the measure in the restricted sample and r_{yy} is the reliability estimate for the measure in the unrestricted population.

As an example, consider comparing the mean ACT Composite scores for STEM-Quantitative and non-STEM majors at an institution. The standard deviation for ACT Composite scores in the national population between 1999 and 2005 (Table 1) is 4.80 and the reliability estimate for the ACT Composite score is .96 (ACT, 2014b). At institution A, the pooled standard deviation for ACT Composite scores for STEM-Quantitative and non-STEM majors is 3.86. Using these figures in equations 3 through 5, the results for institution A are:

$$u_x = 3.86/4.80 = 0.80417$$

$$U_x = 1/0.80417 = 1.24352$$

$$r_{yyi} = 1\text{-}[1.24352^2(1\text{-}.96)] = .93815$$

[3] The software by Schmidt and Le (2004) requires calculations of the estimated mean differences, SD ratios, and reliability estimates for each institutional study before the estimated mean differences, Ns, and reliability estimates for each institutional study are entered into the software program by hand. Analyses conducted in SAS and Excel were cross-checked with analyses run in the Schmidt and Le (2004) software, with final results accurate to the fourth decimal place.

Institutional studies were then weighted by their sample size and the reliability estimate of the measure at their institution,

$$w_i = N_i r_{yyi} \tag{7}$$

where w_i represents the weight of the institutional study. In this way, studies with lower reliability estimates received less weight than they would have if each study had been simply weighted by the institutional sample size.

For each institutional study, the corrected institutional effect size (d_{ci}) was calculated by dividing the observed institutional effect size (d_{oi}) by the square root of the institutional reliability estimate for the measure.

$$d_{(ci)} = d_{oi} / \surd\, r_{yyi} \tag{8}$$

The mean estimated effect size, δ, was calculated by summing the weighted institutional effect sizes (corrected) and dividing this sum by the sum of the institutional study weights.

$$\delta = \sum w_i d_{ci} / \sum w_i \tag{9}$$

The observed variance of the estimated mean effect size $Var(d_c)$ was calculated as follows.

$$Var(d_c) = \sum w_i (d_{ci} - \delta)^2 / \sum w_i \tag{10}$$

When the two groups within an institutional study are the same size, the sampling error variance $Var(e_i)$ is approximately

$$Var(e_i) = [(N_i - 1)/(N_i - 3)][(4/\, N_i)\,(1 + (\text{mean } d_o)^2/8)] \tag{11}$$

where mean d_o is the mean uncorrected effect size, the sum of the weighted institutional effect sizes divided by the sum of the institutional observations. (Note the computation of the mean uncorrected effect size is necessary for the estimation of the sampling error for the corrected effect size.) Even when the two groups have different sample sizes, this equation provides a fairly accurate estimate. However, when the larger of the two groups exceeds 80% of the total sample size, a more accurate estimate of the sampling error variance, based on Hedges's and Olkin's (1985, p. 86) equation

$$Var(e_i) = [(N1_i + N2_i)/(N1_i N2_i)] + \{(\text{mean } d_o)^2/[2(N1_i + N2_i)]\} \tag{12}$$

should be used. When estimating the standardized mean difference between STEM and non-STEM majors within institutions in study 1, the non-STEM majors typically were more than 80% of the total sample; hence, the latter equation was used. For consistency, this equation was used for all meta-analyses even when the smaller group exceeded 20% of the total sample.

The sampling error variance in each corrected institutional effect size was approximately

$$Var(e'_i) = Var(e_i)/r_{yyi} \tag{13}$$

The overall sampling error variance was calculated by summing the weighted institutional sampling error estimates by the summed weights.

$$Var(e') = \sum w_i\, Var(e'_i)/w_i \tag{14}$$

The variance of the population effect sizes was calculated by subtracting the sampling error variance from the observed variance.

$$Var(\delta) = Var(d_c) - Var(e') \tag{15}$$

The standard deviation of the estimated mean effect size SD(δ) is the square root of the variance of the population effect size.

A random effects model was used, which allowed true effect sizes to vary across institutions (Schmidt & Hunter, 2014). Therefore, for each meta-analysis an estimated mean effect size and an 80% credibility interval (CrI)[4]

$$\delta - 1.28SD(\delta) < \delta < \delta + 1.28SD(\delta) \qquad (16)$$

were reported. At institutions similar to the ones included in this meta-analysis, 80% of the true effect sizes (corrected for measurement error and range restriction) at those institutions would be expected to fall between the lower and upper bounds of the credibility interval.

Results

Descriptive Statistics

Recognizing the effects of student attrition over eight semesters is necessary to understanding the results. Table A1 contains the number of students within each SMC, along with the means and standard deviations for ACT scores and HSGPA across eight semesters. Table A2 contains the descriptive statistics for the ACT Interest Inventory scales and the work task dimensions derived from the scales. While the number of students in each of the three categories decreased from one semester to the next, the three categories had different amounts of change. Between the first and eighth semesters, the number of STEM-Quantitative majors decreased from 15,516 to 7,323, a drop of 53%. The number STEM-Biological majors decreased 44%, from 9,217 to 5,160, and the number of non-STEM majors declined from 94,398 to 54,497, a 42% decrease. Note that students may have changed their academic majors multiple times, and they may have changed from one category to another over time. Overall, the STEM majors made up 21% of the enrolled students in the first semester and 19% in the eighth semester.[5]

As the number of enrolled students decreased, the mean ACT scores and HSGPAs (Table A1) for the remaining students increased, which is consistent with past research which indicated that students with lower ACT scores were less likely to persist in college (ACT, 2014b). With the departure of more of the students who had entered college with lower ACT scores and HSGPAs, the remaining students became more homogenous in the pre-college academic achievement levels, and the standard deviations tended to decrease. The smaller standard deviations indicate greater range restriction in the persisting student groups.

The means and standard deviations for the ACT Interest Inventory scales and work task dimensions (Table A2) also changed as the number of persisting students decreased over time. Unlike the cognitive measures, some of the mean scores decreased while others increased. Furthermore, the scale score changes were relatively small in comparison to those found on the ACT test.

[4] An 80% credibility interval is the common choice in meta-analytic research and it is the default setting in the Schmidt and Le (2004) software.

[5] Students without a declared major were included in the calculation of the percentage of STEM majors but they were not included in Tables A1 and A2 because they could not be placed into any of the three categories. The number of students without a declared major ranged from a high of 1,481 in the first semester to a low of 270 in the eighth semester.

Profiles of Persisting STEM Majors

In this study, persisting STEM majors were defined as students who were enrolled as STEM majors in the eighth semester and had been continuously enrolled at the same institution since the first semester. Table 4 contains the means and IQRs of individual STEM majors' ACT scores, HSGPAs, ACT Interest Inventory scores, and work task dimension scores. These figures are for the students who were still enrolled in the eighth semester. The mean ACT Composite, English, mathematics, reading, and science scores for the STEM-Biological majors were 25, 25, 25, 26, and 25, respectively, with an average HSGPA of 3.76. Their average ACT Interest Inventory Science & Technology, Arts, Social Service, Business Operations, Administration & Sales, and Technical scores were 60, 51, 52, 50, 50, and 51, respectively, and their mean PT and DI work task dimension scores were 7 and -21, respectively. For the STEM-Quantitative majors, their mean ACT Composite, English, mathematics, reading, and science scores were 26, 26, 27, 26, and 26, respectively, with a mean HSGPA of 3.74. Their mean ACT Interest Inventory Science & Technology, Arts, Social Service, Business Operations, Administration & Sales, and Technical scores were 57, 51, 50, 52, 50, and 55, respectively, and their mean PT and DI work task dimension scores were 19 and -10, respectively.

Table 4. Profiles of Persisting STEM Majors, Student Means and Interquartile Ranges for Pre-College Academic Achievement and Interest Measures

	STEM-Biological			STEM-Quantitative		
Measure	25th Percentile	Mean	75th Percentile	25th Percentile	Mean	75th Percentile
ACT Composite	23	25	28	23	26	29
ACT English	22	25	29	22	26	29
ACT Mathematics	23	25	28	25	27	30
ACT Reading	22	26	29	22	26	30
ACT Science	22	25	27	23	26	29
HSGPA	3.64	3.76	4.00	3.60	3.74	4.00
Science & Technology	54	60	65	52	57	62
Arts	45	51	58	45	51	57
Social Service	46	52	58	43	50	56
Administration & Sales	44	50	55	46	52	58
Business Operations	43	50	55	45	50	57
Technical	44	51	58	48	55	61
People-Things	-13	7	28	0	19	39
Data-Ideas	-42	-21	0	-31	-10	10

ACT Composite score IQRs for incoming first-year students are contrasted with the IQRs for fourth-year STEM and non-STEM majors at each institution in Figure 2. IQRs for the non-STEM majors are only slightly higher than those for the incoming first-year students overall, but the IQRs for the fourth-year STEM majors tend to be shifted higher. More detailed information is provided in Table A3. Note that the lower bounds of the ACT test scores and HSGPA IQRs for the STEM majors are approximately the same as the means for the incoming first-year students at each institution.

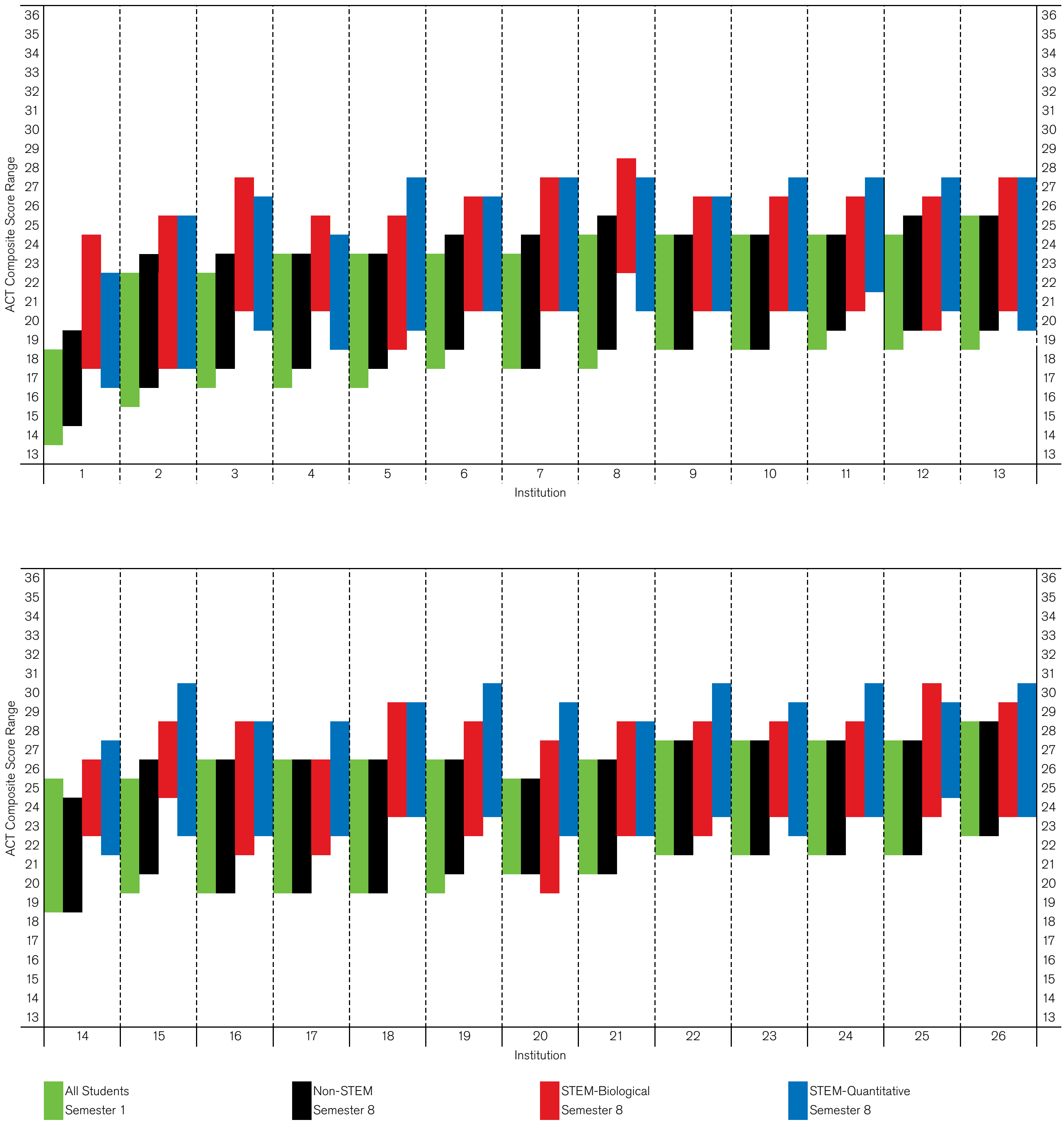

Figure 2. ACT Composite score interquartile ranges for all students in semester 1 and for persisting STEM and non-STEM majors in semester 8, by institution

While the mean scores and HSGPAs for the persisting STEM majors are informative, the mean scores for STEM majors vary across institutions. Table 5 contains the median and IQR of the institutional means for the 26 institutions included in this study. As one would expect, the distribution of institutional means is much narrower than the distribution of individual scores and HSGPAs.

Table 5. Median and Interquartile Ranges of Institutional Means for Pre-College Academic Achievement and Interest Measures

	STEM-Biological			STEM-Quantitative		
Measure	25th Percentile	Median	75th Percentile	25th Percentile	Median	75th Percentile
ACT Composite	23	24	26	24	24	26
ACT English	23	25	26	23	24	26
ACT Mathematics	23	24	26	24	26	27
ACT Reading	24	25	26	23	24	26
ACT Science	23	24	25	23	25	26
HSGPA	3.62	3.74	3.79	3.58	3.67	3.78
Science & Technology	58	60	61	50	51	52
Arts	51	51	52	47	48	50
Social Service	50	51	53	52	52	53
Administration & Sales	49	49	50	48	49	51
Business Operations	47	49	50	53	54	55
Technical	51	52	53	16	20	25
People-Things	6	9	13	-12	-9	-4
Data-Ideas	-29	-22	-17	50	51	52

Differences in Pre-College Academic Achievement Levels

Table A4 contains the meta-analytic results for the STEM-Biological—non-STEM comparisons of ACT scores and HSGPA among the persisting students over eight consecutive semesters. Effect sizes of practical significance (taken to be greater than or equal to |0.20|) with corresponding credibility intervals that do not contain zero are highlighted in bold text. All the effect sizes were positive, indicating that the mean ACT scores and HSGPAs were higher for the STEM-Biological majors than those for the non-STEM majors. Furthermore, all the effect sizes were of practical significance, ranging from 0.26 (ACTR, semester 1) to 0.62 (ACTM, semester 8). Note that the largest estimated mean differences were associated with the ACT mathematics and science scores. Also note that the effect sizes increased over eight semesters for all six measures and there were no declines between the first and eighth semesters.

The meta-analytic results for the STEM-Quantitative—non-STEM comparisons of ACT scores and HSGPA (Table A5) were similar, though somewhat different, to those found for the STEM-Biological—non-STEM comparisons. The effect sizes were always positive, indicating that the STEM-Quantitative majors had, on average, higher levels of pre-college academic achievement than their non-STEM counterparts had. The effect sizes also increased over time, and never decreased from one semester to the next. All the effect sizes were of practical significance, but the moderate to large effect sizes associated with ACT mathematics (0.86 to 1.09) and science (0.72 to 0.90) scores stood out.

The comparisons made between the two STEM groups in Table A6 highlight the differences between STEM-Quantitative majors and STEM-Biological majors in regard to the their pre-college academic achievement levels. STEM-Quantitative majors had higher mean ACT Composite scores, but after the first semester, none of the effect sizes was greater than or equal to 0.20. The largest differences were seen in mathematics (0.48 to 0.50) and science (0.29 to 0.31), with all the effect sizes being of practical significance. There were no differences of practical significance for ACT English and reading scores. The STEM-Biological majors tended to have higher mean HSGPAs, and although none of the credibility intervals contained zero, none of the estimated mean effect sizes exceeded -0.20. Note that for all six measures, the effect sizes did not grow larger over time as with the comparisons between the STEM and non-STEM majors in Tables A4 and A5. Rather, the effect sizes were quite consistent over eight semesters with the widest range of effect sizes only 0.05 (ACT reading).

Differences in Measured Interests

While ACT test scores provide insights on the pre-college academic achievement levels of STEM majors, the ACT Interest Inventory also provides a glimpse at the average interest levels of STEM majors. Table A7 contains the estimated mean differences between STEM-Biological majors and non-STEM majors on the six ACT Interest Inventory scales and the PT and DI work task dimensions. STEM-Biological majors scored higher than non-STEM majors scored on the Science & Technology (Investigative) scale, with large effect sizes ranging between 0.89 and 0.94. On the other hand, STEM-Biological majors scored lower than non-STEM majors scored on the Administration & Sales (Enterprising) scale, with small effect sizes ranging between -0.28 and -0.34 over eight semesters. On the other four scales, none of the effect sizes were of practical significance. For the PT and DI work task dimensions, all the effect sizes were of practical significance, ranging between 0.36 and 0.44 (small effect sizes) for PT and -0.51 and -0.55 (moderate effect sizes) for DI.

Whereas the STEM-Biological and non-STEM majors had differences of practical significance on two of the six ACT Interest Inventory scales, the STEM-Quantitative majors and non-STEM majors had differences of practical significance on five of the scales. In Table A8, the largest differences were associated with the Science & Technology scale (0.51 to 0.54), followed by the Technical (Realistic) scale (0.47 to 0.51). The STEM-Quantitative majors also scored higher than the non-STEM majors scored on the Business Operations (Conventional) scale (0.22 to 0.24), but the STEM-Quantitative majors had lower mean scores on the Administration and Sales (-0.23 to -0.31) and the Social Service (Social) scales (-0.27 to -0.33). Turning to the work task dimensions, STEM-Quantitative and non-STEM majors had moderate to large differences (0.73 to 0.81) on the PT dimension. In contrast, the differences between the two groups on the DI dimension were much smaller, (-0.17 to -0.22).

Table A9 contains the results for the comparisons made between STEM-Quantitative and STEM-Biological majors. There were differences of practical significance on four of the six scales. The STEM-Biological majors had higher mean scores on the Science & Technology scale (-0.39 to -0.42) and the Social Service scale (-0.30 to -0.33), while the STEM Quantitative majors had higher mean scores on the Business Operations scale (0.31 to 0.34) and the Technical scale (0.36 to 0.41). Small effect sizes were also seen on the transformed work task dimension scores, ranging between 0.40 and 0.41 for PT and between 0.35 and 0.37 for DI.

To illustrate these differences, Figure 3 contains the DI and PT plots for non-STEM, STEM-Biological, and STEM-Quantitative majors enrolled for courses in the first and eighth semesters. In the first semester, the non-STEM majors were roughly around the means for both dimensions (PT = -5.8; DI = -2.6), though slightly to the People side of the origin. The plot for the STEM-Biological majors, as expected, was in the lower right quadrant (PT = 4.3; DI = -18.8). Among the enrolled students in the eighth semester, the plot for the non-STEM majors was virtually unchanged (PT = -6.5; DI = -2.3), as was the plot for the Biological/Biomedical Science majors (PT = 7.1; DI = -20.7), though it was shifted slightly further into the lower right quadrant. Much like the STEM-Biological majors, the plot for STEM-Quantitative majors enrolled in the eighth semester (PT = 19.1; DI = -9.9) was slightly shifted down and to the right of the plot for the first semester (PT = 16.8; DI = -8.9).

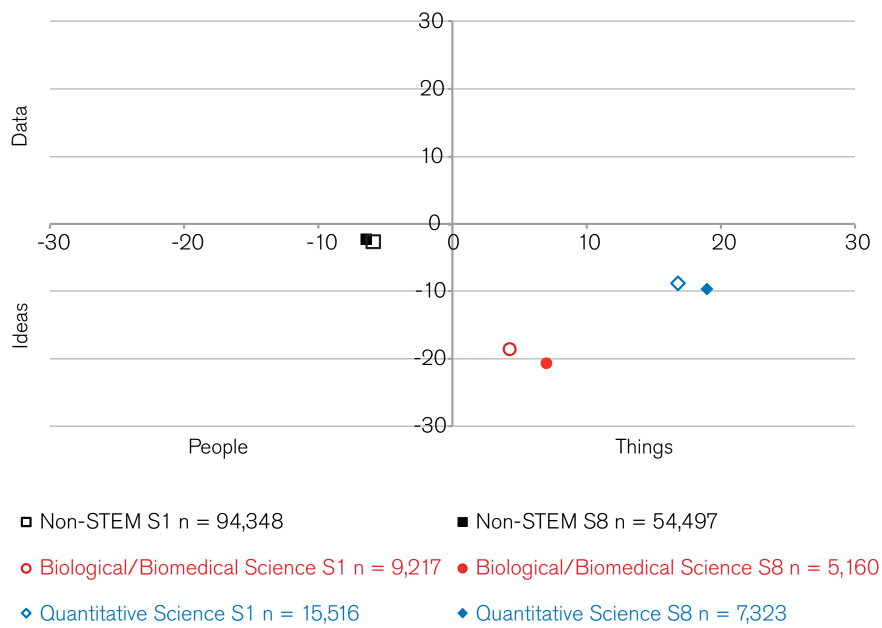

Figure 3. Mean Data/Ideas and People/Things scores for STEM and Non-STEM majors from the entire sample (first and eighth semesters)

While Figure 3 is helpful for understanding the basic differences in students' measured interests across the three SMCs, it should not be interpreted as the exact locations for all students at all institutions. To provide a perspective on the variation of the measured interests of students across institutions, Figure 4 contains the DI and PT plots for the SMCs at institutions that had at least 100 students in each of the STEM SMCs (k = 8, n = 51,236). The plots for the institutions are labeled A to H based on the number students within the institution, starting with the largest, A (n = 8,949), to the institution with the eighth largest number of students, H (n = 1,761). Note that while the distances between the plots for the three SMCs varied across the institutions, the same general pattern was found at each institution.

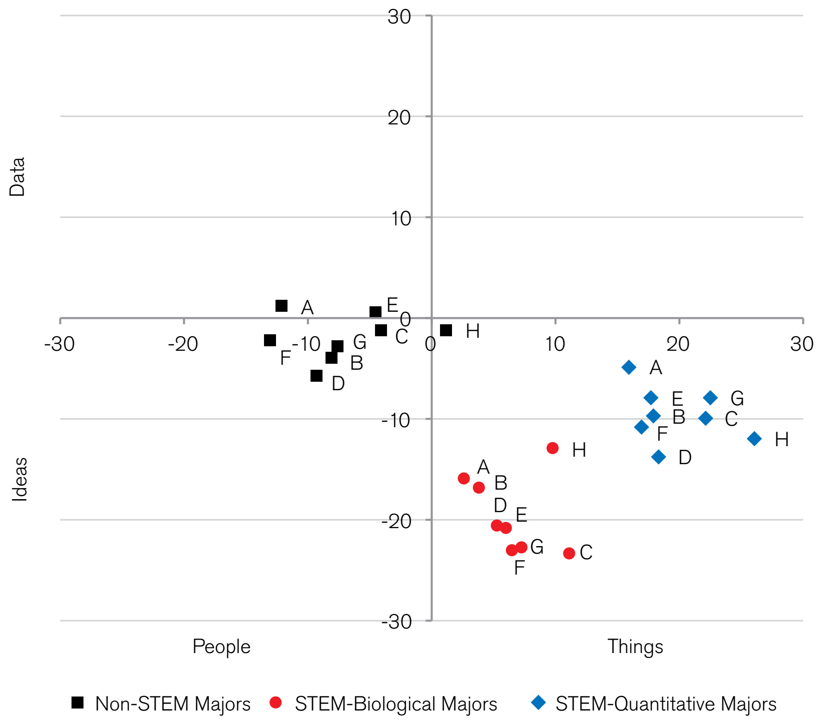

Figure 4. Mean Data/Ideas and People/Things scores for institutions with more than 100 students in each STEM student major category in the eighth semester

Discussion

Summary of Results

The results showed that both STEM groups differed from non-STEM majors in their levels of pre-college academic achievement levels and their measured interests. The overall descriptive statistics and the figures showing the range of scores and HSGPAs indicate that STEM majors have distinct profiles in regard to their pre-college academic achievement levels and their measured interests. The STEM majors tended to have higher ACT scores and HSGPAs, though on the measured interests, the STEM majors sometimes had higher or lower scores. In fact, the mean ACT English, mathematics, reading, and science scores for both the STEM-Biological and STEM-Quantitative majors in Table 4 exceeded the past and current ACT College Readiness Benchmarks (Allen, 2013; Allen & Sconing, 2005). The meta-analytic results indicated that many of these differences were of practical significance (δs greater than or equal to $|0.20|$) within institutions. The STEM majors had higher ACT scores on average, and the effect sizes for ACT mathematics (STEM-Biological: 0.39–0.62; STEM-Quantitative: 0.86–1.09) and ACT science (STEM-Biological: 0.42–0.54; STEM-Quantitative: 0.72–0.90) score comparisons were larger than those for ACT English (STEM-Biological: 0.28–0.41; STEM-Quantitative: 0.24–0.37) and ACT reading (STEM-Biological: 0.26–0.37; STEM-Quantitative: 0.24–0.32) scores. Mean ACT scores and HSGPAs within the SMCs varied across institutions, but within institutions, the gaps between the two STEM SMCs and the non-STEM SMC were evidenced by the estimated mean effect sizes and credibility intervals. Interestingly, the gaps in pre-college academic performance were non-trivial in the first semester and the gaps only grew larger over eight semesters. The mean ACT scores and HSGPAs increased over time for all three groups as more of the less-prepared students dropped out or transferred to other institutions, but the growth in the effect sizes over eight semesters suggests this pattern was more pronounced among the STEM majors.

The meta-analytic results for the comparisons made between STEM-Quantitative and STEM-Biological majors demonstrated that the two groups have unique pre-college academic achievement profiles. Across institutions, the STEM-Quantitative majors had entered college with higher mean ACT mathematics and science scores than did the STEM-Biological majors. The difference in mean ACT mathematics scores is somewhat understandable. While the STEM-Biological majors must complete mathematics courses in their undergraduate studies, it is likely that they do not need to complete the same types of mathematics courses that the STEM-Quantitative majors must complete (Kimura, 2007; Mattern et al., 2015). Students with lower levels of pre-college academic achievement in mathematics may be deterred from even entering a STEM-Quantitative major knowing that the degree requires taking many highly difficult mathematics courses, hence the higher mean ACT mathematics scores for those who do enroll in STEM-Quantitative majors.

However, the differences seen in ACT science scores are harder to explain. It may be that students self-select themselves into STEM majors based on the expected difficulty of the science courses for the majors. Recent research (Mattern et al., 2015) indicated that 38% of STEM students in medical and health majors took Health Science as their first science course, whereas STEM students in science, computer science and mathematics, and engineering and technology enrolled in that type of course at much lower rates (14%, 18%, and 2%, respectively). Furthermore, a higher percentage of medical and health majors (48%) and science majors (48%) took Biology as their first science course than did engineering and technology majors (8%) and computer science and math majors

(26%). In contrast, medical and health majors had a lower percentage of students enrolling in Chemistry as their first science course (40%) than did the science (60%) and engineering and technology (57%) majors. Finally, less than 1% of the medical and health majors took Physics as a first science course, compared to 3% of the science majors, 7% of the computer science and mathematics majors, and 11% of the engineering and technology majors. The STEM categories in that study differed from the categories used in this study. However, if the STEM-Biological and STEM-Quantitative majors in this study self-selected themselves into academic programs that best matched their ability levels, this self-selection may partially explain the estimated mean differences in ACT science scores.

Turning to measured interests, both STEM groups tended to score higher than the non-STEM group scored on the Science and Technology scale, but lower than the non-STEM group on the Administration and Sales scale, suggesting that STEM and non-STEM differed in their interests. However, the STEM-Quantitative majors also differed from the non-STEM majors on the Social Service, Business Operations, and the Technical scales, with the differences on the Technical scale being nearly as large as those on the Science and Technology scale. Furthermore, the two STEM groups differed from one another on four of the six scales. Using the ACT Interest Inventory scale scores to place students on the PT/DI work task dimensions helped illustrate that the STEM-Biological and STEM-Quantitative majors had unique interest profiles, and taken together with the differences seen in their ACT scores, the results support the decision to create two STEM groups.

Implications for STEM Enrollment and Retention

Student retention is an important goal for post-secondary institutions, and past research has shown that students with lower levels of pre-college academic achievement are at greater risk of leaving school without earning a degree (Radunzel & Noble, 2012). The results of this study support those conclusions as the mean ACT scores and HSGPAs rose as student attrition increased (Table A1), indicating that persisting STEM students had higher levels of pre-college academic achievement than did the students who departed their colleges. In regard to interests, the small amount of change in the measured interests of the STEM majors in the first semester and those of the persisting STEM majors in the eighth semester suggests that the measured interests of the students who departed the STEM fields did not differ much from those who persisted. Perhaps the STEM students who departed could have been persisting STEM majors at institutions where their pre-college academic achievement levels were better aligned with those of persisting STEM majors at those institutions. For example, potential engineering students with ACT mathematics scores of 26 may struggle at an institution where the average ACT mathematics score of engineering students is 28, but they may be persisting at an institution where the average ACT mathematics score of engineering students is 24.

To a certain degree, this information is provided to students who take the ACT test. ACT examinees select the schools to which they want their score reports sent, and on their ACT student score reports, the examinees can see information on the profiles of enrolled first-year students at each of the colleges. This information includes high school class ranks (e.g., majority in top 25%), ACT Composite scores (e.g., middle 50% between 21 and 26), and HSGPA (e.g., 3.12). The examinee's personal information is provided underneath the information for the colleges, so the examinee can see how he or she compares to the enrolled first-year students at each college. They also can see whether the program of study they prefer (e.g., Engineering) is offered (e.g., yes; 4-Yr. Degree).

However, the student score report does not tell an examinee how he or she compares to first-year students in their preferred program of study at each college to which he or she chose to have his or her ACT scores sent.[6] A high school student who wants to major in a STEM field may believe that a particular college is a good fit because the student's ACT Composite score falls within the middle 50% of ACT Composite scores for first-year students enrolled at that college. Given the results in this report, the high school student may be mistaken. For example, imagine a high school student with an ACT Composite score of 22 and an ACT mathematics score of 21. The student is interested in an STEM-Quantitative academic major, and the student believes he would be a good fit at Institution 9 in Table A3 because his ACT Composite score is the same as the institution's average ACT Composite score for first-year students. Compared with the persisting STEM-Quantitative majors at that school, the story is quite different. The high school student's ACT Composite score is at the 25th percentile and the student's ACT mathematics score is below the 25th percentile. If the student enrolls at that institution and enters a STEM-Quantitative field, the student may struggle academically. In time, the student may decide to change academic majors or leave the school altogether. Rather than selecting a college where his or her ACT Composite score fell into the middle 50% of enrolled first-year students, the high school student may want to select a college where his or her ACT Composite score was in the top 50% (or 25%) of enrolled first-year students.

The results of this study, however, suggest that STEM students are already doing this. Incoming STEM majors already have higher levels of pre-college academic achievement when compared to non-STEM majors within their colleges. What they may not know is how they compare to other students within their selected major. Some institutions provide multiple profiles of incoming first-year students (e.g., profiles for each college within the university), but others only provide an overall profile for incoming first-year students. If institutions provide only an overall profile, high school students should contact the institutions about the profiles of persisting students in specific programs of study.

At the individual student level, taking these actions would be beneficial, but the results of this study suggest that a large number of students enter STEM programs underprepared. Most if not all colleges already recognize that student attrition is a problem. Many colleges already have student retention plans and programs to assist struggling students. Institutions interested in reducing their STEM attrition rates should identify incoming STEM students who may be at risk of dropping out and provide support for these students. At many institutions it is not uncommon for an incoming student's measured interests to not be aligned with his or her declared STEM major and career goals, and/or the student's pre-college academic achievement levels to be well below the average level for persisting students in that STEM major. When that is the case, both student and institution may benefit from a discussion with the student about his or her choice of major and the student's probability of success in that major.

[6] Institutions participating in the ACT Class Profile Service (2015f) can have this information provided, but students exploring their college options do not see this information on their individual score reports.

Limitations and Future Research

Although this report provides useful information for those interested in the STEM pipeline, it has limitations, the most obvious being its descriptive nature. The profiles for students in the two STEM SMCs are simply the mean and IQRs for the students' pre-college measures. However, the meta-analyses demonstrated that the differences between STEM and non-STEM were of practical significance across institutions and that these results can be generalized to similar institutions not included in this report. The results suggested that the STEM-Biological and STEM-Quantitative groups differ in important ways in regard to their measured interests and their ACT mathematics and science scores. However, for readers interested in prediction models for undergraduate grades and retention, this report does not contain that information.

Another limitation of the report was the number and types of institutions that had enough longitudinal student data to be included in the meta-analyses and that offered both STEM-Quantitative and STEM-Biological majors. The number of institutions could have been increased by including colleges that offered academic majors in only one of the STEM SMCs rather than both, but it was desired to include only institutions that presented students a choice between the two STEM SMCs. Having more institutions would have been beneficial, especially institutions that were self-identified as having selective, liberal, and open admission standards. Twenty-four of the 26 institutions included in this study self-identified as having selective (n = 9) or traditional (n = 15) admission standards. Having more institutions at all five levels of admission selectivity would have permitted the creation of STEM profiles for all five levels in addition to an overall profile.

While the results of this study provide insights on the differences between students in STEM and non-STEM fields of study, additional research is being conducted to build upon the findings in this report. One study examines differences between the persisting STEM majors who are excelling academically and those who are merely getting by in their studies. STEM students earning semester GPAs of 3.0 or higher are compared to STEM students earning semester GPAs below 3.0. Another study examines STEM migration. Some students start in a STEM major and persist in it throughout college. The objective of that study is to compare persisting STEM majors to students who started as STEM majors but migrated out to other academic majors; students who started as STEM majors but departed the institution after the first semester; and students who started as non-STEM majors but later migrated into a STEM field. Finally, a research study examining differences between males and females within each of the STEM SMCs may provide insights on why the proportions of males and females differ in the STEM-Quantitative and STEM-Biological fields. When completed, these follow-on studies will provide additional insights on STEM majors as they move through college.

Conclusion

This study has provided a snapshot of persisting STEM majors' measured pre-college academic achievement levels and their measured interests. Past research examining students' ability-interest fit found that STEM students with higher levels of pre-college academic achievement and interests aligned with those of other STEM majors were more likely to enroll in and/or persist in a STEM major (Allen & Robbins, 2010; Le et al., 2014; Mattern et al., 2015; Radunzel, Mattern, & Westrick, 2015). This study compliments past research by providing descriptive profiles of persisting STEM majors' pre-college academic achievement levels and their measured interests. Using a sample of more than 120,000 students from 26 four-year institutions, this study demonstrated that within institutions, STEM majors enter college with higher levels of pre-college academic achievement levels than do their non-STEM peers, with the largest differences seen on ACT mathematics and ACT science scores. Furthermore, the gaps between the STEM and non-STEM majors generally become larger over four years of study. The creation of two STEM categories—STEM-Biological and STEM-Quantitative—was supported by the differences seen in their ACT mathematics and science scores and their measured interests, though the difference in their ACT scores were smaller than those seen between STEM and non-STEM majors. The results also complement previous research on the ACT Interest Inventory. Although the results of this study were based on academic majors collapsed into three broad categories rather than at the more-detailed academic-major level found in previous reports (ACT, 1995, 2009), it was demonstrated that STEM majors differ from non-STEM majors in regard to their measured interests.

An important finding in this report is that the biggest differences seen between departed STEM majors and persisting STEM majors were in regard to their pre-college academic achievement levels, not their measured interests. Having an interest in STEM is important, but students also need to be academically prepared for the rigors of STEM studies before they enter college. The ACT scores profiles of persisting STEM majors exceeded the ACT College Readiness Benchmarks, especially the mathematics and science benchmarks. High school students that just meet the ACT College Readiness Benchmarks in mathematics and science and then enroll in a STEM field in college will probably find themselves in classes with students much better prepared for the academic rigors of a STEM program. It is imperative that high school students considering a STEM major understand this. ■

References

ACT. (1995). *Technical Manual: Revised Unisex Edition of the ACT Interest Inventory (UNIACT).* Iowa City, IA: ACT.

ACT. (2009). *The ACT Interest Inventory Technical Manual.* Iowa City, IA: ACT.

ACT. (2013). *National collegiate retention and persistence to degree rates.* Iowa City, IA: ACT.

ACT. (2014a). *The Condition of STEM 2013*. Iowa City, IA: ACT.

ACT. (2014b). *Technical Manual: The ACT®*. Iowa City, IA: ACT.

ACT. (2015a). *The ACT Interest Inventory*. Accessed at www.act.org/content/dam/act/unsecured/documents/interest_inventory.pdf.

ACT. (2015b). *World-of-Work Map*. Accessed at www.act.org/wwm.

ACT. (2015c). *The ACT® Student Report*. Accessed at www.act.org/content/dam/act/unsecured/documents/Student-Report.pdf.

ACT. (2015d). *ACT® High School Report*. Accessed at www.act.org/content/dam/act/unsecured/documents/High-School-Report.pdf.

ACT. (2015e). *ACT® College Report*. Accessed at www.act.org/content/dam/act/unsecured/documents/College-Report.pdf.

ACT. (2015f). *Class Profile Service*. Accessed at www.act.org/content/act/en/products-and-services/act-enrollment-management-services/act-class-profile-service.html.

Allen, J. (2013). *Updating the ACT College Readiness Benchmarks* (ACT Research Report 2013-6). Iowa City, IA: ACT.

Allen, J., & Robbins, S. (2010). Effects of interest-major congruence, motivation, and academic performance on timely degree attainment. *Journal of Counseling Psychology*, *57*, 23–35.

Allen, J., & Sconing, J. (2005). *Using ACT Assessment Scores to Set Benchmarks for College Readiness* (ACT Research Report 2005-3). Iowa City, IA: ACT.

Anft, M. (2013). The STEM Crisis: Reality or Myth? *Chronicle of Higher Education, 60*(11), A30–A33. Retrieved from www.chronicle.com/article/The-STEM-Crisis-Reality-or/142879.

Astin, A. W., & Astin, H. S. (1992). *Undergraduate Science Education: The Impact of Different College Environments on the Educational Pipeline in the Sciences*. Los Angeles, CA: The Higher Education Research Institute, University of California-Los Angeles.

Benderly, B. L. (2010). The Real Science Gap. *Miller-McCune*. Retrieved from www.psmag.com/science/the-real-science-gap-16191.

Bridgeman, B., Pollack, J., & Burton, N. (2008). *Predicting grades in different types of college courses* (College Board Research Report 2008-1). New York, NY: The College Board.

Burnham, P. S., & Hewitt, B. A. (1972). Quantitative factor scores as predictors of general academic promise. *Educational and Psychological Measurement, 32*, 403–410.

Chen, X. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education* (NCES 2009-161). National Center for Education Statistics. Washington, DC: US Department of Education.

Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES 2014-001). National Center for Education Statistics. Washington, DC: US Department of Education.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Elliott, R., & Strenta, A. C. (1988). Effects of improving the reliability of the GPA on prediction generally and comparative predictions for gender and race particularly. *Journal of Educational Measurement*, 25, 333–347.

Executive Office of the President, President's Council of Advisors on Science and Technology. (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics*. Retrieved from www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf.

Goldman, R. D., & Hewitt, B. N. (1975). Adaption-level as an explanation for differential standards in college grading. *Journal of Educational Measurement*, 12, 149–161.

Goldman, R. D., & Widawski, M. H. (1976). A within-subjects technique for comparing college grading standards: Implications in the validity of the evaluation of college achievement. *Educational and Psychological Measurement, 36*, 381–390.

Green, K. C. (1989). A profile of undergraduates in the sciences. *American Scientist, 77*, 475–480.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. Orlando, FL: Academic Press.

Holland, J. L. (1997). *Making vocational choices* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

Kimura, D. (2007). "Underrepresentation or misrepresentation?" In S. J. Ceci & W.M. Williams (Eds.), *Why aren't more women in science?* (pp. 39–46). Washington, DC: APA Books.

Kokkelenberg, E. C., & Sinha, E. (2010). Who succeeds in STEM studies? An analysis of Binghamton University undergraduate students. *Economics of Education Review, 29,* 935–946.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). STEM: *Good jobs now and for the future* (US Department of Commerce, Economics and Statistics Administration Issue Brief 03-11). Retrieved from www.esa.doc.gov/sites/default/files/stemfinalyjuly14_1.pdf.

Le, H., Robbins, S. B., & Westrick, P. (2014). Predicting student enrollment and persistence in college STEM fields using an expanded P-E fit framework: A large-scale multilevel study. *Journal of Applied Psychology, 99*(5), 915–947. Retrieved from dx.doi.org/10.1037/a0035998.

Leuwerke, W. C., Robbins, S., Sawyer, R., & Hovland, M. (2004). Predicting engineering major status from mathematics achievement and interest congruence. *Journal of Career Assessment, 12*(2), 135–149.

Lippa, R. (1998). Gender-related individual differences and the structure of vocational interests: The importance of the people-things dimension. *Journal of Personality and Social Psychology, 74*, 996–1009.

Mattern, K., Radunzel, J., & Westrick, P. (2015). *Development of STEM Readiness Benchmarks to Assist Educational and Career Decision Making* (ACT Research Report 2015-3). Iowa City, IA: ACT.

Mendez, G., Buskirk, T. D., Lohr, S., & Haag, S. (2008). Factors associated with persistence in science and engineering majors: An exploratory study using classification trees and random forests. *Journal of Engineering Education, 97*(1), 57–70.

Institute of Medicine, National Academy of Sciences, and National Academy of Engineering. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: The National Academies Press.

National Center for Education Statistics. (2002). *Classification of instructional programs: 2000 edition* (NCES 2002-165). National Center for Education Statistics. Washington, DC: US Department of Education.

National Governors Association (NGA). (2007). *Building a science, technology, engineering and math agenda*. Washington, DC: NGA.

National Research Council. (2013). *Monitoring progress toward successful K–12 STEM education: A nation advancing?* Washington, DC: National Academies Press.

National Science Board. (2007). *A national action plan for addressing the critical needs of the U.S. science, technology, engineering, and mathematics education system* (NSB-07-114). Arlington, VA: National Science Foundation.

National Science Board. (2014). *Science and Engineering Indicators 2014* (NSB 14-01). Arlington, VA: National Science Foundation.

Pennock-Román, M. (1994). *College major and gender differences in the prediction of college grades* (College Board Research Report 94-2). New York, NY: The College Board.

Radunzel, J., Mattern, K., & Westrick, P. (2015). *More than test scores: A multidimensional model of STEM success.* Paper presented at the annual conference for the Association for Institutional Research: Denver, CO.

Radunzel, J., & Noble, J. (2012). *Predicting long-term college success through degree completion using ACT® Composite score, ACT Benchmarks, and high school grade point average* (ACT Research Report 2012-5). Iowa City, IA: ACT.

Salzman, H. (2013). What shortages? The real evidence about the STEM workforce. *Issues in Science and Technology,* 29(4). Retrieved from www.issues.org/29-4/what-shortages-the-real-evidence-about-the-stem-workforce.

Salzman, H., Kuehn, D., & Lowell, B. L. (2013). *Current and proposed high-skilled guestworker policies discourage STEM students and grads from entering IT*. Economic Policy Institute. Retrieved from www.epi.org/publication/current-proposed-high-skilled-guestworker.

Schiel, J., & Noble, J. (1991). *Accuracy of self-reported course work and grade information of high school sophomores* (ACT Research Report 91-6). Iowa City, IA: ACT.

Schmidt, F. L., & Hunter, J. E. (2014). *Methods of meta-analysis* (3rd ed.). Thousand Oaks, CA: Sage.

Schmidt, F. L., & Le, H. (2004). Software for the Hunter-Schmidt meta-analysis methods (Version 1.2) [Computer software]. Iowa City, IA: University of Iowa Department of Management & Organizations.

Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *The National Academic Advising Association Journal, 30*(2), 19–34.

Strenta, A. C., & Elliot, R. (1987). Differential grading revisited. *Journal of Educational Measurement, 24*(4), 281–291.

Strenta, A. C., Elliot, R., Adair, R., Matier, M., & Scott, J. (1994). Choosing and leaving science in highly selective institutions. *Research in Higher Education, 35*(5), 513–547.

Su, R., Rounds, J., & Armstrong, P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin, 135*, 859–884.

Teitelbaum, M. (2014). The myth of the science and engineering shortage. *The Atlantic*. Retrieved from www.theatlantic.com/education/archive/2014/03/the-myth-of-the-science-and-engineering-shortage/284359.

Thorndike, R. L. (1949). *Personnel selection*. New York, NY: John Wiley.

Thorndike, R. L. (1951). Reliability. In E. F. Lindquist (Ed.), *Educational measurement* (pp. 560–620). Washington, DC: American Council on Education.

US Department of Labor. (2007). *The STEM workforce challenge: The role of the public workforce system in a national solution for a competitive science, technology, engineering, and mathematics (STEM) workforce*. Retrieved from www.doleta.gov/youth_services/pdf/STEM_Report_4 07.pdf.

Westrick, P. A. (2012). *Validity Decay Versus Validity Stability in STEM and Non-STEM Fields.* (Doctoral dissertation, University of Iowa). Retrieved from ir.uiowa.edu/etd/3402/.

Westrick, P. A. (2015). *Differential grading: Meta-analyses of STEM and non-STEM fields, gender, and institutional admission selectivity* (ACT Research Report 2015-7). Iowa City, IA: ACT.

Whalen, D. F., & Shelley, M. C. (2010). Academic success for STEM and non-STEM majors. *Journal of STEM Education, 11*(1), 45–60.

Appendix

Tables A1 through A9

Table A1. Means (and Standard Deviations) for STEM and Non-STEM Majors' ACT Scores and HSGPAs

Student Major Category	Semester	*N*	ACT Composite	ACT English	ACT Mathematics	ACT Reading	ACT Science	HSGPA
Non-STEM	1	94,398	22.4 (4.1)	22.6 (5.1)	21.6 (4.5)	23.0 (5.5)	22.0 (4.0)	3.44 (0.50)
	2	86,449	22.6 (4.1)	22.8 (5.0)	21.9 (4.5)	23.2 (5.5)	22.1 (3.9)	3.46 (0.49)
	3	72,913	22.9 (4.1)	23.1 (5.0)	22.2 (4.5)	23.5 (5.5)	22.3 (3.9)	3.50 (0.46)
	4	68,366	23.0 (4.0)	23.2 (5.0)	22.3 (4.5)	23.6 (5.5)	22.4 (3.9)	3.52 (0.45)
	5	61,871	23.2 (4.0)	23.4 (4.9)	22.5 (4.5)	23.7 (5.5)	22.5 (3.9)	3.54 (0.45)
	6	58,974	23.2 (4.0)	23.4 (4.9)	22.5 (4.5)	23.8 (5.5)	22.6 (3.9)	3.55 (0.44)
	7	56,160	23.2 (4.0)	23.4 (4.9)	22.6 (4.5)	23.8 (5.5)	22.6 (3.9)	3.55 (0.44)
	8	54,497	23.3 (4.0)	23.5 (4.9)	22.6 (4.5)	23.8 (5.5)	22.6 (3.9)	3.56 (0.43)
STEM-Biological	1	9,217	23.9 (4.1)	24.0 (4.9)	23.5 (4.6)	24.4 (5.5)	23.3 (4.1)	3.63 (0.40)
	2	8,453	24.2 (4.1)	24.3 (4.9)	23.9 (4.6)	24.7 (5.5)	23.6 (4.1)	3.66 (0.38)
	3	7,378	24.6 (4.1)	24.8 (4.9)	24.3 (4.6)	25.1 (5.4)	23.9 (4.1)	3.70 (0.36)
	4	6,864	24.9 (4.0)	25.0 (4.8)	24.6 (4.6)	25.3 (5.4)	24.1 (4.1)	3.72 (0.35)
	5	6,095	25.1 (4.0)	25.2 (4.8)	24.9 (4.5)	25.4 (5.4)	24.3 (4.1)	3.74 (0.34)
	6	5,750	25.2 (3.9)	25.3 (4.8)	25.1 (4.4)	25.5 (5.4)	24.4 (4.0)	3.75 (0.32)
	7	5,307	25.3 (3.9)	25.4 (4.8)	25.2 (4.3)	25.6 (5.3)	24.5 (4.0)	3.76 (0.31)
	8	5,160	25.4 (3.9)	25.5 (4.8)	25.3 (4.3)	25.7 (5.3)	24.6 (4.0)	3.77 (0.31)

Table A1. (continued)

Student Major Category	Semester	*N*	ACT Composite	ACT English	ACT Mathematics	ACT Reading	ACT Science	HSGPA
STEM-Quantitative	1	15,516	25.2 (4.3)	24.5 (5.1)	26.0 (4.7)	24.9 (5.6)	24.9 (4.4)	3.62 (0.42)
	2	13,575	25.4 (4.3)	24.6 (5.1)	26.3 (4.7)	25.0 (5.7)	25.1 (4.5)	3.64 (0.40)
	3	11,056	25.7 (4.2)	24.9 (5.0)	26.6 (4.6)	25.2 (5.6)	25.3 (4.4)	3.68 (0.38)
	4	9,983	25.8 (4.2)	25.1 (5.0)	26.8 (4.5)	25.4 (5.6)	25.4 (4.4)	3.69 (0.37)
	5	8,800	26.0 (4.2)	25.3 (5.0)	27.1 (4.5)	25.6 (5.6)	25.6 (4.4)	3.71 (0.35)
	6	8,197	26.1 (4.1)	25.4 (4.9)	27.3 (4.4)	25.7 (5.6)	25.7 (4.4)	3.73 (0.35)
	7	7,593	26.2 (4.1)	25.5 (4.9)	27.4 (4.4)	25.7 (5.5)	25.8 (4.4)	3.74 (0.34)
	8	7,323	26.3 (4.1)	25.5 (4.9)	27.5 (4.3)	25.8 (5.5)	25.9 (4.4)	3.74 (0.33)

Table A2. Means (and Standard Deviations) for STEM and Non-STEM Majors' ACT Interest Inventory Scores and Calculated Work Task Dimension Scores

Student Major Category	Semester	*N*	Science & Technology	Arts	Social Services	Business Operations	Administration & Sales	Technical	People-Things	Data-Ideas
Non-STEM	1	94,398	51.9 (8.9)	52.1 (9.6)	52.0 (10.7)	50.1 (8.8)	52.4 (10.0)	50.3 (9.5)	-5.8 (32.2)	-2.6 (34.3)
	2	86,449	52.0 (8.9)	52.1 (9.6)	52.1 (10.7)	50.1 (8.8)	52.5 (10.0)	50.4 (9.5)	-6.0 (32.3)	-2.7 (34.3)
	3	72,913	52.1 (8.9)	52.2 (9.6)	52.2 (10.7)	50.1 (8.8)	52.6 (10.0)	50.3 (9.4)	-6.3 (32.2)	-2.7 (34.4)
	4	68,366	52.1 (8.9)	52.2 (9.6)	52.2 (10.7)	50.1 (8.8)	52.6 (9.9)	50.3 (9.4)	-6.4 (32.3)	-2.7 (34.4)
	5	61,871	52.2 (8.9)	52.2 (9.5)	52.3 (10.7)	50.2 (8.8)	52.7 (9.9)	50.3 (9.4)	-6.4 (32.4)	-2.5 (34.5)
	6	58,974	52.2 (8.9)	52.2 (9.5)	52.3 (10.7)	50.2 (8.8)	52.7 (9.9)	50.4 (9.4)	-6.4 (32.4)	-2.4 (34.5)
	7	56,160	52.2 (8.9)	52.2 (9.5)	52.3 (10.7)	50.2 (8.8)	52.8 (9.9)	50.4 (9.4)	-6.4 (32.4)	-2.3 (34.5)
	8	54,497	52.2 (8.9	52.2 (9.5)	52.3 (10.7)	50.2 (8.8)	52.8 (9.9)	50.3 (9.4)	-6.5 (32.4)	-2.3 (34.4)
STEM-Biological	1	9,217	59.5 (9.0)	51.0 (9.3)	52.7 (10.7)	49.4 (8.6)	50.2 (9.8)	51.0 (9.8)	4.3 (30.5)	-18.8 (32.1)
	2	8,453	59.7 (9.0)	51.1 (9.4)	52.6 (10.7)	49.4 (8.6)	50.1 (9.7)	51.1 (9.8)	5.1 (30.4)	-19.4 (32.0)
	3	7,378	59.7 (9.0)	51.2 (9.4)	52.6 (10.8)	49.4 (8.6)	50.0 (9.6)	51.3 (9.9)	5.4 (31.2)	-19.8 (32.3)
	4	6,864	59.9 (9.0)	51.3 (9.4)	52.5 (10.7)	49.6 (8.6)	50.1 (9.6)	51.4 (9.9)	5.9 (30.7)	-19.9 (32.3)
	5	6,095	60.0 (8.9)	51.3 (9.4)	52.5 (10.8)	49.6 (8.6)	50.0 (9.6)	51.5 (9.9)	6.2 (30.7)	-20.3 (32.0)
	6	5,750	60.1 (8.9)	51.3 (9.4)	52.5 (10.7)	49.7 (8.6)	50.0 (9.6)	51.6 (9.9)	6.6 (30.7)	-20.3 (31.9)
	7	5,307	60.2 (8.8)	51.3 (9.4)	52.4 (10.6)	49.6 (8.6)	49.9 (9.5)	51.5 (10.0)	6.9 (30.8)	-20.6 (31.8)
	8	5,160	60.2 (8.8)	51.3 (9.4)	52.3 (10.6)	49.7 (8.6)	49.9 (9.5)	51.5 (10.0)	7.0 (30.8)	-20.6 (31.7)
STEM-Quantitative	1	15,516	56.7 (8.8)	51.2 (8.9)	49.8 (10.7)	52.0 (8.5)	50.6 (9.4)	54.7 (9.5)	16.8 (30.4)	-8.9 (31.3)
	2	13,575	56.8 (8.8)	51.1 (8.9)	49.7 (10.7)	52.1 (8.5)	50.5 (9.4)	54.8 (9.4)	17.4 (30.3)	-9.1 (31.5)
	3	11,056	56.9 (8.7)	51.1 (8.8)	49.6 (10.7)	52.2 (8.6)	50.4 (9.3)	54.8 (9.5)	17.9 (30.3)	-9.2 (31.5)
	4	9,983	56.9 (8.7)	51.1 (8.8)	49.5 (10.6)	52.2 (8.6)	50.4 (9.3)	54.9 (9.4)	18.4 (30.4)	-9.4 (31.5)
	5	8,800	57.0 (8.6)	51.1 (8.8)	49.5 (10.5)	52.2 (8.6)	50.4 (9.3)	55.0 99.4)	18.7 (30.3)	-9.4 (31.7)
	6	8,197	57.0 (8.6)	51.1 (8.8)	49.4 (10.4)	52.2 (8.6)	50.3 (9.3)	55.0 (9.4)	18.9 (30.2)	-9.6 (31.6)
	7	7,593	57.1 (8.6)	51.1 (8.8)	49.5 (10.4)	52.3 (8.6)	50.4 (9.3)	55.0 (9.4)	19.1 (30.3)	-9.6 (31.6)
	8	7,323	57.2 (8.6)	51.1 (8.8)	49.5 (10.4)	52.3 (8.6)	50.4 (9.3)	55.0 (9.4)	19.1 (30.4)	-9.7 (31.5)

Table A3. Interquartile Ranges (IQRs) for Incoming First-Year Students and Eighth Semester STEM and Non-STEM Students

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
1	ACTC	14	16	18	15	19	18	24	17	22
	ACTE	12	16	18	13	20	18	25	16	21
	ACTM	14	16	17	15	18	17	24	18	26
	ACTR	13	16	19	13	20	16	23	16	23
	ACTS	14	17	19	15	20	19	22	20	22
	HSGPA	2.40	2.83	3.25	2.62	3.39	3.07	3.82	3.33	3.80
	PT	-25	-6	15	-30	8	-30	6	-7	34
	DI	-10	8	26	-7	29	-22	33	-16	21
2	ACTC	16	19	22	17	23	18	25	18	25
	ACTE	15	19	23	17	24	19	26	18	25
	ACTM	15	18	20	16	22	17	24	17	26
	ACTR	15	19	23	16	24	18	27	17	26
	ACTS	17	19	22	18	22	19	23	19	23
	HSGPA	2.50	2.98	3.50	2.73	3.67	3.00	3.89	3.04	3.81
	PT	-24	-3	18	-27	15	-13	30	-8.5	34
	DI	-22	0	21	-24	22	-47	7	-16	22
3	ACTC	17	20	22	18	23	21	27	20	26
	ACTE	16	19	22	17	24	21	28	18	27
	ACTM	16	19	21	17	22	17	24	19	27
	ACTR	16	20	24	17	25	21	28	20	26
	ACTS	17	20	22	18	23	21	25	20	26
	HSGPA	2.87	3.24	3.71	3.15	3.83	3.43	4.00	3.40	4.00
	PT	-20	1	24	-21	23	2	42	-4	30
	DI	-24	-3	17	-22	21	-54	-18	-26	9
4	ACTC	17	20	23	18	23	21	25	19	24
	ACTE	16	20	23	17	24	20	25	18	23
	ACTM	16	19	22	17	22	20	24	20	27
	ACTR	16	20	24	17	24	22	28	19	25
	ACTS	18	20	23	18	23	22	25	20	25
	HSGPA	2.93	3.28	3.75	3.09	3.88	3.64	4.00	3.29	4.00
	PT	-17	4	26	-18	24	-4	27	16	46
	DI	-19	0	19	-16	21	-33	3	-36	0
5	ACTC	17	20	23	18	23	19	25	20	27
	ACTE	17	20	23	17	24	18	25	20	28
	ACTM	16	19	21	16	22	17	23	19	25
	ACTR	17	21	24	17	25	19	27	20	27
	ACTS	18	20	23	18	23	19	24	20	26
	HSGPA	3.07	3.39	3.80	3.24	3.88	3.63	4.00	3.44	3.94
	PT	-18	4	26	-21	23	-17	32	-4	43
	DI	-26	-3	17	-24	22	-31	17	-41	9

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A3. (continued)

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
6	ACTC	18	21	23	19	24	21	26	21	26
	ACTE	18	21	24	19	25	20	27	20	27
	ACTM	17	20	22	17	23	20	26	20	27
	ACTR	18	22	25	19	26	20	27	19	28
	ACTS	19	21	23	19	23	21	25	21	27
	HSGPA	3.00	3.36	3.77	3.23	3.88	3.50	4.00	3.41	3.95
	PT	-26	-5	16	-30	12	-12	26	1	42
	DI	-26	-4	19	-24	21	-45	-3	-38	7
7	ACTC	18	21	23	18	24	21	27	21	27
	ACTE	17	21	24	18	25	21	28	21	27
	ACTM	16	19	22	17	22	20	25	21	28
	ACTR	17	21	25	18	26	21	28	21	28
	ACTS	18	20	23	18	23	20	25	21	27
	HSGPA	3.08	3.42	3.86	3.22	3.94	3.78	4.00	3.71	4.00
	PT	-19	1	23	-22	21	-15	27	-2	39
	DI	-24	-4	17	-24	19	-36	2	-29	7
8	ACTC	18	21	24	19	25	23	28	21	27
	ACTE	17	21	24	19	26	21	29	20	26
	ACTM	17	20	23	18	25	21	27	21	28
	ACTR	17	21	25	18	27	24	30	21	27
	ACTS	18	21	23	19	24	21	26	21	26
	HSGPA	3.15	3.47	3.92	3.44	4.00	3.78	4.00	3.50	4.00
	PT	-15	5	27	-17	26	-6	34	12	52
	DI	-24	-3	17	-22	19	-52	-9	-33	14
9	ACTC	19	22	24	19	24	21	26	21	26
	ACTE	18	21	24	18	24	19	26	19	25
	ACTM	18	22	25	18	25	21	26	23	28
	ACTR	19	22	26	19	26	20	28	19	27
	ACTS	20	22	24	20	24	21	26	22	27
	HSGPA	3.00	3.29	3.64	3.00	3.69	3.36	3.94	3.23	3.89
	PT	-26	-4	17	-29	13	-13	28	4	43
	DI	-26	-4	17	-24	19	-43	-2	-29	10
10	ACTC	19	21	24	19	24	21	26	21	27
	ACTE	19	22	25	19	26	22	28	20	28
	ACTM	17	20	23	17	24	20	26	21	28
	ACTR	18	22	25	18	26	20	27	20	27
	ACTS	19	21	23	19	23	20	26	21	26
	HSGPA	2.92	3.29	3.73	3.07	3.79	3.46	4.00	3.36	3.91
	PT	-20	3	25	-21	23	-12	31	11	44
	DI	-24	-3	17	-22	19	-33	9	-31	12

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A3. (continued)

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
11	ACTC	19	22	24	20	24	21	26	22	27
	ACTE	18	21	24	18	24	19	25	21	25
	ACTM	18	21	24	18	24	20	26	24	28
	ACTR	18	22	25	19	26	19	27	20	29
	ACTS	19	22	24	20	24	21	25	23	27
	HSGPA	2.83	3.22	3.69	3.07	3.80	3.40	4.00	3.21	4.00
	PT	-20	0	21	-22	19	-11	25	-11	30
	DI	-26	-4	17	-26	19	-38	9	-24	7
12	ACTC	19	22	24	20	25	20	26	21	27
	ACTE	19	22	25	19	26	20	28	19	27
	ACTM	17	21	24	18	25	18	27	20	27
	ACTR	19	22	26	19	26	20	28	20	28
	ACTS	19	22	24	20	24	20	26.5	22	28
	HSGPA	3.07	3.41	3.85	3.29	3.93	3.41	4.00	3.21	3.97
	PT	-19	3	24	-19	24	-17	33.5	16	54
	DI	-28	-4	17	-26	22	-36	0	-21	20
13	ACTC	19	22	25	20	25	21	27	20	27
	ACTE	19	22	25	19	26	21	28	20	29
	ACTM	18	22	25	18	25	22	27	22	29
	ACTR	19	22	25	20	25	21	27	19	28
	ACTS	19	22	24	19	24	22	26	20	26
	HSGPA	2.93	3.27	3.63	3.00	3.67	3.40	3.93	3.29	4.00
	PT	-22	-1	21	-24	19	-12	31	6	49
	DI	-22	1	22	-21	29	-55	7	-5	31
14	ACTC	19	22	25	19	24	23	26	22	27
	ACTE	18	21	25	19	25	22	27	19	26
	ACTM	18	21	25	18	25	22	25	25	28
	ACTR	19	23	26	18	26	21	29	21	27
	ACTS	19	22	24	19	24	23	27	23	27
	HSGPA	3.00	3.30	3.75	3.09	3.80	3.41	3.73	3.70	4.00
	PT	-23	-2	19	-23	17	4	42	-17	22
	DI	-24	-3	19	-24	19	-35	-7	-24	21
15	ACTC	20	23	25	21	26	25	28	23	30
	ACTE	19	22	25	19	26	23	27	22	29
	ACTM	18	22	25	19	26	25	29	24	29
	ACTR	20	23	27	20	28	25	31	24	31
	ACTS	20	22	25	20	25	25	29	24	29
	HSGPA	2.90	3.28	3.76	3.08	3.85	3.73	4.00	3.60	4.00
	PT	-21	0	22	-22	20	2	41	-3	41
	DI	-36	-12	10	-36	12	-53	-18	-54	-5

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A3. (continued)

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
16	ACTC	20	23	26	20	26	22	28	23	28
	ACTE	19	22	26	19	26	22	29	20	27
	ACTM	19	23	26	19	26	23	29	25	30
	ACTR	20	24	28	20	28	22	29	22	29
	ACTS	20	23	25	20	25	21	27	23	28
	HSGPA	3.20	3.48	3.86	3.29	3.88	3.63	4.00	3.58	4.00
	PT	-15	7	29	-19	24	1	41	6	50
	DI	-33	-12	10	-31	14	-52	-1	-31	5
17	ACTC	20	23	26	20	26	22	26	23	28
	ACTE	20	23	26	20	27	23	28	21	28
	ACTM	19	22	26	19	25	22	26	25	28
	ACTR	19	24	28	19	28	21	28	22	29
	ACTS	20	23	25	20	25	22	26	23	27
	HSGPA	3.00	3.31	3.73	3.07	3.73	3.42	3.93	3.36	3.92
	PT	-27	-7	14	-30	10	-9	30	0	30
	DI	-33	-8	14	-33	16	-42	-3	-29	22
18	ACTC	20	23	26	20	26	24	29	24	29
	ACTE	21	24	28	21	28	24	30	23	30
	ACTM	19	22	26	19	25	24	28	24	29
	ACTR	20	24	28	20	27	23	30	22	30
	ACTS	20	23	25	20	25	22	27	23	28
	HSGPA	3.09	3.43	3.86	3.14	3.86	3.60	4.00	3.57	4.00
	PT	-30	-8	14	-33	9	-14	24	-2	35
	DI	-22	-1	21	-21	22	-36	9	-24	16
19	ACTC	20	23	26	21	26	23	28	24	30
	ACTE	20	23	27	20	27	22	29	23	30
	ACTM	19	22	26	19	25	22	28	26	31
	ACTR	20	24	28	20	27	23	30	23	31
	ACTS	20	23	25	20	25	22	28	24	29
	HSGPA	3.33	3.57	3.93	3.40	3.94	3.68	4.00	3.74	4.00
	PT	-22	0	23	-26	18	-11	33	2	41
	DI	-28	-4	17	-24	21	-45	-5	-31	10
20	ACTC	21	23	25	21	25	20	27	23	29
	ACTE	20	23	26	21	26	21	29	21	28
	ACTM	19	22	25	19	25	19	27	24	30
	ACTR	20	24	27	20	27	20	29	21	28
	ACTS	20	23	25	21	25	20	26	22	28
	HSGPA	3.13	3.41	3.77	3.21	3.80	3.45	3.94	3.38	3.92
	PT	-20	1	23	-24	18	-9	35	6	40
	DI	-29	-6	17	-29	19	-42	-9	-24	7

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A3. (continued)

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
21	ACTC	21	24	26	21	26	23	28	23	28
	ACTE	22	25	28	22	28	23	30	22	29
	ACTM	20	23	26	20	26	23	28	24	29
	ACTR	21	24	28	21	28	23	29	21	29
	ACTS	21	23	25	21	25	22	27	22	27
	HSGPA	3.14	3.44	3.79	3.17	3.80	3.58	4.00	3.38	3.92
	PT	-26	-4	19	-30	14	-16	24	-1	38
	DI	-29	-6	16	-26	19	-36	2	-29	12
22	ACTC	22	25	27	22	27	23	29	24	31
	ACTE	22	25	28	22	28	23	30	24	30
	ACTM	20	24	27	20	27	23	29	26	32
	ACTR	21	25	29	21	29	23	30	23	31
	ACTS	21	24	26	21	26	23	28	24	30
	HSGPA	3.50	3.66	3.95	3.53	4.00	3.75	4.00	3.69	4.00
	PT	-26	-4	19	-31	12	-15	26	-2	38
	DI	-31	-8	14	-29	17	-43	2	-35	9
23	ACTC	22	25	27	22	27	24	28	23	29
	ACTE	21	24	27	21	28	22	29	22	28
	ACTM	22	25	28	22	28	23	28	26	30
	ACTR	21	25	29	22	29	23	30	22	29
	ACTS	22	24	27	22	26	24	28	24	29
	HSGPA	3.36	3.59	3.95	3.42	4.00	3.71	4.00	3.56	4.00
	PT	-15	7	29	-17	26	-11	31	4	42
	DI	-28	-6	16	-24	19	-50	-3	-21	19
24	ACTC	22	25	27	22	27	23	28	24	30
	ACTE	21	24	27	21	27	22	29	22	29
	ACTM	22	25	28	22	27	24	29	26	31
	ACTR	21	25	29	21	28	22	30	22	30
	ACTS	21	24	26	21	25	22	27	23	29
	HSGPA	3.60	3.75	4.00	3.60	4.00	3.77	4.00	3.73	4.00
	PT	-22	0	22	-26	17	-13	28	-2	38
	DI	-26	-4	17	-22	22	-42	-2	-28	10
25	ACTC	22	25	27	22	27	24	30	25	29
	ACTE	21	24	27	21	28	23	30	23	30
	ACTM	21	24	27	21	27	23	29	25	31
	ACTR	22	26	29	22	29	24	32	25	31
	ACTS	21	24	27	21	27	23	29	24	29
	HSGPA	3.31	3.57	3.93	3.38	3.93	3.67	4.00	3.64	4.00
	PT	-19	3	26	-26	17	-3	48	9	46
	DI	-45	-21	2	-43	3	-55	-23	-48	-1

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A3. (continued)

		Semester 1			Semester 8					
		Overall			Non-STEM		STEM-Biological		STEM-Quantitative	
Inst.	Measure	25th Percentile	Mean	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile	25th Percentile	75th Percentile
26	ACTC	23	25	28	23	28	24	29	24	30
	ACTE	22	25	29	22	29	22	29	23	29
	ACTM	23	26	29	23	28	25	29	27	32
	ACTR	22	26	30	22	30	23	30	23	30
	ACTS	22	24	27	21	26	22	28	23	29
	HSGPA	3.65	3.78	4.00	3.67	4.00	3.75	4.00	3.73	4.00
	PT	-28	-6	15	-34	8	-12	26	-3	37
	DI	-29	-6	17	-26	21	-43	-2	-31	9

Note: Inst. = institution; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science; PT = People-Things; DI = Data-Ideas.

Table A4. Estimated Mean Effect Sizes for STEM-Biological—Non-STEM Comparisons for ACT Scores and HSGPAs

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Biological	Non-STEM	ACTC	1	26	103,615	0.35	**0.37**	0.17	**[0.15, 0.58]**
			2	26	94,902	0.38	**0.39**	0.16	**[0.18, 0.60]**
			3	26	80,291	0.41	**0.42**	0.13	**[0.25, 0.59]**
			4	26	75,230	0.44	**0.45**	0.13	**[0.29, 0.62]**
			5	26	67,966	0.46	**0.48**	0.14	**[0.30, 0.65]**
			6	26	64,724	0.49	**0.51**	0.13	**[0.34, 0.67]**
			7	26	61,467	0.50	**0.52**	0.12	**[0.36, 0.68]**
			8	26	59,657	0.52	**0.54**	0.14	**[0.36, 0.71]**
STEM-Biological	Non-STEM	ACTE	1	26	103,615	0.26	**0.28**	0.16	**[0.08, 0.49]**
			2	26	94,902	0.28	**0.30**	0.15	**[0.11, 0.49]**
			3	26	80,291	0.30	**0.33**	0.13	**[0.15, 0.50]**
			4	26	75,230	0.33	**0.35**	0.14	**[0.18, 0.53]**
			5	26	67,966	0.34	**0.37**	0.15	**[0.19, 0.56]**
			6	26	64,724	0.37	**0.40**	0.14	**[0.22, 0.57]**
			7	26	61,467	0.37	**0.40**	0.13	**[0.24, 0.57]**
			8	26	59,657	0.38	**0.41**	0.14	**[0.24, 0.59]**
STEM-Biological	Non-STEM	ACTM	1	26	103,615	0.36	**0.39**	0.16	**[0.19, 0.59]**
			2	26	94,902	0.41	**0.44**	0.15	**[0.24, 0.64]**
			3	26	80,291	0.43	**0.47**	0.13	**[0.30, 0.64]**
			4	26	75,230	0.47	**0.51**	0.11	**[0.36, 0.66]**
			5	26	67,966	0.51	**0.55**	0.12	**[0.40, 0.70]**
			6	26	64,724	0.55	**0.59**	0.11	**[0.45, 0.73]**
			7	26	61,467	0.57	**0.61**	0.12	**[0.45, 0.76]**
			8	26	59,657	0.58	**0.62**	0.13	**[0.45, 0.80]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A4. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Biological	Non-STEM	ACTR	1	26	103,615	0.24	**0.26**	0.16	**[0.05, 0.47]**
			2	26	94,902	0.25	**0.28**	0.15	**[0.08, 0.47]**
			3	26	80,291	0.27	**0.30**	0.12	**[0.15, 0.46]**
			4	26	75,230	0.29	**0.32**	0.13	**[0.15, 0.49]**
			5	26	67,966	0.29	**0.33**	0.14	**[0.15, 0.51]**
			6	26	64,724	0.31	**0.35**	0.14	**[0.17, 0.53]**
			7	26	61,467	0.32	**0.36**	0.12	**[0.20, 0.51]**
			8	26	59,657	0.33	**0.37**	0.13	**[0.20, 0.54]**
STEM-Biological	Non-STEM	ACTS	1	26	103,615	0.35	**0.42**	0.15	**[0.23, 0.61]**
			2	26	94,902	0.37	**0.45**	0.16	**[0.24, 0.65]**
			3	26	80,291	0.39	**0.47**	0.13	**[0.30, 0.63]**
			4	26	75,230	0.42	**0.50**	0.11	**[0.36, 0.65]**
			5	26	67,966	0.44	**0.53**	0.13	**[0.37, 0.69]**
			6	26	64,724	0.46	**0.55**	0.11	**[0.41, 0.70]**
			7	26	61,467	0.48	**0.57**	0.12	**[0.42, 0.72]**
			8	26	59,657	0.49	**0.58**	0.13	**[0.42, 0.75]**
STEM-Biological	Non-STEM	HSGPA	1	26	103,615	0.40	**0.45**	0.14	**[0.27, 0.63]**
			2	26	94,902	0.41	**0.46**	0.13	**[0.29, 0.64]**
			3	26	80,291	0.42	**0.47**	0.13	**[0.30, 0.64]**
			4	26	75,230	0.44	**0.50**	0.11	**[0.36, 0.64]**
			5	26	67,966	0.45	**0.50**	0.12	**[0.35, 0.65]**
			6	26	64,724	0.47	**0.53**	0.12	**[0.37, 0.69]**
			7	26	61,467	0.48	**0.54**	0.13	**[0.37, 0.71]**
			8	26	59,657	0.48	**0.54**	0.14	**[0.35, 0.72]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A5. Estimated Mean Effect Sizes for STEM-Quantitative—Non-STEM Comparisons for ACT Scores and HSGPAs

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	Non-STEM	ACTC	1	26	109,914	0.51	**0.53**	0.19	**[0.29, 0.77]**
			2	26	100,024	0.54	**0.56**	0.19	**[0.32, 0.81]**
			3	26	83,969	0.58	**0.60**	0.19	**[0.35, 0.84]**
			4	26	78,349	0.59	**0.61**	0.19	**[0.37, 0.85]**
			5	26	70,671	0.62	**0.65**	0.18	**[0.42, 0.87]**
			6	26	67,171	0.64	**0.66**	0.17	**[0.44, 0.88]**
			7	26	63,753	0.66	**0.68**	0.17	**[0.46, 0.90]**
			8	26	61,820	0.67	**0.69**	0.17	**[0.47, 0.91]**
STEM-Quantitative	Non-STEM	ACTE	1	26	109,914	0.23	**0.24**	0.15	**[0.05, 0.44]**
			2	26	100,024	0.24	**0.26**	0.16	**[0.06, 0.46]**
			3	26	83,969	0.27	**0.29**	0.16	**[0.07, 0.50]**
			4	26	78,349	0.28	**0.30**	0.17	**[0.07, 0.52]**
			5	26	70,671	0.30	**0.32**	0.16	**[0.12, 0.53]**
			6	26	67,171	0.31	**0.34**	0.16	**[0.14, 0.54]**
			7	26	63,753	0.33	**0.36**	0.15	**[0.17, 0.55]**
			8	26	61,820	0.35	**0.37**	0.15	**[0.18, 0.56]**
STEM-Quantitative	Non-STEM	ACTM	1	26	109,914	0.80	**0.86**	0.21	**[0.58, 1.13]**
			2	26	100,024	0.85	**0.91**	0.21	**[0.64, 1.19]**
			3	26	83,969	0.89	**0.96**	0.20	**[0.70, 1.21]**
			4	26	78,349	0.92	**0.99**	0.19	**[0.74, 1.23]**
			5	26	70,671	0.95	**1.03**	0.18	**[0.80, 1.25]**
			6	26	67,171	0.97	**1.05**	0.18	**[0.81, 1.28]**
			7	26	63,753	0.99	**1.07**	0.17	**[0.85, 1.29]**
			8	26	61,820	1.01	**1.09**	0.17	**[0.87, 1.31]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A5. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	Non-STEM	ACTR	1	26	109,914	0.21	**0.24**	0.16	**[0.03, 0.45]**
			2	26	100,024	0.22	**0.25**	0.16	**[0.04, 0.45]**
			3	26	83,969	0.24	**0.27**	0.17	**[0.06, 0.48]**
			4	26	78,349	0.25	**0.28**	0.17	**[0.06, 0.49]**
			5	26	70,671	0.27	**0.30**	0.16	**[0.10, 0.50]**
			6	26	67,171	0.27	**0.31**	0.15	**[0.12, 0.49]**
			7	26	63,753	0.28	**0.31**	0.16	**[0.11, 0.51]**
			8	26	61,820	0.29	**0.32**	0.16	**[0.12, 0.52]**
STEM-Quantitative	Non-STEM	ACTS	1	26	109,914	0.61	**0.72**	0.18	**[0.49, 0.96]**
			2	26	100,024	0.64	**0.76**	0.19	**[0.51, 1.01]**
			3	26	83,969	0.66	**0.79**	0.18	**[0.56, 1.03]**
			4	26	78,349	0.67	**0.81**	0.17	**[0.58, 1.03]**
			5	26	70,671	0.71	**0.85**	0.16	**[0.65, 1.05]**
			6	26	67,171	0.72	**0.86**	0.16	**[0.66, 1.07]**
			7	26	63,753	0.74	**0.88**	0.16	**[0.68, 1.08]**
			8	26	61,820	0.75	**0.90**	0.16	**[0.69, 1.10]**
STEM-Quantitative	Non-STEM	HSGPA	1	26	109,914	0.26	**0.29**	0.13	**[0.12, 0.45]**
			2	26	100,024	0.27	**0.31**	0.13	**[0.14, 0.47]**
			3	26	83,969	0.31	**0.35**	0.12	**[0.19, 0.51]**
			4	26	78,349	0.31	**0.35**	0.14	**[0.18, 0.53]**
			5	26	70,671	0.34	**0.38**	0.13	**[0.22, 0.55]**
			6	26	67,171	0.36	**0.40**	0.13	**[0.23, 0.57]**
			7	26	63,753	0.37	**0.41**	0.13	**[0.25, 0.58]**
			8	26	61,820	0.38	**0.42**	0.13	**[0.26, 0.59]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A6. Estimated Mean Effect Sizes for STEM-Quantitative—STEM-Biological Comparisons for ACT Scores and HSGPAs

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	STEM-Biological	ACTC	1	26	24,733	0.19	**0.20**	0.13	**[0.03, 0.36]**
			2	26	22,028	0.18	0.18	0.12	[0.03, 0.34]
			3	26	18,434	0.17	0.18	0.09	[0.06, 0.30]
			4	26	16,847	0.16	0.17	0.09	[0.05, 0.29]
			5	26	14,895	0.17	0.18	0.10	[0.05, 0.31]
			6	26	13,947	0.16	0.17	0.11	[0.03, 0.31]
			7	26	12,900	0.17	0.18	0.11	[0.04, 0.31]
			8	26	12,483	0.17	0.18	0.11	[0.04, 0.32]
STEM-Quantitative	STEM-Biological	ACTE	1	26	24,733	-0.01	-0.01	0.10	[-0.14, 0.12]
			2	26	22,028	-0.02	-0.02	0.08	[-0.12, 0.08]
			3	26	18,434	-0.03	-0.03	0.07	[-0.12, 0.06]
			4	26	16,847	-0.04	-0.04	0.07	[-0.13, 0.04]
			5	26	14,895	-0.03	-0.03	0.09	[-0.15, 0.08]
			6	26	13,947	-0.04	-0.04	0.09	[-0.15, 0.07]
			7	26	12,900	-0.03	-0.03	0.08	[-0.13, 0.07]
			8	26	12,483	-0.03	-0.03	0.08	[-0.14, 0.08]
STEM-Quantitative	STEM-Biological	ACTM	1	26	24,733	0.46	**0.49**	0.16	**[0.28, 0.69]**
			2	26	22,028	0.45	**0.48**	0.16	**[0.28, 0.68]**
			3	26	18,434	0.45	**0.49**	0.14	**[0.31, 0.66]**
			4	26	16,847	0.45	**0.48**	0.13	**[0.31, 0.65]**
			5	26	14,895	0.45	**0.49**	0.14	**[0.31, 0.67]**
			6	26	13,947	0.45	**0.48**	0.15	**[0.29, 0.68]**
			7	26	12,900	0.45	**0.49**	0.14	**[0.31, 0.67]**
			8	26	12,483	0.46	**0.50**	0.14	**[0.32, 0.67]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A6. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	STEM-Biological	ACTR	1	26	24,733	0.00	0.00	0.11	[-0.14, 0.14]
			2	26	22,028	-0.02	-0.02	0.11	[-0.15, 0.12]
			3	26	18,434	-0.03	-0.03	0.08	[-0.13, 0.07]
			4	26	16,847	-0.03	-0.04	0.08	[-0.14, 0.07]
			5	26	14,895	-0.02	-0.02	0.09	[-0.14, 0.10]
			6	26	13,947	-0.03	-0.03	0.09	[-0.14, 0.09]
			7	26	12,900	-0.02	-0.03	0.08	[-0.13, 0.08]
			8	26	12,483	-0.03	-0.03	0.09	[-0.14, 0.08]
STEM-Quantitative	STEM-Biological	ACTS	1	26	24,733	0.27	**0.31**	0.12	**[0.16, 0.47]**
			2	26	22,028	0.26	**0.30**	0.11	**[0.17, 0.44]**
			3	26	18,434	0.26	**0.30**	0.06	**[0.23, 0.37]**
			4	26	16,847	0.25	**0.29**	0.05	**[0.22, 0.36]**
			5	26	14,895	0.27	**0.31**	0.04	**[0.26, 0.36]**
			6	26	13,947	0.26	**0.30**	0.05	**[0.24, 0.36]**
			7	26	12,900	0.26	**0.31**	0.08	**[0.21, 0.40]**
			8	26	12,483	0.27	**0.31**	0.07	**[0.22, 0.41]**
STEM-Quantitative	STEM-Biological	HSGPA	1	26	24,733	-0.14	-0.15	0.11	[-0.29, -0.01]
			2	26	22,028	-0.14	-0.15	0.10	[-0.28, -0.03]
			3	26	18,434	-0.13	-0.14	0.09	[-0.26, -0.03]
			4	26	16,847	-0.15	-0.16	0.10	[-0.29, -0.03]
			5	26	14,895	-0.12	-0.14	0.08	[-0.24, -0.04]
			6	26	13,947	-0.13	-0.15	0.10	[-0.28, -0.02]
			7	26	12,900	-0.13	-0.15	0.10	[-0.27, -0.02]
			8	26	12,483	-0.12	-0.14	0.10	[-0.26, -0.01]

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero. *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size; ACTC = ACT Composite; ACTE = ACT English; ACTM = ACT mathematics; ACTR = ACT reading; ACTS = ACT science.

Table A7. Estimated Mean Effect Sizes for STEM-Biological—Non-STEM Comparisons for ACT Interest Inventory Scores and Calculated Work Task Dimension Scores

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Biological	Non-STEM	Science & Technology	1	26	103,615	0.88	**0.93**	0.18	**[0.69, 1.16]**
			2	26	94,902	0.87	**0.91**	0.15	**[0.72, 1.11]**
			3	26	80,291	0.85	**0.89**	0.15	**[0.70, 1.08]**
			4	26	75,230	0.87	**0.91**	0.14	**[0.72, 1.09]**
			5	26	67,966	0.88	**0.92**	0.12	**[0.76, 1.08]**
			6	26	64,724	0.88	**0.92**	0.11	**[0.78, 1.07]**
			7	26	61,467	0.90	**0.94**	0.11	**[0.79, 1.08]**
			8	26	59,657	0.89	**0.94**	0.10	**[0.80, 1.07]**
STEM-Biological	Non-STEM	Arts	1	26	103,615	-0.13	-0.14	0.05	[-0.21, -0.08]
			2	26	94,902	-0.13	-0.14	0.06	[-0.22, -0.06]
			3	26	80,291	-0.11	-0.11	0.05	[-0.18, -0.05]
			4	26	75,230	-0.10	-0.11	0.07	[-0.20, -0.02]
			5	26	67,966	-0.10	-0.10	0.08	[-0.21, 0.00]
			6	26	64,724	-0.09	-0.10	0.08	[-0.20, 0.00]
			7	26	61,467	-0.10	-0.10	0.10	[-0.23, 0.03]
			8	26	59,657	-0.10	-0.11	0.10	[-0.23, 0.02]
STEM-Biological	Non-STEM	Social Service	1	26	103,615	0.02	0.02	0.05	[-0.04, 0.08]
			2	26	94,902	0.00	0.00	0.06	[-0.08, 0.08]
			3	26	80,291	0.00	0.00	0.07	[-0.09, 0.09]
			4	26	75,230	0.00	0.00	0.05	[-0.06, 0.06]
			5	26	67,966	0.00	0.00	0.05	[-0.06, 0.07]
			6	26	64,724	0.00	0.00	0.05	[-0.06, 0.06]
			7	26	61,467	-0.02	-0.02	0.05	[-0.09, 0.05]
			8	26	59,657	-0.02	-0.03	0.06	[-0.11, 0.06]
STEM-Biological	Non-STEM	Business Operations	1	26	103,615	-0.11	-0.11	0.07	[-0.20, -0.02]
			2	26	94,902	-0.10	-0.10	0.06	[-0.18, -0.03]
			3	26	80,291	-0.11	-0.11	0.07	[-0.20, -0.02]
			4	26	75,230	-0.09	-0.09	0.06	[-0.17, -0.01]
			5	26	67,966	-0.09	-0.10	0.06	[-0.17, -0.02]
			6	26	64,724	-0.08	-0.08	0.04	[-0.14, -0.03]
			7	26	61,467	-0.08	-0.09	0.00	[-0.09, -0.09]
			8	26	59,657	-0.08	-0.09	0.00	[-0.09, -0.08]

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

Table A7. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Biological	Non-STEM	Administration & Sales	1	26	103,615	-0.27	**-0.28**	0.10	**[-0.40, -0.16]**
			2	26	94,902	-0.28	**-0.30**	0.09	**[-0.42, -0.19]**
			3	26	80,291	-0.30	**-0.32**	0.10	**[-0.45, -0.19]**
			4	26	75,230	-0.29	**-0.31**	0.09	**[-0.42, -0.20]**
			5	26	67,966	-0.30	**-0.32**	0.07	**[-0.41, -0.23]**
			6	26	64,724	-0.30	**-0.32**	0.06	**[-0.40, -0.25]**
			7	26	61,467	-0.32	**-0.34**	0.07	**[-0.43, -0.25]**
			8	26	59,657	-0.32	**-0.34**	0.07	**[-0.44, -0.25]**
STEM-Biological	Non-STEM	Technical	1	26	103,615	0.06	0.06	0.06	[-0.01, 0.13]
			2	26	94,902	0.07	0.08	0.07	[-0.01, 0.16]
			3	26	80,291	0.09	0.10	0.03	[0.06, 0.14]
			4	26	75,230	0.10	0.11	0.04	[0.06, 0.17]
			5	26	67,966	0.11	0.12	0.04	[0.07, 0.18]
			6	26	64,724	0.12	0.13	0.03	[0.09, 0.17]
			7	26	61,467	0.12	0.13	0.03	[0.09, 0.16]
			8	26	59,657	0.12	0.13	0.00	[0.13, 0.13]
STEM-Biological	Non-STEM	People-Things	1	26	103,615	0.36	**0.36**	0.11	**[0.22, 0.49]**
			2	26	94,902	0.38	**0.38**	0.11	**[0.24, 0.52]**
			3	26	80,291	0.38	**0.38**	0.11	**[0.24, 0.53]**
			4	26	75,230	0.40	**0.40**	0.10	**[0.27, 0.52]**
			5	26	67,966	0.40	**0.40**	0.11	**[0.27, 0.54]**
			6	26	64,724	0.41	**0.41**	0.10	**[0.28, 0.55]**
			7	26	61,467	0.43	**0.43**	0.11	**[0.29, 0.57]**
			8	26	59,657	0.44	**0.44**	0.10	**[0.32, 0.56]**
STEM-Biological	Non-STEM	Data-Ideas	1	26	103,615	-0.51	**-0.51**	0.13	**[-0.67, -0.35]**
			2	26	94,902	-0.52	**-0.52**	0.11	**[-0.66, -0.37]**
			3	26	80,291	-0.52	**-0.52**	0.12	**[-0.68, -0.37]**
			4	26	75,230	-0.52	**-0.52**	0.12	**[-0.67, -0.36]**
			5	26	67,966	-0.54	**-0.54**	0.10	**[-0.67, -0.40]**
			6	26	64,724	-0.53	**-0.53**	0.09	**[-0.65, -0.42]**
			7	26	61,467	-0.55	**-0.55**	0.10	**[-0.67, -0.43]**
			8	26	59,657	-0.55	**-0.55**	0.10	**[-0.68, -0.42]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

Table A8. Estimated Mean Effect Sizes for STEM-Quantitative—Non-STEM Comparisons for ACT Interest Inventory Scores and Calculated Work Task Dimension Scores

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	Non-STEM	Science & Technology	1	26	109,914	0.48	**0.51**	0.09	[0.39, 0.63]
			2	26	100,024	0.49	**0.51**	0.09	[0.40, 0.63]
			3	26	83,969	0.50	**0.52**	0.09	[0.40, 0.64]
			4	26	78,349	0.50	**0.52**	0.10	[0.40, 0.64]
			5	26	70,671	0.51	**0.53**	0.08	[0.42, 0.63]
			6	26	67,171	0.51	**0.53**	0.08	[0.42, 0.64]
			7	26	63,753	0.52	**0.54**	0.09	[0.42, 0.66]
			8	26	61,820	0.52	**0.54**	0.09	[0.43, 0.65]
STEM-Quantitative	Non-STEM	Arts	1	26	109,914	-0.12	-0.13	0.10	[-0.26, -0.00]
			2	26	100,024	-0.13	-0.14	0.08	[-0.25, -0.04]
			3	26	83,969	-0.15	-0.16	0.07	[-0.24, -0.07]
			4	26	78,349	-0.14	-0.15	0.07	[-0.24, -0.06]
			5	26	70,671	-0.13	-0.14	0.07	[-0.23, -0.05]
			6	26	67,171	-0.13	-0.14	0.06	[-0.21, -0.06]
			7	26	63,753	-0.12	-0.13	0.05	[-0.20, -0.06]
			8	26	61,820	-0.12	-0.13	0.05	[-0.20, -0.06]
STEM-Quantitative	Non-STEM	Social Service	1	26	109,914	-0.25	**-0.27**	0.07	**[-0.37, -0.17]**
			2	26	100,024	-0.26	**-0.28**	0.06	**[-0.35, -0.21]**
			3	26	83,969	-0.27	**-0.29**	0.04	**[-0.34, -0.24]**
			4	26	78,349	-0.28	**-0.31**	0.05	**[-0.37, -0.24]**
			5	26	70,671	-0.29	**-0.31**	0.04	**[-0.36, -0.26]**
			6	26	67,171	-0.30	**-0.32**	0.04	**[-0.37, -0.27]**
			7	26	63,753	-0.30	**-0.33**	0.05	**[-0.39, -0.26]**
			8	26	61,820	-0.31	**-0.33**	0.06	**[-0.40, -0.26]**
STEM-Quantitative	Non-STEM	Business Operations	1	26	109,914	0.21	**0.22**	0.05	[0.15, 0.29]
			2	26	100,024	0.22	**0.23**	0.06	[0.15, 0.30]
			3	26	83,969	0.23	**0.24**	0.07	[0.15, 0.32]
			4	26	78,349	0.22	**0.23**	0.07	[0.14, 0.32]
			5	26	70,671	0.23	**0.24**	0.08	[0.13, 0.34]
			6	26	67,171	0.22	**0.23**	0.08	[0.13, 0.33]
			7	26	63,753	0.22	**0.23**	0.08	[0.13, 0.33]
			8	26	61,820	0.22	**0.23**	0.07	[0.14, 0.32]

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

Table A8. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	Non-STEM	Administration & Sales	1	26	109,914	-0.22	**-0.23**	0.08	**[-0.34, -0.13]**
			2	26	100,024	-0.23	**-0.25**	0.09	**[-0.36, -0.13]**
			3	26	83,969	-0.25	**-0.27**	0.09	**[-0.39, -0.15]**
			4	26	78,349	-0.26	**-0.28**	0.10	**[-0.41, -0.16]**
			5	26	70,671	-0.27	**-0.29**	0.07	**[-0.38, -0.20]**
			6	26	67,171	-0.28	**-0.30**	0.06	**[-0.38, -0.22]**
			7	26	63,753	-0.28	**-0.30**	0.07	**[-0.39, -0.22]**
			8	26	61,820	-0.29	**-0.31**	0.06	**[-0.38, -0.23]**
STEM-Quantitative	Non-STEM	Technical	1	26	109,914	0.44	**0.47**	0.14	**[0.29, 0.66]**
			2	26	100,024	0.45	**0.47**	0.15	**[0.28, 0.66]**
			3	26	83,969	0.45	**0.48**	0.14	**[0.30, 0.67]**
			4	26	78,349	0.46	**0.49**	0.14	**[0.31, 0.68]**
			5	26	70,671	0.48	**0.51**	0.13	**[0.34, 0.68]**
			6	26	67,171	0.47	**0.50**	0.13	**[0.33, 0.67]**
			7	26	63,753	0.48	**0.51**	0.12	**[0.36, 0.66]**
			8	26	61,820	0.48	**0.51**	0.11	**[0.37, 0.65]**
STEM-Quantitative	Non-STEM	People-Things	1	26	109,914	0.73	**0.73**	0.12	**[0.58, 0.88]**
			2	26	100,024	0.75	**0.75**	0.12	**[0.60, 0.90]**
			3	26	83,969	0.77	**0.77**	0.11	**[0.62, 0.92]**
			4	26	78,349	0.79	**0.79**	0.11	**[0.64, 0.93]**
			5	26	70,671	0.80	**0.80**	0.10	**[0.67, 0.93]**
			6	26	67,171	0.81	**0.81**	0.10	**[0.68, 0.93]**
			7	26	63,753	0.81	**0.81**	0.10	**[0.68, 0.94]**
			8	26	61,820	0.81	**0.81**	0.10	**[0.69, 0.94]**
STEM-Quantitative	Non-STEM	Data-Ideas	1	26	109,914	-0.17	-0.17	0.06	[-0.25, -0.10]
			2	26	100,024	-0.17	-0.17	0.06	[-0.25, -0.10]
			3	26	83,969	-0.18	-0.18	0.06	[-0.25, -0.10]
			4	26	78,349	-0.19	-0.19	0.06	[-0.27, -0.11]
			5	26	70,671	-0.20	**-0.20**	0.03	**[-0.24, -0.15]**
			6	26	67,171	-0.21	**-0.21**	0.04	**[-0.26, -0.16]**
			7	26	63,753	-0.21	**-0.21**	0.06	**[-0.29, -0.14]**
			8	26	61,820	-0.22	**-0.22**	0.06	**[-0.29, -0.15]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

Table A9. Estimated Mean Effect Sizes for STEM-Quantitative—STEM-Biological Comparisons for ACT Interest Inventory Scores and Calculated Work Task Dimension Scores

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	STEM-Biological	Science & Technology	1	26	24,733	-0.40	**-0.42**	0.15	**[-0.61, -0.22]**
			2	26	22,028	-0.39	**-0.40**	0.14	**[-0.58, -0.22]**
			3	26	18,434	-0.37	**-0.39**	0.15	**[-0.58, -0.20]**
			4	26	16,847	-0.39	**-0.40**	0.16	**[-0.61, -0.20]**
			5	26	14,895	-0.39	**-0.41**	0.16	**[-0.62, -0.20]**
			6	26	13,947	-0.39	**-0.41**	0.15	**[-0.61, -0.22]**
			7	26	12,900	-0.39	**-0.41**	0.14	**[-0.59, -0.23]**
			8	26	12,483	-0.39	**-0.40**	0.13	**[-0.58, -0.23]**
STEM-Quantitative	STEM-Biological	Arts	1	26	24,733	0.00	0.00	0.05	[-0.07, 0.07]
			2	26	22,028	-0.01	-0.01	0.05	[-0.08, 0.06]
			3	26	18,434	-0.04	-0.04	0.05	[-0.11, 0.02]
			4	26	16,847	-0.05	-0.05	0.05	[-0.11, 0.01]
			5	26	14,895	-0.05	-0.05	0.07	[-0.14, 0.04]
			6	26	13,947	-0.04	-0.05	0.06	[-0.12, 0.03]
			7	26	12,900	-0.04	-0.04	0.07	[-0.12, 0.05]
			8	26	12,483	-0.03	-0.03	0.07	[-0.12, 0.05]
STEM-Quantitative	STEM-Biological	Social Service	1	26	24,733	-0.28	**-0.30**	0.06	**[-0.39, -0.22]**
			2	26	22,028	-0.28	**-0.30**	0.08	**[-0.40, -0.20]**
			3	26	18,434	-0.28	**-0.30**	0.08	**[-0.41, -0.20]**
			4	26	16,847	-0.29	**-0.32**	0.07	**[-0.40, -0.23]**
			5	26	14,895	-0.30	**-0.32**	0.06	**[-0.40, -0.24]**
			6	26	13,947	-0.30	**-0.33**	0.06	**[-0.40, -0.25]**
			7	26	12,900	-0.29	**-0.31**	0.07	**[-0.40, -0.23]**
			8	26	12,483	-0.29	**-0.31**	0.07	**[-0.41, -0.22]**
STEM-Quantitative	STEM-Biological	Business Operations	1	26	24,733	0.31	**0.33**	0.06	**[0.26, 0.40]**
			2	26	22,028	0.32	**0.33**	0.06	**[0.26, 0.40]**
			3	26	18,434	0.32	**0.34**	0.09	**[0.23, 0.45]**
			4	26	16,847	0.30	**0.32**	0.09	**[0.21, 0.43]**
			5	26	14,895	0.31	**0.32**	0.07	**[0.23, 0.42]**
			6	26	13,947	0.29	**0.31**	0.06	**[0.24, 0.38]**
			7	26	12,900	0.31	**0.32**	0.03	**[0.28, 0.36]**
			8	26	12,483	0.30	**0.32**	0.00	**[0.32, 0.32]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

Table A9. (continued)

Group 1	Group 2	Variable	Semester	*k*	*N*	*d*	δ	*SD*δ	80% CrI
STEM-Quantitative	STEM-Biological	Administration & Sales	1	26	24,733	0.04	0.04	0.03	[0.00, 0.08]
			2	26	22,028	0.04	0.05	0.04	[-0.01, 0.10]
			3	26	18,434	0.03	0.03	0.06	[-0.05, 0.11]
			4	26	16,847	0.02	0.02	0.06	[-0.06, 0.09]
			5	26	14,895	0.02	0.02	0.00	[0.02, 0.02]
			6	26	13,947	0.02	0.02	0.00	[0.02, 0.02]
			7	26	12,900	0.03	0.03	0.04	[-0.02, 0.09]
			8	26	12,483	0.03	0.03	0.05	[-0.03, 0.10]
STEM-Quantitative	STEM-Biological	Technical	1	26	24,733	0.38	**0.41**	0.09	**[0.29, 0.53]**
			2	26	22,028	0.37	**0.40**	0.10	**[0.27, 0.52]**
			3	26	18,434	0.35	**0.37**	0.10	**[0.25, 0.50]**
			4	26	16,847	0.35	**0.37**	0.10	**[0.24, 0.50]**
			5	26	14,895	0.34	**0.37**	0.10	**[0.24, 0.49]**
			6	26	13,947	0.34	**0.36**	0.09	**[0.24, 0.48]**
			7	26	12,900	0.35	**0.37**	0.09	**[0.25, 0.49]**
			8	26	12,483	0.35	**0.37**	0.08	**[0.27, 0.47]**
STEM-Quantitative	STEM-Biological	People-Things	1	26	24,733	0.41	**0.41**	0.08	**[0.30, 0.51]**
			2	26	22,028	0.40	**0.40**	0.08	**[0.30, 0.50]**
			3	26	18,434	0.41	**0.41**	0.06	**[0.34, 0.48]**
			4	26	16,847	0.41	**0.41**	0.06	**[0.33, 0.49]**
			5	26	14,895	0.41	**0.41**	0.05	**[0.34, 0.48]**
			6	26	13,947	0.41	**0.41**	0.06	**[0.33, 0.48]**
			7	26	12,900	0.40	**0.40**	0.09	**[0.29, 0.51]**
			8	26	12,483	0.40	**0.40**	0.07	**[0.31, 0.49]**
STEM-Quantitative	STEM-Biological	Data-Ideas	1	26	24,733	0.36	**0.36**	0.11	**[0.22, 0.50]**
			2	26	22,028	0.36	**0.36**	0.09	**[0.24, 0.47]**
			3	26	18,434	0.36	**0.37**	0.10	**[0.23, 0.50]**
			4	26	16,847	0.35	**0.35**	0.11	**[0.21, 0.50]**
			5	26	14,895	0.36	**0.36**	0.11	**[0.23, 0.50]**
			6	26	13,947	0.35	**0.35**	0.10	**[0.23, 0.48]**
			7	26	12,900	0.36	**0.36**	0.11	**[0.22, 0.51]**
			8	26	12,483	0.36	**0.36**	0.12	**[0.20, 0.52]**

Note: **Bold** indicates that the estimated mean effect size (δ) exceeds |0.20| and the credibility interval (CrI) does not contain zero.; *k* = number of institutional studies; *SD*δ = standard deviation of estimated mean effect size.

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