

IMPACT OF HIGH SCHOOL STUDENTS' COURSEWORK ON THEIR ACT SCORES

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ABSTRACT—Student level data were used in this study to examine the relationship between student performance on ACT Mathematics and course-taking in mathematics. The purpose is to tease out earlier achievement, coursework and later achievement. In order to achieve the objective, students' ninth grade ITED Mathematics results four years prior were used as a baseline measure to control for achievement levels and subsequent course-taking patterns were assessed to determine the impact on ACT scores. An effort was made to study the education opportunities and outcomes of students from different subgroups and schools in different sizes. The results support that higher level mathematics courses taken has a strong impact on ACT Mathematics scores for all students in study across all achievement levels.

INTRODUCTION—The relationship between student coursework and achievement has been a common topic for educators, test developers and researchers for a half century. Studies show positive correlation between students' courses taken in certain subject areas and their later performance on achievement tests (Covanagh, 2007; Sawyer et al., 1988) and positive correlation between number of courses a student takes in the relevant area and student's achievement scores (Laing et al., 1987). In addition, some studies have focused on the relationships between advanced course taken and students' performance (Rock, 1995; Wang and Snyder, 2006) and the findings are: students who take the higher level courses show greater gains in mathematics and science. Some researchers also pay attention on impact of rigorous courses on performance for students in subgroups (Coley, 1999; Dervarics, 2005). The studies show that African American and low-income students can succeed in rigorous courses, but too few get the opportunity. As these studies grow, the data available and possible questions for further investigation also increase. One of the specific questions is: are high achievers more likely to take higher level courses and/or more courses or students in all achievement levels can gain test scores from the more higher level courses taken.

The purposes of this research are: 1) to examine the relationship between students' performance on the ACT assessment and their high school courses taken, 2) to compare education opportunities and outcomes for students from different demographic subgroups and from schools/districts in different enrollment sizes, and 3) to see the impact of students' course taken on their later outcomes for students in all achievement levels by controlling for students' pre-course taken achievement. This study examines one particular content area, mathematics, in order to provide a specific example of how coursework

impacts long term college readiness and career readiness. The study questions are as follows: 1) Are taking higher level mathematics (HLM) courses more beneficial for the students who had high Iowa Tests of Educational Development (ITED) Mathematics scores to begin with? 2) Does taking HLM courses lead to a higher ACT Mathematics score for all students? 3) Are the same educational opportunities and outcomes for students who are in different demographic subgroups? Moreover, are the same educational opportunities and outcomes for students in small schools/districts compared to those for their peers in larger schools/districts?

SIGNIFICANCES OF THIS STUDY—

Education Policy: Several new education policy initiatives supporting more rigorous curriculum requirements will have an impact on students. For example, Iowa Governor Chet Culver signed Senate File 2216 into law in May of 2008 which requires the full implementation of the Iowa Core Curriculum between July 2010 and 2014-2015. The Iowa Core Curriculum will focus on the areas of literacy, mathematics, science, social studies, and 21st century skills. Most recently, Governor Culver and Iowa Department of Education Director Judy Jeffrey have joined the 49 states in Common Core State Standards Initiative which is committed to the development of a common core of state standards in English-language arts and mathematics for grades K -12. At the National Academy of Sciences Annual Meeting in April of 2009, President Barack Obama made a remark to encourage students to consider careers in science and mathematics and engineering “because our future depends on it.” Lastly, the recent blueprint for re-authorization of Elementary and Secondary Education Act (ESEA) would require all students to be college or career ready by 2020. The ACT has been widely used as a tool for measuring college readiness.

The study provides sound evidence of the link between students’ coursework and their achievement and it supports these new education policy initiatives that encourage schools to offer more rigorous curriculum, and to encourage more students to take higher level courses. Further, this study can be used in order to gauge overall preparedness for post-secondary success. The study results can be shared with parents, general public, educators and policymakers to support high school students’ success.

Education Opportunities and Outcomes: This study examines student demographic differences and the role of coursework and early test scores in predicting subsequent achievement. Student’s eligibility to receive free or reduced-price lunch was used as a measurement for socioeconomic differences. This study focuses on whether the same education opportunities are provided for free or reduced-price lunch eligible students compared to other students and whether the free or reduced-price lunch eligible students have the same outcomes compared to other students. The study applies the same efforts to examine education opportunities and outcomes for students in different racial/ethnic groups. Students in Iowa attend schools and districts of different enrollment sizes that range from 100 to over 31,000 students for a district and vary from 25 to over 2,500 students for a high school. This study evaluates the role of school/district size in determining education opportunities and outcomes. The research results will provide valuable information to educators and policymakers on issues regarding school size and district re-organization. Previous studies have shown a positive correlation between students’ test outcomes and

their coursework. However, there was lack of the effort and evidence to answer the basic question regarding the correlation: are high test scores the result of higher level courses taken by a student or the result of student's achievement level attained prior to taking higher level courses? In other words, are only past high achievers more likely to take higher level courses and do well on future achievement tests? By controlling ITED Mathematics scores attained prior to taking higher level courses, this study will provide an answer to the fundamental question: does taking higher level mathematics courses only benefit students who had high ITED Mathematics scores to begin with or do these courses benefit to all students regardless of their achievement levels prior taking the higher level courses.

METHODS—

Data Sources: Over 19,000 seniors in 2007-2008 who were enrolled in an Iowa public school from 2004-2005 to 2007-2008 and took ACT in grades eleven or twelve were included in this study. Approximately 150 students in this graduating class who took ACT in grades seven to ten were eliminated from the analyses because a student would have only taken a partial set of courses before taking ACT.

ACT provided the assessment scores for the graduating class of 2008. This data set included a self-reported courses-taken core status. Students' background information and four years of school-reported courses-taken were available from the Iowa Department of Education student-level data collections through Project EASIER. The ITED Mathematics National Percentile Rank (NPR) and National Standard Scores (NSS) four years prior for the graduating class 2008 were available from Iowa Testing Programs. Students included in the study took the ITED Mathematics when they were in ninth grade, but because Iowa does not require ninth graders to take ITED, only 16,000 of the 19,000 ACT test-takers (or 84.2 percent) took ITED Mathematics in 2004-2005. After matching student records from the three data sources, over 16,000 students remained in the study.

Students and Variables—

Test Scores: The ACT Mathematics score for each student was the outcome variable in this study. The ACT scores range from 1 to 36. A z-score was created using the student's ITED Mathematics Standard Score with 0 as the mean and 1 as the standard deviation. The ITED can be administered between September and May each year. Three separate norms are used for each of the test periods (fall, mid-year and spring) to yield standard scores. The converted z-score makes it possible to pool the scores from the three periods together. The ITED Mathematics z-score was used as one of the predictors in the regression models. The ITED Mathematics NPR scores were used as baseline performance to control student pre course-taken achievement levels. The ITED has five achievement levels: Low or below proficient (NPR scores less than 41); Low-Intermediate (NPR scores between 41 and 75); High-Intermediate (NPR scores between 76 and 89); Low-High (NPR scores between 90 and 94); and High-High (NPR scores between 95 and 99).

Courses Taken: The higher level mathematics courses included in this study were Pre-Calculus, Calculus, Advanced Placement (AP) Calculus, Trigonometry, and AP Statistics. In the regression analyses, the scale for HLM courses taken was coded in a range of 0 to 4: '0' indicates that a student took no higher level mathematics courses; '1' indicates that a student began taking HLM courses in grade 12; '2' indicates that a student began taking HLM courses in grade 11; '3' indicates that a student began taking HLM courses in grade 10; and '4' indicates that a student began taking HLM courses in ninth grade. Therefore, a higher value of HLM means that not only did a student take HLM courses early, but also that the student had the opportunities to take more HLM courses. In the descriptive statistics, the HLM courses taken pattern was coded as '0' and '1': '0' indicates that a student took no higher level mathematics courses and '1' indicates that a student took at least one HLM course. Algebra II taken was defined as a separate indicator in this study. The scale for taking Algebra II was also from 0 to 4. '0' indicates no Algebra II was taken and '4' indicates that a student took the course in grade nine. One additional coursework variable used in the study was student self-reported core (value 1) and less than core (value 0) status. ACT defines high school consisting of four or more years of English and three or more years of mathematics, science and social studies each as core.

Students' Demographic Characteristics: The following student demographic variables were used as predictor variables in regression analyses: gender ('1' for males and '0' for females), race/ethnicity, free or reduced price lunch eligibility ('1' for eligible and '0' for not eligible), status of Limited English Proficient (LEP, '1' for LEP and '0' for not LEP), and student disability status (determined by Individual Education Plan/Program-IEP, '1' for IEP and '0' for not IEP). Race/ethnicity was coded as a dummy variable in the study where '1' indicates an African American, American Indian and Hispanic and '0' indicates Asian and White.

District Size: Districts' certified enrollments in 2007-2008 were entered in regression models as one of the main effect predictors. To examine the interaction effect between HLM courses taken and enrollment, size categories were created as follows: Size '1' indicates a district enrollment less than 300, '2' for enrollment in a range of 300 to 599, '3' for enrollment between 600 and 999, '4' for enrollment between 1,000 and 2,499, '5' for enrollment between 2,500 and 7,499, and '6' for enrollment as 7,500 or more. Since the main effect predictor of HLM courses taken is in a scale of 0 to 4 and enrollment size is from 1 to 6, the interaction of HLM and enrollment size combined can be 0 to 24.

Students in the Study: Over 16,000 student records included in the study had valid ACT Mathematics and ITED Mathematics scores. Among them, about 100 students (or less than 1 percent) did not have race/ethnicity codes. More than 2,000 ACT test-takers (less than 13 percent) did not report their core status.

Data Analyses—

Simple and Multiple Regression: The ACT Mathematics score was the outcome (dependent) variable in all of the simple and multiple regression models. The main effect predictors included: ITED Mathematics z-score as a measure of prior achievement; five

student demographic variables: gender, race/ethnicity, LEP, IEP and free or reduced price lunch eligibility; three coursework variables: ACT core status, Algebra II taken and HLM courses taken; and district enrollment. First, as many as 10 independent variables were paired with ACT Mathematics score one by one in order to examine the correlation between each predictor variable with the outcome variable and to determine the contribution from each predictor variable to ACT Mathematics scores. The study reports all potential models with a predictor's p value from $P < .001$ to $P < .0001$. Second, some multiple regressions were applied to include all possible combinations of two or more predictor variables. The early multiple regressions were applied to two predictors and the later regressions included six or seven main effect predictors. To compare models, the author reports coefficient of multiple determination criterion (R-Square) and adjusted coefficient of multiple determination criterion (Adj R-Square) for each model and p value for each of the predictors. All the simple and multiple regression models were pursued to examine the contributions of predictor variable or combined predictor variables to predict the dependent variable - ACT Mathematics scores.

Some descriptive statistics and effect size analyses were used to compare the average scores of ACT Mathematics and the variances between the students who took higher level mathematics courses to the students who didn't. Also, similar analyses were used to examine the relationships between student ACT scores by student free or reduced-price lunch status. Students' achievement levels attained prior to take higher level courses and defined by ITED (Low/below proficient, Low-intermediate, High-intermediate, Low-high, and High-high) were controlled for all students to ascertain the impact of the courses taken on student outcome scores on ACT Mathematics.

RESULTS AND DISCUSSION—About 60 percent of the Iowa high school graduates took ACT during their junior or senior years. Because this study is restricted to the graduates who took ACT, it contains less information about the graduates who did not take ACT. The percent of the ACT test-takers who took higher level mathematics was much higher (over 62 percent) than the percent of Non-ACT test-takers who took HLM (over 15 percent, see Table 1). Generally speaking, the ACT test-takers are higher achievers in high school and most of them will pursue postsecondary education. It is also likely that the students in this study would perform relatively better than those not in the study on an end-of-school test if such a test existed for all high school graduates. Because of the nature of the ACT test-takers, it may lower the R-Square values in regressions between the outcome and predictor variables and lower the effect sizes between HLM courses taken and non-HLM courses taken groups on their outcome scores. More specifically, the minimum ACT Mathematics score for the students in this study was 11. If all Iowa graduates took ACT, the score range could be 1 to 36 instead of 11 to 36. Table 2 presents a similar result for students took ACT and those who didn't. The majority of the ACT test-takers had ITED Mathematics NPR scores above proficient. Overall, only less than 3 percent of the students who took ACT and had an ITED Mathematics NPR score below 41 (Low achievement level). About 18 percent of the students did not take ACT and had a pre course achievement level in Low and another 18.7 percent of the students did not take ACT were in Low-Intermediate ITED Mathematics achievement level.

TABLE 1—Percent of Students That Took At Least One Higher Level Mathematics Course

Achievement Level	Students with ACT Scores	Students without ACT Scores	Students in Graduating Class of 2008
Percent of Students with Higher Level Mathematics	62.11%	15.3%	37.1%

Source: Iowa Department of Education.

TABLE 2—Distributions of Pre-Coursework Achievement Levels for Students Who Took ACT vs. Students Who Did Not

	ITED Mathematics Achievement Level					ITED
	<41	41-75	76-89	90-94	95-99	NA
Number Students Took ACT Later	1,053	5,375	4,355	2,527	2,728	3,090
Percent for Students with ACT Scores	2.6%	13.1%	10.6%	6.2%	6.6%	7.5%
Number Students that Didn't Take ACT	7,258	7,679	2,437	843	656	3,071
Percent for Students w/o ACT Scores	17.7%	18.7%	5.9%	2.0%	1.6%	7.5%

Notes: Figures in RED indicate the students in the current study. Most students in the study took ACT in their junior or senior years - between 2006-2007 and 2007-2008.

Simple and Multiple Regressions: Table 3 reports the models where the predictor had a p value less than .001 (most of them had $P < .0001$). District enrollment is included even though the p value was .0137 in a simple regression. District enrollment was kept because this predictor variable provides a significant contribution in the multiple regressions. Overall, ITED Mathematics z-score, the pre coursework test score, was the largest contributor to ACT Mathematics in all the models shown. Higher level mathematics courses taken had the second greatest impact on ACT Mathematics scores, and were followed by two other coursework predictors, the Algebra II taken and the ACT core status. The other significant main effect predictors were student demographic variables: gender, free or reduced lunch eligibility, race/ethnicity, and LEP status. The R-Square was .5323 when examining the ITED Mathematics z-score as the single predictor of later achievement. The R-Square was .3345 when higher level mathematics courses taken was used alone to predict ACT Mathematics. However, when ITED z-score and HLM courses taken are combined to predict ACT scores, the R-Square increased to .5956.

TABLE 3—Simple and Multiple Regressions with ACT Mathematics as Dependent Variables

Independent Variables	Model DF	Error DF	MSE	R-Sq	Adj R-Sq	P
ITED_Mathematics Z Score	1	16036	10.90	0.5323	0.5323	<.0001
HLM (0-4)	1	16036	15.51	0.3345	0.3344	<.0001
Algebra_II (0-4)	1	16036	19.96	0.1435	0.1434	<.0001
ACT_Core (Core=1, NonCore=0)	1	13960	21.70	0.0609	0.0608	<.0001
Gender (Male=1, Female=0)	1	16036	22.71	0.0252	0.0252	<.0001
Free/Reduced Price Lunch	1	16036	22.86	0.0192	0.0191	<.0001
Race/Ethnicity (B/H/ I=1; A/W=0)	1	15928	22.89	0.0176	0.0176	<.0001
LEP (LEP=1, Non-LEP=0)	1	16036	23.24	0.0027	0.0026	<.0001
District Enrollment	1	15929	23.29	0.0004	0.0003	0.0137

Independent Variables	Model DF	Error DF	MSE	R-Sq	Adj R-Sq	P
ITED_M, HLM	2	16035	9.42	0.5956	0.5956	<.0001
ITED_M, Alg_II	2	16035	10.64	0.5432	0.5432	<.0001
ITED_M, Gender	2	16035	10.76	0.5381	0.5380	<.0001
ITED_M, ACT_Core	2	13959	10.69	0.5374	0.5374	<.0001
ITED_M, District Enrollment	2	15927	10.83	0.5353	0.5353	<.0001
ITED_M, F/R	2	16035	10.84	0.5346	0.5345	<.0001
HLM, ACT_Core	2	13959	14.99	0.3514	0.3513	<.0001

Independent Variables	Model DF	Error DF	MSE	R-Sq	Adj R-Sq	Parameter Est	P
ITED_M, HLM, F/R, Race, Gender, ACT_Core, District Enrollment	7	13867	9.12	0.6052	0.6050		<.0001
Intercept						19.6693	<.0001
ITED_M						2.7269	<.0001
HLM						1.3222	<.0001
F/R						-0.3995	<.0001
Race						-0.5274	0.0007
Gender						0.7976	<.0001
ACT_Core						0.7640	<.0001
District Enrollment						0.00002777	<.0001

Table 3 also shows the result of the multiple-regression model with seven main effect predictors. The R-Square was .6052 when ITED z-score, HLM courses taken, gender, free or reduced lunch eligibility, race/ethnicity, ACT core and district enrollment were all in the model.

Results in Table 3 demonstrates that almost 60 percent of the ACT Mathematics score variance was shared with the combination of the ITED z-score and HLM courses taken, the shared variance went up less than 1 percent when the other five predictors were added in a multiple regression model.

Figure 1 shows the changes on R-Squares when the number of predictor variables increase. The regression coefficient increased from .5323 when a simple regression was applied to ITED Mathematics as a single predictor, to .6052 when other predictors joined in the model to predict ACT Mathematics scores. The R-Square increased from .3345 when HLM courses-taken was a single independent variable to predict ACT Mathematics scores, to .3773, when other predictor variables were included. Normally, the R-Square increases tell us that the more predictor variables in a regression model will yield a stronger prediction. However, in this study the largest R-Square gain was when HLM courses taken and ITED Mathematics combined (.5956) in a two-predictor multiple regression. The result was an over 6 percent gain in variances to predict ACT Mathematics scores. Appendix A (will be included in the full paper) provides a complete breakdown of the results on all regression models.

FIGURE 1—Dependent Variable: ACT Mathematics

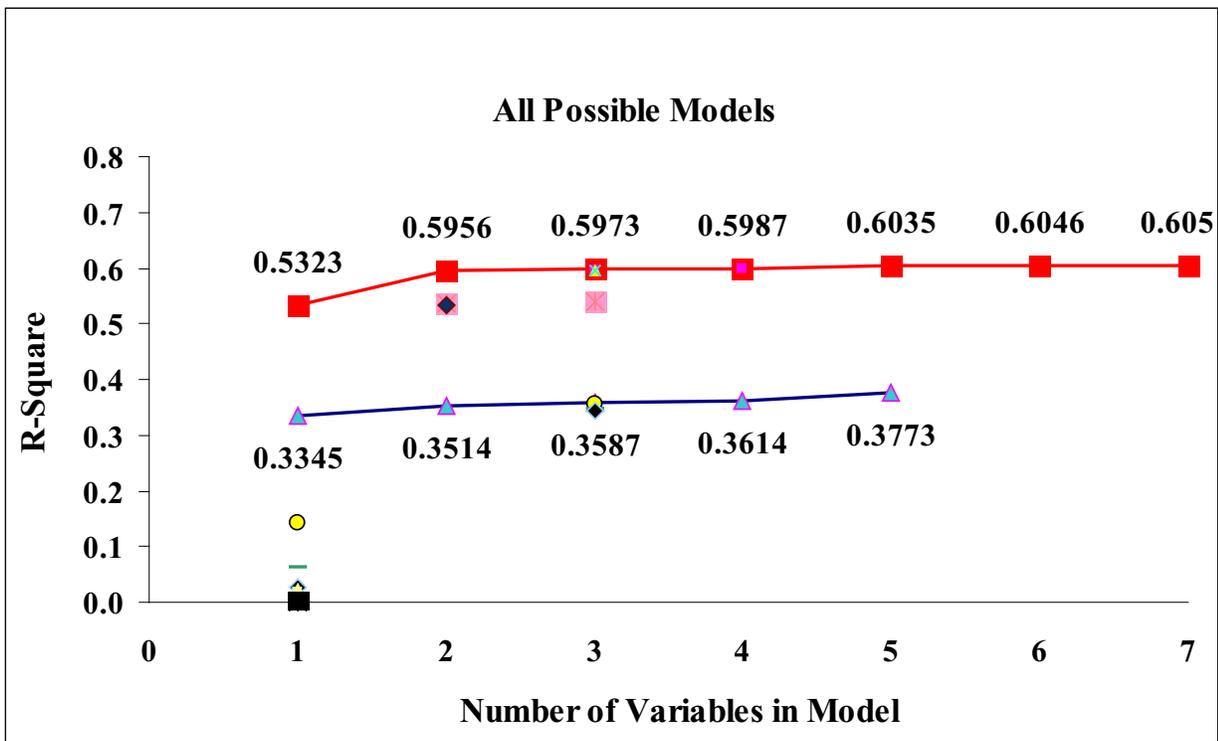


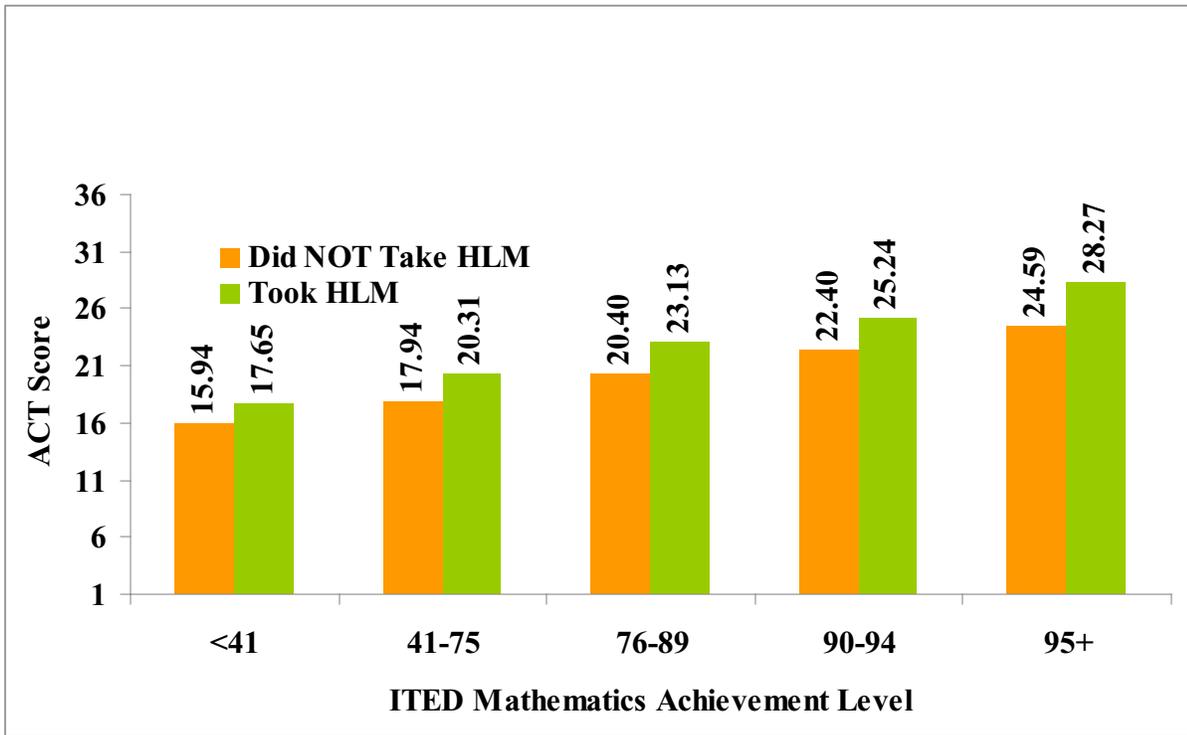
Table 4 shows the regression models when district size and HLM as an interaction variable along with ITED Mathematics z-score, gender and ACT core to predict ACT Mathematics scores. The R-Square was .6102 when the interaction variable was included. Appendix B (will be included in the full paper) provides more comprehensive explanations on why the interaction variable works better than when the district enrollment and HLM courses taken were separated as two main effect predictors. Data in Appendix B also provide evidence that students in larger districts had a higher proportion taking higher level mathematics courses and also performed better on ACT Mathematics.

TABLE 4—Regressions with ACT Mathematics as Outcome and Add an Interactive Predictor

Independent Variables	Model DF	Error DF	MSE	R-Sq	Adj R-Sq	Parameter Est	P
(District Size) X (HLM)	1	16036	15.72	0.3253	0.3253		<.0001
Intercept						19.3854	<.0001
(District Size) X (HLM)						0.5777	<.0001
ITED_M, (District Size) X (HLM)	2	16035	9.23	0.6040	0.6040		<.0001
Intercept						20.6743	<.0001
ITED_M						2.8823	<.0001
(District Size) X (HLM)						0.3045	<.0001
ITED_M, (District Size) X (HLM), Gender, ACT_Core	4	13957	9.01	0.6102	0.6101		<.0001
Intercept						19.7823	<.0001
ITED_M						2.7594	<.0001
(District Size) X (HLM)						0.2928	<.0001
Gender						0.7963	<.0001
ACT_Core						0.8118	<.0001

Descriptive Statistics: About 62 percent of the ACT test-takers in this study took at least one of the higher level mathematics (HLM) courses. For the students took HLM courses, the average ACT Mathematics scores were 1.7 (Low/below proficient achievement level) to 3.7 (High-high achievement level) higher than the averages for those did not take HLM courses by pre coursework achievement levels (see Figure 2). Table 5 shows more details regarding ACT score gaps: students in early high achievement levels had a greater proportion to take HLM courses and had larger gaps in ACT scores between HLM and not HLM courses taken than the students in lower pre coursework achievement levels. However the effect sizes for gaps in ACT scores between HLM and not HLM courses were large (.74 to .95) for all of the five achievement levels.

FIGURE 2—ACT Mathematics by Baseline Achievement Level



Source:

TABLE 5—ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED Achievement Level for All Students

		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	843	3,035	1,415	505	278
	Avg. ACT Math	15.94	17.94	20.40	22.40	24.59
	STD. ACT Math	1.95	2.51	2.98	3.25	3.73
Took One or More HLM Course	Number of Students	210	2,340	2,940	2,022	2,450
	AVG. ACT Math	17.65	20.31	23.13	25.24	28.27
	STD ACT Math	3.01	3.28	3.27	3.21	3.61
	ACT Mathematics Score Gap	1.71	2.38	2.73	2.84	3.68
% Students Took HLM		19.9%	43.5%	67.5%	80.0%	89.8%
Effect Size for ACT Score Gain		.74	0.77	.80	0.83	0.95

Although the percent of the higher level courses taken varied from one subgroup to another, the effect sizes on gaps in ACT scores (between the students who took and those who did not take higher level mathematics courses) were very large for students in different demographic groups: free or reduced lunch eligibility (Tables 6 and 7); race/ethnicity (Tables 8 and 9); and gender (Tables 10 and 11).

TABLE 6—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED Achievement Level for Students Eligible for Free/Reduced Lunch

Students Eligible for Free/Reduced Price Lunch		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	193	453	178	42	31
	Avg. ACT Math	15.32	17.55	19.48	22.17	24.35
	STD. ACT Math	1.74	2.39	2.80	3.94	3.41
Took HLM	Number of Students	33	249	220	156	140
	AVG. ACT Math	17.21	19.53	22.67	24.69	27.38
	STD ACT Math	2.47	3.03	3.21	3.32	3.37
	ACT Mathematics Score Gap	1.89	1.98	3.19	2.52	3.03
% Students Took HLM		14.6%	35.5%	55.3%	78.8%	81.9%
Effect Size for ACT Score Gain		.96	0.71	.93	0.70	0.85

TABLE 7—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED Achievement Level for Students Not Eligible for Free/Reduced Lunch

Students NOT Eligible for Free/Reduced Price Lunch		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	650	2,582	1,237	463	247
	Avg. ACT Math	16.12	18.00	20.54	22.42	24.62
	STD. ACT Math	1.97	2.52	2.98	3.19	3.77
Took HLM	Number of Students	177	2,091	2,720	1,866	2,310
	AVG. ACT Math	17.73	20.40	23.17	25.29	28.32
	STD ACT Math	3.10	3.30	3.28	3.20	3.62
	ACT Mathematics Score Gap	1.61	2.40	2.63	2.87	3.70
% Students Took HLM		21.4%	44.7%	68.7%	80.1%	90.3%
Effect Size for ACT Score Gain		0.69	0.77	0.77	0.84	.98

TABLE 8—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED Achievement Level for White and Asian Students

White and Asian Students		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	685	2,812	1,365	486	265
	Avg. ACT Math	16.12	17.95	20.40	22.38	24.61
	STD. ACT Math	1.99	2.50	2.97	3.26	3.72
Took HLM	Number of Students	186	2,216	2,868	1,971	2,422
	AVG. ACT Math	17.73	20.40	23.17	25.29	28.32
	STD ACT Math	3.06	3.28	3.27	3.22	3.60
	ACT Mathematics Score Gap	1.61	2.45	2.77	2.91	3.71
% Students Took HLM		21.4%	44.1%	67.7%	80.2%	90.1%
Effect Size for ACT Score Gain		0.69	0.79	0.81	0.85	.98

TABLE 9—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED Achievement Level for African American, American Indian and Hispanic Students

African American, American Indian and Hispanic Students		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	136	174	32	9	4
	Avg. ACT Math	15.00	17.63	19.88	22.44	24.25
	STD. ACT Math	1.44	2.39	3.24	3.24	2.22
Took HLM	Number of Students	24	124	72	51	28
	AVG. ACT Math	17.04	18.88	22.86	24.57	26.75
	STD ACT Math	2.56	2.82	3.23	3.09	3.77
	ACT Mathematics Score Gap	2.04	1.25	2.98	2.13	2.50
% Students Took HLM		15.0%	41.6%	69.2%	85.0%	87.5%
Effect Size for ACT Score Gain		1.13	.47	.85	0.67	0.68

TABLE 10—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED NPR Achievement Level for Female Students

Female Students		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	501	1,842	763	272	111
	Avg. ACT Math	15.78	17.74	20.06	22.31	24.32
	STD. ACT Math	1.85	2.36	2.84	3.16	3.81
Took HLM	Number of Students	135	1,441	1,585	1,051	1,074
	AVG. ACT Math	17.47	19.92	22.77	24.88	27.77
	STD ACT Math	3.01	3.15	3.31	3.16	3.56
	ACT Mathematics Score Gap	1.69	2.18	2.71	2.57	3.45
% Students Took HLM		21.2%	43.9%	67.5%	79.4%	90.6%
Effect Size for ACT Score Gain		0.75	0.74	0.79	0.77	.93

TABLE 11—The ACT Mathematics Scores by Higher Level Mathematics Course Taken and ITED NPR Achievement Level for Male Students

Male Students		Achievement Level				
		<41	41-75	76-89	90-94	95-99
Didn't Take HLM Course	Number of Students	342	1193	652	233	167
	Avg. ACT Math	16.17	18.23	20.80	22.51	24.78
	STD. ACT Math	2.06	2.69	3.09	3.36	3.67
Took HLM	Number of Students	75	899	1355	971	1376
	AVG. ACT Math	17.99	20.93	23.55	25.64	28.65
	STD ACT Math	2.99	3.39	3.18	3.23	3.60
	ACT Mathematics Score Gap	1.82	2.70	2.75	3.13	3.87
% Students Took HLM		18.0%	43.0%	67.5%	80.6%	89.2%
Effect Size for ACT Score Gain		.77	0.82	.81	0.90	1.02

CONCLUSION—Higher level mathematics courses taken have a strong impact on ACT Mathematics scores for all students in the study across all achievement levels. The HLM courses taken have a positive impact on ACT Mathematics scores for students eligible for free or reduced price lunch as well as those not eligible. Further, results suggest that all race/ethnicity groups, African American, American Indian and Hispanics as well as Asian and white, benefit from taking HLM courses as evidenced by their significant gains in ACT scores. Both female and male students benefit from taking HLM courses in all pre course-work achievement levels. The students with high ITED Mathematics scores to begin with had a greater proportion taking HLM courses which greatly impacted their ACT scores. The students in small schools/districts had a lower proportion taking HLM courses compared to their peers in larger schools/districts, however, for any students who took HLM courses, their ACT Mathematics score gains were significant in terms of the large effect sizes shown. The results suggest that while earlier achievement does play a role in predicting later achievement it is not the only contributor. Students that were earlier in lower achievement levels also saw significant gains in later achievement when combined with rigorous coursework. This suggests that regardless of race/ethnicity, gender or socioeconomic differences, the introduction to more difficult courses during high school will impact subsequent performance thus increasing the likelihood of postsecondary education and future career success.

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