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The Relationship of Grade Span in 9th Grade to Math Achievement in High School

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ABSTRACT

Purpose, Scope, and Method of Study: *The purpose of this study was to determine if a correlation exists between grade span for ninth grade and gains in math achievement test scores in 10th grade and 12th grade. A quantitative, longitudinal, correlational research design was employed to investigate the research questions. The population was high school students in the United States from public and private schools who were in the ninth grade for the first time during the 1989-1990 school year. The data collection instrument was the National Educational Longitudinal Study of 1988 (NELS:88). Further sampling and data analysis was conducted through SPSS and hierarchical linear modeling (HLM) software programs. A three-level, repeated-observations, HLM model was employed. The first level included scores and data collected over time nested within students. The second level included within schools data. Data were compared between schools for the third level of the full model.*

Findings and Conclusion: *This study confirmed the significance of race, socioeconomic status, math courses taken, math credits earned, different rates of growth in mathematics, and school level factors that affect individual student math performance. School level factors also contributed to student learning at a significant level. Although this study did not identify a correlation between grade span and math achievement, it may have provided other researchers and practitioners' recommendations that will guide practice and further research. This study also indicated the need, based on the unexplained variance, to identify additional factors that may contribute to improvement in learning for students.*

Keywords: math, achievement, grade span, school level factors affecting performance

Throughout the development of current age-related grade levels, educators and policy makers have considered many issues. With the recognition of the unique developmental stage of adolescence came a significant debate as to how to address the educational needs of this group of students. In

1918, the Commission on the Reorganization of Secondary Education met to address these needs (Weiss & Kipnes, 2006). The junior high was proposed and implemented to reduce dropout percentages and to prepare students academically for high school (Bedard & Do, 2005). The junior high concept was accepted very quickly. By 1960, eighty percent of schools were configured with three grade spans. Primary school was six years, junior high three years, and high school three years (Paglin & Fager, 1997).

By the middle of the twentieth century, the junior high model began to be questioned. The junior high was proposed to prepare students for high school, but it resembled high school structure too closely and served more as an extension rather than a preparation (Paglin & Fager, 1997). The more developmentally-focused middle school was introduced. While the grade span of middle schools most often included grades six through eight, the junior high was most commonly comprised of grades seven through nine; however, the primary difference between the two was that of purpose. The junior high was focused on academic preparation for high school, while the middle school's focus was on the developmental needs of the students (Bedard & Do, 2005). The middle school was designed to be a "transition to high school not a replica" (Weiss & Kipnes, 2006, p. 242). Throughout the 1960s, the number of middle schools increased. At the time of the initial data collection for this study, 1988, the number of junior highs and middle schools was approximately the same (Wells, 1989).

The issues regarding adolescents and the best educational solution for them are "similar to the concerns that have been expressed for the past one hundred years" (Juvonen, Le, Kaganoff, Augustine, & Constant, 2004, p. xvi). Grade span has been a recurring topic in these discussions. Decisions about grade span "often had more to do with labor market needs or the capacity of school buildings than with educational or developmental considerations" (Juvonen et al., p. xvi). However, researchers have recognized the potential impact of grade span and its influence on the effectiveness of schools (Stevenson, 2006; Wihry et al., 1992).

> If grade spans differ in their effectiveness, they do so not simply because of the nominal characteristic of encompassing one set of grades versus another, but because they differ systematically in underlying characteristics and processes that make for greater school effectiveness. (Wihry et al., 1992, p. 59)

These effects are most evident in the instructional and social arenas (Zvoch, 2006).

Several factors make 9th grade an appropriate focus for grade span research. The 9th grade is a pivotal year for high school students (Jerald, 2006). It is the first year of high school and the first year in which most courses are recorded on a permanent transcript. Researchers have identified the 9th grade as the "most critical point to intervene" for current and future academic success (Reents, 2002, p. 1). Ninth grade students have the lowest grade point average of all high school grades (Walsh, 2002). "Research from numerous sources has documented the difficulties that students experience when they enter high school: grades decline, the likelihood of course failure rises dramatically, behavioral trouble increases, and absences become much more common" (Weiss & Bearman, 2007, p. 395). Ninth grade students face unique challenges even if they do not change schools. This first year of high school comes with more "complexity in the school environment . . . [and] an increase in academic demands as students are introduced to new analytic and conceptual skills" (Roderick & Camburn, 1999, p. 306). This puts them at risk for future academic failure and warrants attention to the learning environment (Reents, 2002).

STATEMENT OF THE PROBLEM

Several researchers have identified the effects of grade span. In studies comparing middle school (6-8) and junior high (7-9) grade spans, students who attended middle schools had more discipline problems (Cook, MacCoun, Muschkin & Vigdor, 2007) and a lower on-time graduation rate (Bedard & Do, 2005). When comparing K-8 schools to middle schools, the elementary setting had a positive effect on performance on achievement tests (Offenberg, 2001; Wihry et al., 1992), in math and English grades (Abella, 2005; Connolly, Yakimowski-Srebnick, & Russo, 2002), and attendance (Abella, 2005). Although Weiss and Kipnes (2006) did not find any significant difference in grade point averages for 8th grade students in either setting, they did find that 8th grade students in middle school settings felt less safe and had lower self-esteem, both of which contribute to lower educational aspirations. In a comparison of grade span effects in 10th grade, two studies found better attendance rates and higher achievement test scores for students in K-12 schools than for students in other grade configurations (Franklin & Glascock, 1998; Howley, 2002).

Although evidence exists that grade span can affect various student outcomes, the current studies on grade span are limited and do not provide an adequate research base for educators to make conclusive decisions about the best building configurations for 9th grade (Howley, 2002; Renchler, 2000). There is a need for additional studies (Weiss & Bearman, 2007). Although studies exist that focus on grade settings through the 8th grade (Offenberg, 2001; Wihry et al., 1992), national studies on the relationship between grade span for 9thgrade and student achievement as measured by math standardized test scores are lacking (Stevenson, 2006).

PURPOSE OF THE STUDY

The purpose of this study was to determine if a correlation exists between grade span for 9th grade and gains in math achievement test scores in 10th grade and 12th grade. Based on the purpose of the study, the following hypotheses were posited:

1. Gains in math achievement test scores between 8th grade and 10th grade will vary based on grade span for 9th grade.
2. Gains in math achievement test scores between 10th grade and 12th grade will vary based on grade span for 9th grade.

METHODOLOGY

A quantitative, longitudinal, correlational, research design was employed to investigate the research hypotheses (Gay & Airasian, 2000). School effects, and specifically grade span, are difficult to isolate from individual student variables (Coladarci & Hancock, 2002). In order to gather enough data to consider all relevant variables, a complex data collection tool must be used (Curtin, Ingels, Wu, & Heuer

2002). These two concerns require a sophisticated statistical analysis that can deal with all variables and isolate their variance as related to the research questions (Raudenbush & Bryk, 2002).

Specifically, a three-level hierarchical linear modeling approach adapted from Lee, Smith, and Croninger (1997) was developed. The first level was within-person since this study included scores and data collected over time nested within students. Those students were nested within schools, which represented the second level. Finally, those data were compared between schools, which represented the third level.

Instrument

The data collection instrument was the National Educational Longitudinal Study of 1988 (NELS:88). Further sampling and data analysis was conducted through SPSS and HLM software programs (Smith, 2006; Quinn, 2003; Raudenbush & Bryk, 2002). The NELS:88 was conducted to collect data where the student was the primary subject, with supplementary contextual information from parents, teachers, and administrators. The study design allowed “the examination of change in young people’s lives and the role of schools in promoting growth and positive life outcomes” (Curtin et al., 2002, p. 151). This study was selected as the data source because of the opportunity it provided to examine the hypotheses using a national sample. NELS:88 collected five waves of data over a period of 12 years. This study used data from the first three waves. The Base Year Study was administered to almost 25,000 8thgrade students sampled from a “clustered, stratified national probability sample of 1,052 public and private schools” during the spring semester of 1988 (Curtin et al., 2002, p. 6). Included in these waves were a student questionnaire and cognitive test, an administrator questionnaire, two teacher questionnaires, and a parent survey. In 1990, questionnaires and tests were administered to the same groups, excluding the parents. In 1992, the study added transcript data and reintroduced a parent survey in addition to the components administered in previous waves (Curtin et al., 2002).

A restricted-use license from the National Center for Education Statistics (NCES) was required in order to have access to data with potentially identifying information in the NELS:88 database (Institute of Education Sciences, 2007). In order to use these data, a professor at the university applied for a license and followed strict protocol on the handling and use of the data. All analysis with identifiable information had to be performed onsite on a stand-alone computer. Results could not be presented in any way as to disclose the content of identifying data.

Population and Sample

The population was high school students in the United States from public and private schools who were in the 9th grade for the first time during the 1989-1990 school year (Curtin et al., 2002). The sample from the NELS:88 were students in 12th grade who met the following conditions:

- Their high schools and teachers must have filled out questionnaires.

- There must have been five or more students from each sampled high school who were still survey participants in 10th grade.
- The high school of record had to be the same for both 10th and 12th grades.
- Each sampled student must also have the complete test score data from the three survey waves. (Lee, Smith, & Croninger, 1997)

Data Analysis

The analyses employed in this study were adapted from Lee's et al. (1997) study of the effects of school restructuring. The skeleton of the study remained the same, including relevant control variables, measure of growth in students, and the hierarchical design. The primary difference between the studies is the between-schools comparison criteria. Lee et al. compared school level outcomes based on type of school organization, while this study compared school outcomes based on grade span for 9th grade.

Hierarchical linear modeling (HLM) was chosen because it accounts for the nested structure of the data. Raudenbush and Bryk (2002) described the benefits of such an analytic approach especially when multiple variables are considered at more than one level of the combined model. Variation is not properly estimated without models at each level of the equation accounting for each variable's effect. HLM also combines the different level models and their variables into one full model that describes how all of the variables interact and to what degree.

A three-level, repeated-observations, HLM model was employed (Raudenbush & Bryk, 2002). Using this three-level structure, a series of models was developed to isolate the variance in the dependent variable, math achievement, due to the effects of grade span for 9th grade. The Level-1 model measured math achievement growth within individuals. As in Lee et al. (1997), cognitive test scores were used to determine a trajectory of growth over time. The two periods of growth, between 8th grade and 10th grade and 10th grade and 12th grade, became measures of growth for each student.

The Level-2, within-school, model was also fashioned after the Lee et al. (1997) study. The control variables included gender, socio-economic status (SES), minority (Hispanic, Black, or Native American), and constructed composite variables that accounted for 8th grade academic engagement, prior achievement, and course taking.

The Level-3, between-schools model was a comparison of student growth based on a student's grade span for the 9th grade school year. Control variables for the between-school model were school average SES, school minority concentration, and school sector. After controlling for the above variables, grade span for 9th grade was added to the Level-3 model to isolate its effects on math achievement test scores.

Procedure

NCES provided a disk with restricted access data from the NELS:88 database. This disk is referred to as the Electronic Codebook (ECB) (Institute of Education Sciences, 2002). Within the software of the ECB, the variables, weights, and flags were selected for each level of the HLM model. Flags were used to identify variables by category for weighting, which was necessary in some instances in order to "compensate for the unequal probabilities of selection and to adjust for non-response," thus making the sample representative of the population (Curtin et al., 2002, p. 161).

For each level of the HLM model, a separate data file was created from the NELS:88 data. This file was imported into SPSS, where descriptive analyses were run and where the Multivariate Data Matrix (MDM) was built using the variables previously identified. Level-1 was developed by running the analysis adding one variable at a time until the structure adequately accounted for the variance. Each of the other levels was built by adding one variable at a time to avoid high standard errors. Each level MDM file was built separately and sorted by school identification number (id) within SPSS. Files that did not meet the sub-sampling criteria were deleted.

After the data were cleaned, the three MDM files representing the three levels were imported into HLM. In HLM, each level was built by adding one variable at a time into the equation. Even though the basic structure of the design was replicated, each step of data analysis and model building was repeated. The differences in variables and especially the final comparative groups in Level-3 required unique consideration as they could have affected the interaction of variables and, subsequently, the results (Raudenbush & Bryk, 2010).

Variables

All variables were taken or constructed from data in the NELS:88 restricted access data files after the second follow-up wave of data collection. The variables are described by level below. Each variable below has three descriptors: name, variable, description. The first listed is the name of the variable for this study. The second component, variable, is the name of the variable as given by NELS:88 unless it was a constructed variable. If it was a constructed variable, it was still given a name, but it was not a unique variable developed by NELS:88. The last part listed is a description of the variable and how it was developed (Institute of Education Sciences, 2002; Lee & Smith, 1992; Lee et al., 1997).

Level 1

- **Math Achievement, MATHACH.** The math IRT scores from achievement tests given during three waves (8^{th}, 10^{th} and 12^{th} grade years).
- **10^{th} Growth, GROWTH10.** This variable is a constructed variable measuring the growth from the 8^{th} grade IRT Math score to the 10^{th} grade IRT Math score.
- **12^{th} Growth, GROWTH12.** This variable is a constructed variable measuring the growth from the 10^{th} grade IRT Math score to the 12^{th} grade IRT Math score.

Level 2

- **Socio-economic Status, BYSES, socio-economic status composite.** This variable was constructed using information about the parent's occupation, education attainment, and family income.
- **Minority Status, RACE, composite race.** This variable represents the student's race based on all questionnaire data. It was recoded to 0=white or Asian; 1=Black, Hispanic, or Native American.
- **Student courses in mathematics summed for courses taken in 10th grade or before**. The course offerings were Prealgebra, Algebra I, Geometry, Algebra II, Trigonometry, Precalculus, Calculus.
- **A sum of the mathematics courses taken in grades 11 or 12.** The course offerings were Algebra I, Algebra II, Geometry, Trigonometry, Precalculus, Calculus.

Level 3

- **Grade Span, GSPAN.** Schools were categorized based on whether the transition to high school was before or after 9th grade.
- **Average Socio-economic Status, AVESES**. This combined variable based on parents' education and occupations, and family income for an individual was averaged for the school.
- **Minority Concentration, MINPERCE.** This variable was recoded to a dichotomous variable indicating above or below 40% minority, where Black, Hispanic, and Native American are minority.

RESULTS

Summary of Descriptive Statistics

Level-1 of the hierarchical model was the within persons level (see Table 1). The variable MATHACH included the math IRT scores from achievement tests given during three waves (8th, 10th, and 12th grade years). The total number of scores was 31,671, which included three scores for each individual in the study. The data were sorted as separate cases with a separate index variable coded to represent the scores in each of the three waves. The mean of MATHACH was the mean of the three scores for each individual.

The other two variables, GROWTH10 and GROWTH12, were the coded variables indicating the wave from which each score came. They represented the parameters to model the growth trajectory of the math scores (Raudenbush & Bryk, 2002). The math achievement growth, as demonstrated in NELS:88, was not linear. The slope of the growth between 8th and 10th grades was steeper than the growth between 10th and 12th grades. In order to best represent the slopes in HLM, a simplified piecewise linear growth model was parameterized and associated with the three waves of testing data (Lee, Smith, & Croninger, 1997).

Table 1
Level-1 Descriptive Statistics (Within Persons)

Variable	N	Mean	SD	Minimum	Maximum
MATHACH	31,671	51.22	10.36	24.87	99.98
GROWTH10	31,671	0.67	0.47	0.00	1.00
GROWTH12	31,671	0.33	0.47	0.00	1.00

Note. N = total number of math scores; MATHACH = math IRT scores from each of the three waves; GROWTH10 and GROWTH12 = coded variables indicating the wave from which the scores came.

Level-2 of the model was between students (see Table 2). The variables at this level accounted for differences between individual study participants that would likely affect math IRT scores. Each student had values for each variable. RACE was a binary variable where "0" was not Black, Hispanic, or Native American, and "1" was considered Black, Hispanic, or Native American. COURSETO represented the number of courses taken in math during secondary years of grades 7-12. MATHCRED was the total number of math credits earned during high school years. BYSES was a composite variable constructed to represent a number of factors including parent education level and household income.

Table 2
Level-2 Descriptive Statistics (Within Schools)

Variable	N	Mean	SD	Minimum	Maximum
RACE	10,557	0.19	0.39	0.00	1.00
COURSETO	10,557	3.77	2.10	0.00	28.00
MATHCRED	10,557	2.78	1.31	0.00	7.00
BYSES	10,557	0.02	0.78	-2.41	2.56

Note. N = total number of students; RACE = binary variable where "1" indicates Black, Hispanic, or Native American; COURSETO = number of courses taken during secondary years; MATHCRED = total number of math credits earned during high school years; BYSES = composite variable indicating socioeconomic status in 8th grade.

Level-3 of the model was between schools (see Table 3). Data at this level included GSPAN, the primary variable of interest in this study. Schools were coded into three grade span categories. If a student transitioned to a school containing 9th grade in any year prior to the 8th grade year but did not have another transition prior to high school graduation, the grade span code for that individual was "1". If a student transitioned between the 8th and 9th grade years and did not transition again prior to high school graduation, the grade span code for that individual was "2". If a student transitioned after 9th grade in any year prior to high school graduation, the grade span code for that individual was "3".

Table 3
Level-3 Descriptive Statistics (Between Schools)

Variable	N	Mean	SD	Minimum	Maximum
GSPAN	799	1.95	0.57	1.00	3.00
AVESES	799	-0.04	0.60	-1.35	4.28
MINPERCE	799	0.22	0.27	0.00	1.00

Note. N = total number of schools; GSPAN = category of grade span for 9th grade; AVESES = school's average composite socioeconomic status; MINPERC = binary variable where "1" indicates minority percentage of 40% or more.

The variable AVESES was the school's average composite SES based on several factors including parent education and income level. The variable MINPERCE was a school level variable coded based on the percentage of minority students enrolled in the school. Schools with 40% or more minority students enrolled were coded "1". All other schools were coded "0".

Summary of HLM Statistics

The study was designed to measure differences based on grade span, a school organization characteristic that indicates the range of grades housed in a school. In testing the hypotheses, several HLM models were developed to isolate the effects of each tested variable. The data were sorted based on school identification number which became the first test of variance.

The first model developed was the null model, Model A, that analyzed the study participants' math scores in each of the first three waves of data in the NELS:88 database (see Table 4). The differences in scores at each wave were measured by the slope between each wave. The slope of the growth trajectory between 8^{th} and 10^{th} grades was steeper than the slope of the growth trajectory between 10^{th} and 12^{th} grades. That slope remained the same in each subsequent model. Model A demonstrated a variance in math scores between schools. This indicated the need for additional variables to be added to the analysis to account for the variance between schools.

Since the primary predictor variable of interest for this study was grade span, Model B was developed to measure the effects of grade span on math scores. This model accounted for more of the variance and the reduction of deviance than Model A (see Table 5). It identified grade span as a significant variable correlated to math scores at the $p < .021$ level. However, this result would not be final until other expected predictors were tested for their significance.

To form Model C, two student variables identified as likely predictors from previous research were added to Model B. These variables were race, indicating either Black or Hispanic, and socio-economic status, a variable developed based on several factors, including family income and parents' educational attainment. Both variables were significant predictors of math scores; however, after these predictors were accounted for, grade span was no longer a significant predictor of math scores. Note that since grade span was the primary variable of interest for this study and was found to not be a significant predictor of math achievement, the output table is not included. The primary variable of grade span did not predict math scores after accounting for differences due to race and socio-economic status for Model C.

Table 4
Model A: Null Model Results

Fixed Effect	Coefficient	S.E.	*t*-ratio	Appr. *df*	*p*-value
Final estimation of fixed effects (with robust standard errors)					
For INTRCPT1					
For INTRCPT2					
INTRCPT3	46.23**	0.17	271.94	798	<0.001
For GROWTH10 slope					
For INTRCPT2					
INTRCPT3	5.47**	0.070	78.14	20,313	<0.001
For GROWTH12 slope					
For INTRCPT2					
INTRCPT3	3.29**	0.060	51.52	20,313	<0.001
Random Effect	**S.D.**	**Variance**	***d.f.***	χ^2	***p*-value**
Final estimation of Level-1 and Level-2 variance components					
INTRCPT1	7.56	57.10**	9758	113,141.55	<0.001
level-1	4.02	16.16			
Final estimation of Level-3 variance components					
INTRCPT1/INTRCPT2	4.58	21.02**	798	4361.29	<0.001
INTRCPT3	5.47**	0.070	78.14	20,313	<0.001

Note. $^{**}p < .001$.

School characteristics have been shown to be related to individual student outcomes. Model D added two school level variables to the previous model that were expected to account for differences in individual student math scores. One variable was the average socio-economic status for the school. The other variable categorized the school by the percentage of minority students enrolled. Of the three school level predictors in this model, only average socio-economic status was a predictor of math scores. Neither the percentage of minority students enrolled nor grade span significantly predicted math scores. Once again, since grade span was the primary variable of interest for this study and was found to not be a significant predictor of math achievement, the output table is not included. In the previous model, the individual student characteristics of race and socio-economic status predicted math scores and remained predictors in this model.

Table 5

Model B: Grade Span Only Results (School Level Variables)

Fixed Effect	Coefficient	S.E.	*t*-ratio	Appr. *df*	*p*-value
Final estimation of fixed effects (with robust standard errors)					
For INTRCPT2					
For INTRCPT3	52.61**	0.77	68.33	797	<0.001
GSPAN	-0.84*	0.36	-2.310	797	0.021
For GROWTH10 slope					
For INTRCPT2					
INTRCPT3	5.47**	0.07	78.15	20,313	<0.001
For GROWTH12 slope					
For INTRCPT2					
INTRCPT3	3.29**	0.06	51.523	20,313	<0.001
Random Effect	S.D.	Variance	*d.f.*	χ^2	*p*-value
Final estimation of Level-1 and Level-2 variance components					
INTRCPT1	7.56	57.10**	9758	113,141.55	<0.001
level-1	4.02	16.16			
Final estimation of Level-3 variance components					
INTRCPT1/INTRCPT2	4.56	20.78**	797	4,303.15	<0.001

Note. ** $p < .001$.

The final model, Model E, added two factors at the student level that would account for math exposure and explain some of the difference between students' math scores (see Table 6). The variables were total math credits earned and total math courses taken. Both variables improved the overall model's explanation of the variance in math scores. The student level variables of race and socio-economic status and the school level variable of average socio-economic status remained predictors of math scores. Once again, grade span did not account for variance in math scores.

Table 6
Model E: Student Academic Predictors Results

Fixed Effect	Coefficient	S.E.	*t*-ratio	Appr. *df*	*p*-value
Final estimation of fixed effects (with robust standard errors)					
For INTRCPT1					
For INTRCPT2					
INTRCPT3	36.72**	0.45	82.02	796	<0.001
GSPAN	-0.17	0.20	-0.84	796	0.404
AVESES	1.59**	0.30	5.30	796	<0.001
For RACE					
INTRCPT3	-2.94**	0.20	-15.01	9,754	<0.001
For COURSETO					
INTRCPT3	0.18**	0.04	4.33	9,754	<0.001
For MATHCRED					
INTRCPT3	3.56**	0.07	53.51	9,754	<0.001
For BYSES					
INTRCPT3	1.93**	0.12	16.70	9,754	<0.001
For GROWTH10 slope					
For INTRCPT2					
INTRCPT3	5.47**	0.07	78.15	20,313	<0.001
For GROWTH12 slope					
For INTRCPT2					
INTRCPT3	3.29**	0.06	51.523	20,313	<0.001
Random Effect	**S.D.**	**Variance**	***d.f.***	**χ^2**	***p*-value**
Final estimation of Level-1 and Level-2 variance components					
INTRCPT1	5.62	31.64**	9,754	66,994.10	<0.001
level-1	4.02	16.16			
Final estimation of Level-3 variance components					
INTRCPT1/INTRCPT2	2.30	5.27**	796	2,288.83	<0.001

Note. **$p < .001$.

CONCLUSION

The impact of school level factors, specifically grade span, on student math achievement was the focus of this study. Despite previous research that pointed to school organizational structures' relationship to student outcomes, this study did not find a correlation between grade span for 9th grade and math test scores. However, a difference in math scores between schools was found. After controlling for individual and school variables, a portion of the variance between schools remained unexplained. This suggested that some unidentified characteristic of schools is the difference factor. That factor could be an organizational factor.

Differences between students accounted for the largest percentage of variance in this study. After controlling for individual factors, more than half of the variance remained unexplained at the student level. These findings suggest that unique aspects of individuals are likely to have an effect on math scores. Schools may benefit from programs that address the unique needs of different student populations.

The number of math courses taken in secondary years, math credits earned, and the number of high school level courses passed for credit were identified as predictors of math scores. Math credits earned had a greater effect on math scores than math courses taken. This suggests that taking math courses alone is not as beneficial as the standard of passing a math course for high school credit.

Another finding of this study highlighted the difference in the rate of growth in math before and after 10th grade. Growth declined after 10th grade. An associated finding was the growth correlated to earning math credits. Since most math credits are earned during high school years (9-12), and growth in math scores declined after 10th grade, this suggests that students should take more math courses for credit throughout high school in order to continue math growth.

RECOMMENDATIONS FOR PRACTICE

The following are recommendations for practice based on the conclusions and results of this study.

1. The systems and practices within buildings may either help or inhibit student performance. Noting the differences in achievement based on individual student socio-economic status and race found in this study, it may be important to consider the likely effects that building organization including grade span could have on underperforming populations.

2. This study supported the positive relationship between math scores and math credits earned. There was also more growth in math between 8th and 10th grades than between 10th and 12th grades. It may be useful to encourage students to earn more math credits later in high school to continue growth in math.

3. This study demonstrated the inequitable distribution of math achievement based on individual student race and socio-economic status. Attention to improving the lower school performance

based on race and socio-economic status continues to be a need in schools. Increasing activities that engage these populations in school and target the deficit may improve academic outcomes such as math achievement.

RECOMMENDATIONS FOR FURTHER RESEARCH

At both the student and school levels, further study is justified to identify those factors that contribute to differences in math scores. The following are recommendations for further research based on the results of this study.

1. This study did not compare academic measures other than math. Further research is needed to measure the effects of grade span on other academic areas.

2. This study did not consider factors associated with grade span beyond the number of grades contained within the span. Further research is needed to subdivide the grade span categories based on additional school level factors that have been shown to correlate to student test performance, such as number of grades tested within a grade span and performance based on position within the grade span.

3. Considering the amount of unexplained variance and the primary focus on academic outcomes, further research is needed to measure non-academic student outcomes, such as discipline and student perceptions of schooling.

4. This study did not identify effects on graduation rate or grade point averages. Further research is needed to identify the effects of grade span for 9^{th} grade on graduation rate and grade point averages.

5. This study did not examine differences in test scores based on subpopulation performance within different grade spans. Further research is needed to examine how test scores vary within grade spans based on demographics.

Schools face a daunting task of teaching students from a wide range of backgrounds and abilities. The factors that contribute to successful learning for each child are numerous. This study confirmed the significance of race, socio-economic status, math courses taken, math credits earned, the potential for different rates of growth in mathematics, and school level factors that affect individual student math performance. School level factors, while not the major contributing effects to student learning, contribute at a significant level. Although this study did not identify a correlation between grade span and math achievement, it may have provided other researchers and practitioners recommendations that will guide practice and further research. This study also indicated the need, based on the unexplained variance, to identify additional factors that may contribute to improvement in learning for students.

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