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Examining the Mathematical Education Gaps during the Transition from Middle School to High School

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TABLE OF CONTENTS

List of Tables

Table 1: PSAT Overall Math Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	Scores remained steady. (Overall increase in mean score but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 2: PSAT Overall Math Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	373.361
9Th Grade Fall 2022	381.008
9th Grade Spring 2023	386.176

Table 3: PSAT Heart of Algebra Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	Scores remained steady. (Overall increase in mean score but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 4: PSAT Heart of Algebra Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	5.987
9Th Grade Fall 2022	6.454
9th Grade Spring 2023	6.563

Table 5: PSAT Number of Students Meeting Standards	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	The proportion remained steady. (Overall decrease in number of students but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	The proportion of students meeting standards increased.
8th Grade Spring 2022 to 9th Grade Spring 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)

Table 6: MAP Overall Math Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall decrease in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Winter 2023	Scores Improved
9th Grade Winter 2023 to 9th Grade Spring 2023	Scores remained steady. (Overall increase in mean score but not statistically significant)
9th Grade Fall 2023 to 9Th Grade Spring 2023	Scores Improved
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 7: MAP Overall Math Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	218.038
9Th Grade Fall 2022	217.633
9th Grade Winter 2023	220.846
9th Grade Spring 2023	221.117

Table 8: MAP Operations and Algebraic Thinking Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Winter 2023	Scores Improved
9th Grade Winter 2023 to 9th Grade Spring 2023	Scores remained steady. (Overall decrease in mean score but not statistically significant)
9th Grade Fall 2023 to 9Th Grade Spring 2023	Scores Improved
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 9: MAP Operations and Algebraic Thinking Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	219
9Th Grade Fall 2022	220.812
9th Grade Winter 2023	223.588
9Th Grade Spring 2023	223.1

Table 10: MAP Number of Students Meeting Benchmark	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	The proportion of students meeting the benchmark increased.
9Th Grade Fall 2022 to 9Th Grade Winter 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)
9th Grade Winter 2023 to 9th Grade Spring 2023	The proportion of students meeting the benchmark decreased.
9th Grade Fall 2023 to 9Th Grade Spring 2023	The proportion remained steady. (Overall decrease in number of students but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)

Abstract

This research examines the transition from middle school to high school and the effects that this transition has on a student's mathematical gains. PSAT 8/9 test scores and NWEA MAP scores were collected for a unified district and paired T hypothesis tests were utilized to examine the change in test scores throughout the transition from eighth grade to freshmen year. This data shows that overall, there was an increase in the mean score for each test from the end of eighth grade to the end of freshmen year and there was an increase in the number of students meeting the benchmark, however the percentage of students testing at grade level by the end of freshmen year is still significantly low.

Keywords: transition from middle school to high school, math achievement, standardized test scores, achievement gap

Transition from Middle School to High School

Any factor that causes a student to transition to a new school building can have academic and non-academic consequences. Students often go through a transition in between elementary school and attending either a junior high or a middle school. Although researchers are uncertain of the causes, there are large, significantly negative effects of attending a middle school or junior high (Dhuey, 2013). Students who experience kindergarten through eighth grade in the same building have more positive social and academic outcomes. Minimizing movement between buildings as students' progress through school may help, but it may not always be feasible, especially in districts with a large student population. Considering the rather short duration of middle school or junior high, students may not have fully recovered before they then must transition to high school. The transition to high school is pivotal in a student's academic career. During this transition, students are faced with many stressors that all play a role in the decline of student performance.

During the transition to high school, students often fall into one of two categories. They either attend a smaller school district, in which there is only one middle school or junior high that feeds into the high school, or they attend a larger district that has multiple schools that feed into the high school. A decline in student performance is associated with both options, however there are slight differences among the two groups. A single-feeder school district has a more positive effect on students with a strong peer group who are performing well academically prior to high school, but a multiple-feeder school districts provides more protection against failure for low achieving students (Langenkamp, 2010). Students who are performing well academically prior to high school will have less social network disruptions in a single-feeder school so they will be able to maintain some of the networks that are working well for them. A student who is low

achieving prior to high school may be in classes with peers that are not a good support group (Felmlee, McMillan, Rodis, & Osgood, 2018). A multiple-feeder school district can change the social network in a positive light for these students.

One of the most obvious stressors that students face during the transition to high school is learning their new environment. They must learn the layout of the new building to locate their classes and any other areas in the building which they wish to visit. The high school often has different rules that must be learned to ensure they are being followed correctly. They must learn a new schedule not only of their classes but the bell schedule at the high school is more than likely different from the schedule that they followed at their middle school or junior high. These environmental stressors are likely very similar regardless of the type of district the student attends since they are transitioning to a new building.

Another stressor that students face is the loss of relationships with teachers and staff members. Langenkamp and DeLamar both discuss the importance of teacher-student relationships and their impact on student success in school. When students transition to high school, they no longer have easy access to the adults that they trust. They must restart and begin to determine which adults at the high school are adults that they feel they can talk to, which will take time. While they are going through this process, they may not feel they have an adult that they can talk to when needed. This stressor may look different for a single-feeder school compared to a multiple-feeder school. A single-feeder school district may have vertical connections in which the students may still be able to easily communicate with the teachers from the middle school or junior high (Langenkamp, 2010). A high school that has multiple feeder schools may not be able to easily organize communication among multiple buildings.

The most significant impact of this transition is students' relationships with their peers. A student's social network is severely impacted during this transition, especially in a district with multiple feeder schools. Student schedules may separate friend groups which can lead to a feeling or isolation and low self-esteem (Felmlee, McMillan, Rodis, & Osgood, 2018). As stated, students are dealing with multiple stressors during this time. 238. If a student feels isolated from their peers during the transition, it can make coping with the environmental factors more challenging. The severity of this stressor is largely dependent on the size of the district and the degree to which the student's social network was impacted, which varies between districts and between students. For a small group of students, this transition may bring about change that is beneficial. This opportunity for a new social group can be beneficial for students who were not thriving in the social environment that they were in prior to the transition. This is only true for a very small population of students. In general, social ties to both teachers and students from middle school provide some protection against failing a course during their freshmen year of high school (Langenkamp, 2010).

Considering the above stressors and knowing that adolescence and puberty also come with their own set of complications, it is no shock that many students see a decline in their academic performance during this transition. This decline is evident in multiple aspects of student performance such as grades, standardized test scores, attendance, GPA, and number of failed classes. "Approximately 22 to 40 percent of students have to repeat classes taken during their first year of high school, which can lead some students to drop out of school" (Felmlee, McMillan, Rodis, & Osgood, 2018, p. 159). There has been a multitude of research conducted on this decline in academic performance. In addition to the research cited above, Ding suggests that the initial decline during ninth grade is a result of high school level classes that are more rigorous

than classes that students have taken prior (2008). Once students adjust to the new environment of the building and become comfortable with the level of difficulty, it is anticipated that students bounce back (Langenkamp, 2010). Although many students do recover and start to see academic growth after freshmen year, the growth is not enough to compensate for the loss during the transition (Ding, 2008).

Academic Achievement

In general, students' academic performance declines during their freshman year of high school. However, most of the research is based on English and Math since those are the subjects with the most data from standardized tests. Research shows that math and reading gaps emerge as early as in kindergarten. One study indicates that many students who enter Kindergarten with less skills than their peers are members of families with a lower socio-economic status (Quinn, 2015). Unfortunately, this gap widens by the end of a student's kindergarten year. Research has also considered other factors such as racial differences, school quality, effectiveness of teachers, and parental belief in the importance of math. The analysis shows that school quality may be the main cause of the widening of the reading gap, but the widening of the math gap cannot be linked to any of above hypotheses (Quinn, 2015). If this cycle continues and the academic gap continues to grow, a student who is entering high school may be significantly behind their peers. When considering achievement gaps in high school, Ding's research shows that students primarily fall into two categories. Some students experience a large academic decline from seventh grade to ninth grade and other students do not see a significant decline until sophomore year (Ding, 2008).

When considering the academic achievement of high school students, socio-economic status seems to be a primary cause, however, when the focus is math achievement, racial

differences tend to play a larger role. As students get older and more aware, they fall victim to stereotype threat and racial opportunity cost. Stereotype threat is the risk of confirming negative stereotypes. High performing minority students may perform poorly on assessments because they become anxious or fearful regarding the stereotype of their academic performance (Riegle-Crumb & Grodsky, 2010). In the past, minority students were severely underrepresented in advanced courses at the high school level. Minority students with greater math ability may be less likely to take advanced courses due to the racial opportunity cost and feeling alienated from their same-race peers (Kotok, 2017). Recently, schools have set goals to ensure that more minority students are offered the opportunity to take advanced classes. School districts believed that if students were given the opportunity to take advanced classes, they would rise to rigor of the class and the academic gap would begin to narrow. In general, schools have increased the number of minority students in advanced class, but this has not led to an increase in scores for minority students (Riegle-Crumb & Grodsky, 2010).

Contrary to belief, the achievement gap between white and minority students is the largest in the advanced level classes (Kotok, 2017). To put this into perspective, consider a junior in high school. For most high schools, a standard junior level class is Algebra 2, and an advanced class would be Pre-Calculus, AP Calculus or AP Statistics. Kotok indicates that the gap between the lowest performing Algebra 2 student and the highest performing Algebra 2 student is significantly smaller than the gap between the lowest performing AP math student and the highest performing AP math student. It is important to note that the minority students who are enrolled in advanced classes are outperforming their peers who are not enrolled in advanced classes (Riegle-Crumb & Grodsky, 2010). Students in advanced classes are still reaping some

benefits compared to taking a standard course, however, simply enrolling more minority students in advanced classes is not enough to close the achievement gap.

Based on all the above research, there are numerous factors that cause students to be below grade level when it comes to their mathematical ability. Some gaps begin as early as Kindergarten and may be an effect of socio-economic status. These gaps then continue to widen and severely impact students' transitions, more notably from elementary to middle school and then middle school to high school. The primary focus moving forward will be the transition from middle school to high school. It is imperative that high schools find ways to lessen the impact of the transition and begin narrowing the achievement gap to ensure student success post-high school.

PSAT Data Analysis

This research will consider the mathematical achievement gap during a students' freshmen year of high school. The sample includes 365 eighth grade students during the 2021-2022 school year who attended a south suburban school in Illinois. Based on the Illinois School Report Card from 2021-2022, this school has a racial diversity that is 15% white, 65% black, 15% Hispanic, and 5% two or more races. There are 1409 total students enrolled in the high school and 100% of them are low income. The graduation rate is 91% and the chronic absenteeism rate is 48%. Based on SAT, 12% of the students are meeting benchmarks in ELA and 10% are meeting the math benchmarks.

The standardized tests used by this district are the PSAT 8/9 and NWEA Map. The results of these tests are used to track student growth and to determine college readiness. To track students through their freshman year transition, data was collected from the freshman class of the

2022-2023 school year. The PSAT 8/9 is taken during the fall and spring semesters. Data for this test included the Spring of 2022, Fall of 2022, and Spring of 2023. The NWEA Map test is taken in the fall, winter, and spring. Data for this test includes the Spring of 2022, Fall of 2022, Winter of 2023, and Spring of 2023. Before performing any statistical analysis, student scores were matched to individual students and students with missing scores were removed. This study also removed students who moved in or out of the district during this period and ensured that the analysis was for the same cohort of students. Once this was completed there were 238 students with complete PSAT 8/9 math test data and 240 students with complete NWEA Map Math data.

Beginning with the PSAT 8/9 Math data, this study hypothesized that students would score lower at the beginning of their freshman year than they did at the end of their eighth-grade year as they deal with the other implications of beginning high school. A paired T hypothesis test was used with a null hypothesis that the difference between the means was zero and an alternate hypothesis that the difference is greater than zero. The alternative hypothesis suggests that the mean of the scores from the Fall of 2022 is lower than the mean of the scores from the Spring of 2022. This T test produced a p-value of 0.93 which means that we fail to reject the null hypothesis, there is not enough statistical evidence to claim that the PSAT 8/9 math scores have decreased from the end of eighth grade to the beginning of freshman year. Looking at the descriptive statistics, the mean for the Spring of 2022 is 373.36 and the mean for the Fall of 2022 is 381.01. Based on the mean alone, it appears that scores have increased. If another T test is run with an alternate hypothesis less than zero to account for this, the p-value is 0.07. This still results in a fail to reject the null hypothesis which shows that the increase of the means is not statistically significant.

After the students have had some time to adjust to high school, it is hoped that there would be growth in their test scores by the end of their freshman year. Another paired T test was used to compare the Fall of 2022 and Spring of 2023 test scores. The null hypothesis remained the same and the alternate hypothesis was that the difference between the means was less than zero to test if the mean in the spring is higher than the fall. This resulted in a p-value of 0.15 and therefore a fail to reject the null hypothesis. There is not enough statistical evidence to claim that the mean of the spring math scores is higher than the mean of the fall math scores.

In order to encompass a students' full transition and their first full year of high school, it may be more helpful to look more broadly and compare their end of eighth grade scores with their end of ninth grade scores. Another paired T test was used with a null hypothesis that the difference of the means is zero and an alternate hypothesis that the difference is less than zero. This T test produced a p-value of 0.0014 which allows us to reject the null hypothesis. There is enough statistical evidence to claim that students' PSAT 8/9 math test scores are higher at the end of their freshman year than they were at the end of their eighth-grade year. Table 1 and 2 provide a summary of the overall PSAT math score analysis.

Table 1: PSAT Overall Math Scores

Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	Scores remained steady. (Overall increase in mean score but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 2: PSAT Overall Math Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	373.361
9Th Grade Fall 2022	381.008
9th Grade Spring 2023	386.176

The PSAT 8/9 also provides students with scores for their subcategories. A typical freshman in high school is enrolled in an Algebra 1 class which would suggest that their sub score for the category labeled "The heart of algebra" should increase. Paired T tests for this category were run as they were for the students' overall scores with similar results. The T test that compared the Spring of 2022 with the Fall of 2022 had a p-value of 0.997 and therefore fails to reject the null hypothesis. The p-value for the comparison of Fall of 2022 to Spring of 2023 had a p-value of 0.242 and therefore fails to reject the null hypothesis as well. The comparison of the Spring of 2022 to the Spring of 2023 had a p-value of less than 0.0001 which indicates that the null hypothesis can be rejected and there is enough evidence to claim that the algebra sub score is higher at the end of freshman year compared to the end of eighth grade. This shows that a students' overall PSAT 8/9 math score and their Algebra sub score follow a similar trajectory for this group of students. Table 3 and 4 provide a summary of these results.

Table 3: PSAT Heart of Algebra Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	Scores remained steady.

	(Overall increase in mean score but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 4: PSAT Heart of Algebra Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	5.987
9Th Grade Fall 2022	6.454
9th Grade Spring 2023	6.563

Although there is evidence of growth in student test scores, high schools are often more concerned with the number of students who are meeting benchmarks and on track of college readiness. College Board provides benchmarks for the PSAT 8/9 math test in three categories. For eighth grade students, a score of 430-720 places them in the green category which indicates they are testing at or above grade level. A score of 410-420 places them in the yellow category which indicates they are within one academic year of growth and a score of 120-400 places them in the red category which indicates they are below standards by more than one academic year. For ninth grade students, the range for the categories changes slightly. The green category is 450-720, the yellow category is 430-440, and the red category is 120-420. Using the student test scores that were collected, a separate column was added to denote the category of the score. A zero was used to denote the red category, a 1 was used for the yellow category, and a 2 was used for the green category.

A two-sample proportion hypothesis test was used to compare the proportion of students meeting the benchmark. The null hypothesis states the difference of the proportions is zero while

the alternate hypothesis states the difference of the proportions is greater than zero. When comparing Spring of 2022 with Fall of 2022, the p-value was 0.4482 which indicates a fail to reject the null hypothesis and there is not enough evidence to claim that the proportion of students meeting the benchmark has decreased. When comparing Fall of 2022 and Spring of 2023, the null hypothesis remained that the difference of the means is zero while the alternate hypothesis changed to the difference of the means is less than zero. This resulted in a p-value of 0.044 which rejects the null hypothesis. There is enough evidence to claim that the proportion of students who are meeting the benchmark by the end of freshman year is higher than the proportion of students meeting benchmark at the beginning of freshman year. Similarly, comparing the Spring of 2022 to the Spring of 2023 resulted in a p-value of 0.0582. This p-value fails to reject the null hypothesis which indicates that there is not enough evidence to claim that the proportion of students meeting the benchmark at the end of ninth grade is higher than the proportion of students meeting the benchmark at the end of eighth grade. Table 5 provides a summary of these results.

Table 5: PSAT Number of Students Meeting Standards

Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	The proportion remained steady. (Overall decrease in number of students but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Spring 2023	The proportion of students meeting standards increased.
8th Grade Spring 2022 to 9th Grade Spring 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)

PSAT Data Results

The statistical results of the PSAT 8/9 math data are interesting when compared to prior research. When comparing the end of eighth grade to the beginning of ninth grade there is not enough evidence to suggest that student scores decreased as prior research would suggest. As students make their way through their freshman year and begin to adjust, it is likely that they begin to see growth in their test scores again, however, it was unlikely that they would be able to make up for what was lost during the transitional period. Based on the results of the paired T hypothesis test, this group of students were able to make statistically significant growth. Unfortunately, once students make it to the high school level, simply getting higher test scores may not be enough if they still are not meeting benchmarks. Students at the high school level have limited time to close gaps to be considered college ready by the time they graduate. The proportion test indicates that this still may be the case. There was not enough evidence to indicate that the proportion of students meeting the benchmark by the end of ninth grade was higher than at the end of eighth grade. Considering the p-value for this proportion test was 0.0582 which is relatively close to a rejection of the null hypothesis, it may be interesting to look deeper into the raw numbers. There were 35 students who were meeting the benchmark at the end of eighth grade and 48 students meeting benchmark by the end of ninth grade out of a total of 238 students. Although the statistical analysis may not have shown significance, these numbers produce an increase of over 5% which many school districts would be extremely pleased with that increase. Overall, this still shows that only 20% of the students in this study are meeting benchmark by the end of ninth grade. This poses the question of what a school district can do about the other 80% of students who are not meeting the benchmark to attempt to close the gap over the next three years.

MAP Data Analysis

Considering that MAP scores are available for the same cohort of students, it is necessary to run similar statistical analyses on these scores to see if they align with the results of the PSAT scores. To begin, multiple paired T hypothesis tests were run to compare the mean scores of each testing period. The first testing period that was examined was from the spring of eighth grade to the fall of freshmen year. A paired T test with a null hypothesis that the difference of the means is zero and an alternate hypothesis that the difference of the means is greater than zero was used. The alternate hypothesis suggests that scores will be lower in the fall of freshman year than they were in the spring of their eighth-grade year. This T test produced a p-value of 0.3352 which leads to a fail to reject the null hypothesis. There is not enough evidence to support scores decreasing from the end of eighth grade to the beginning of freshman year.

Again, once students get beyond the beginning of freshman year, we hope that they can settle in and start to grow academically. Another paired T test was used to compare the scores from the fall of freshman year to their winter scores. The null hypothesis is that the difference is zero and the alternate is that the difference is less than zero which suggests an increase in scores. This test produced a p-value of 0.0002 which results in a rejection of the null hypothesis. There is enough statistical evidence to support an increase in scores. Next, the winter scores to the spring scores during freshman year is analyzed with the same null and alternate hypothesis. This test produced a p-value of 0.327 which fails to reject the null. There is not enough evidence to support an increase in scores over this period. Lastly, consider the beginning of freshman year to the end of freshman year which compares the fall to the spring scores. Using the same null and alternate hypothesis for this test, a p-value of 0.001 is produced. This rejects the null hypothesis and supports an increase in scores from the beginning of freshman year to the end of freshman

year. It is also beneficial to consider the entire transitional period and compare the scores at the end of eighth grade to the scores at the end of ninth grade. Using a null that the difference is zero and an alternate that the difference is less than zero, a p-value of less than 0.0001 is produced. This leads to a rejection of the null and supports and increase in scores during this period. Based on these T tests, it appears that most of the growth is occurring during the first half of freshman year, however it is evident that there is an increase in scores for the entire year and the entire transition. This is important to note because it indicates that although there may not be significant growth in between other time periods, there also isn't significant loss to negate the gains made in the first half of the year. Table 6 and 7 provide a summary.

Table 6: MAP Overall Math Scores	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall decrease in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Winter 2023	Scores Improved
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8th Grade Spring 2022 to 9th Grade Spring 2023	Scores Improved

Table 7: MAP Overall Math Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	218.038
9Th Grade Fall 2022	217.633
9th Grade Winter 2023	220.846

9th Grade Spring 2023	221.117

The MAP also provides students with scores for their subcategories. A typical freshman in high school is enrolled in an Algebra 1 class which would suggest that their sub score for the category labeled "Operations and Algebraic Thinking" should increase. Paired T tests for this category were run as they were for the students' overall scores with similar results. The paired T test that compared the end of eighth grade to the beginning of ninth grade produced a p-value of 0.9647 which fails to reject the null and does not support a decrease in scores for this category. The p-value for the comparison of fall of freshman year to winter is 0.004 which rejects the null and shows that there is evidence for an increase in scores during this period. When considering winter of freshman year to spring, the p-value is 0.7307 which fails to reject the null and does not support an increase in scores. Lastly, spring of eighth grade to spring of ninth grade was considered and produced a p-value of 0.0001 which rejects the null hypothesis. There is enough statistical evidence to support an increase in this subcategory during the transitional period. Table 8 and 9 provide a summary of the results.

Table 8: MAP Operations and Algebraic Thinking Scores

Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	Scores remained steady. (Overall increase in mean score but not statistically significant)
9Th Grade Fall 2022 to 9Th Grade Winter 2023	Scores Improved
9th Grade Winter 2023 to 9th Grade Spring 2023	Scores remained steady. (Overall decrease in mean score but not statistically significant)
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Table 9: MAP Operations and Algebraic Thinking Mean Scores	
Time Period	Mean Score
8th Grade Spring 2022	219
9Th Grade Fall 2022	220.812
9th Grade Winter 2023	223.588
9Th Grade Spring 2023	223.1

Although these MAP scores are showing growth in student scores, it is imperative to consider the number of students who are meeting the benchmark. MAP has a normative chart that provides benchmark scores for each testing period. The benchmark score for the end of eighth grade is 230.3, fall of freshman year is 226.4, winter of freshman year is 228.67, and spring of freshman year is 230.03. Using the student test scores that were collected, a separate column was added to denote whether the score met the benchmark or not. A zero was used to denote a score that did not meet the benchmark and a 1 was used to denote a score that met or exceeded the benchmark.

A two-sample proportion hypothesis test was used to compare the proportion of students meeting the benchmark. The null hypothesis states the difference of the proportions is zero while the alternate hypothesis states the difference of the proportions is greater than zero. This test produced a p-value of 0.9866 which fails to reject the null hypothesis. There is not enough evidence to support a decrease in the number of students who are meeting the benchmark. When considering the descriptive statistics, it appears that the proportion of students meeting the benchmark has increased. Of the 240 students, 42 students were meeting the benchmark in the

spring of eighth grade and 62 students were meeting the benchmark in the fall of ninth grade. Another two-sample proportion hypothesis test was used to compare a null hypothesis that the difference of the proportions is zero and an alternate hypothesis that the difference is less than zero. This test produced a p-value of 0.0134 which rejects the null hypothesis and supports an increase in the proportion of students meeting the benchmark during this period.

A similar two-sample proportion hypothesis test was used to compare the proportions from the fall of freshman year to the winter. This produced a p-value of 0.1793 which fails to reject the null hypothesis. This indicates that there is not enough evidence to support an increase in the proportion of students meeting the benchmark during this time. This is rather shocking considering this is the period that saw the most growth in overall student scores. This suggests that overall test scores are increasing but the number of students meeting the benchmark is not.

The two-sample proportion test that was used to compare the winter of freshman year to the spring produced a p-value of 0.9515 which fails to reject the null hypothesis and does not support an increase in the number of students meeting benchmark during this time. This goes hand in hand with the results of the overall student scores. Lastly, the period of spring of eighth grade to spring of ninth grade was considered and produced a p-value of 0.0697. This fails to reject the null and does not support an increase in the proportion of students meeting benchmark from the end of eighth grade to the end of ninth grade. Again, this indicates that although scores are increasing overall, the number of students meeting benchmark is not. When looking at the descriptive statistics, it indicates that at the end of eighth grade there were 42 students meeting the benchmark and at the end of ninth grade there were 55 students meeting the benchmark. Since there are 240 students in this sample, that suggests an increase from 17.5% to 22.9% which is an overall increase of 5.4% of the student body. The statistical analysis may not prove to be

significant, but most school districts would be pleased with this increase. Table 10 shows the results of these proportion tests.

Table 10: MAP Number of Students Meeting Benchmark	
Time Period	Results
8th Grade Spring 2022 to 9th Grade Fall 2022	The proportion of students meeting the benchmark increased.
9Th Grade Fall 2022 to 9Th Grade Winter 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)
9th Grade Winter 2023 to 9th Grade Spring 2023	The proportion of students meeting the benchmark decreased.
9th Grade Fall 2023 to 9Th Grade Spring 2023	The proportion remained steady. (Overall decrease in number of students but not statistically significant)
8th Grade Spring 2022 to 9th Grade Spring 2023	The proportion remained steady. (Overall increase in number of students but not statistically significant)

PSAT and MAP Results Comparison

It is interesting to compare the PSAT 8/9 data to the MAP data and notice that the data from both standardized tests tell a similar story. This cohort of students does not seem to be affected by the transition from middle school to high school, in terms of their standardized test scores, as prior research would suggest. Their test scores overall increased when research would suggest a decrease. However, as noted earlier, their scores increased but the number of students meeting grade level benchmark did not. This primarily comes from the students who came into high school testing more than one grade level below. Their test scores are increasing but the gap is so wide that they are unable to catch up in one academic year. Since the data did not indicate

what was predicted, it opens the opportunity for further research. It is apparent that many students are testing below grade level, and it would be interesting to examine when this decrease happens initially. Student's test scores would need to be tracked from the first standardized test that they take in elementary school all the way through high school. Analyzing this data could pinpoint the grade in which students are struggling the most and where the initial decline begins so that proactive approaches can be taken to remedy the situation earlier in a student's academic career.

It may also be beneficial to consider the remainder of these student's high school careers. According to this data, at the end of their freshman year this cohort had 20% of its student body meeting standards. When considering the report card for this district over the past few years, only about 10% of the junior class is meeting standards on the SAT. This leads to many future questions about this cohort. It questions whether this cohort of students is simply a higher scoring cohort who will have a higher SAT percentage when they take the SAT their junior year. It also leads to further questions about systems at the high school. If this cohort models an average cohort of students from this district, it suggests that only about 10% of this class will meet the SAT benchmark. If this is the case, the systems at the high school need to be addressed. It may be beneficial to look at data for this cohort for their sophomore and junior years to see if there is a drastic decline at any point in those two academic years. It is possible that the struggles of the transition from middle school to high school have been adequately addressed with appropriate resources for students, but maybe more resources need to be put into place as students transition to their upper classmen years.

Possible Remedies

Although this data does not support a decrease in student test scores during the transition from middle school to high school, it is important that this transition is adequately addressed and that students are given the proper support. As mentioned previously, students may struggle during this time because their social groups have changed, and they are learning the layout of a new building while also learning which staff members they can turn to for different issues. One idea that is utilized by many high schools is a freshmen orientation. This orientation looks different depending on district programming, but the two most common models are discussed next. Some districts use the model of an eighth grade step up day which allows current eighth grade students to shadow a high school student for a day. This typically happens towards the end of the school year and allows the eighth grader to experience an average day in high school while allowing them the opportunity to meet some of the teachers, staff, and students. Another model that is utilized is an orientation day that happens at the beginning of freshmen year. This is often a day that only freshmen attend and allows them the opportunity to tour the building, learn their schedule, meet their teachers, and meet their fellow classmates without the added stress of having the upper classmen in the building as well. Both models are valuable and serve the same purpose which is to ensure that the freshmen class feels more comfortable on their first day of high school.

These are great models that districts should be utilizing; however, a singular orientation day may not be enough for all students. High schools may want to incorporate a more extensive program for students that have been identified as at-risk. “On the Block is an orientation and intervention program that begins in middle school and continues through students’ freshman year to help prepare students for the high school transition” (DeLamar & Brown, 2012, p. 33). The On

the Block program provided students with eight days of mock lessons, a review of procedures, and opportunity to get to know staff and students before their first day (DeLamar & Brown, 2012). Students who participated in the On the Block program showed gains in grade point average, fewer referrals, and fewer absences (DeLamar & Brown, 2012). High schools should consider a program like On the Block for their at-risk students since those students are more heavily impacted during the transition from middle school to high school.

A freshmen orientation program has shown to help students transition to high school in terms of social groups, but it's not likely to help if they are anxious about their math class. They may be comfortable with their classmates and even their teacher, but they may still be worried about their math ability especially if math has been a struggle for them in the past. High school math teachers need strategies for ensuring student success, especially during freshmen year. Considering the data showed that 80% of students ended freshman year below grade level, effective strategies are needed to close this gap before they graduate.

One strategy for closing this gap is to allow all eighth-grade students to take algebra. In many districts, math in eighth grade is similar to a pre-algebra course and is meant to prepare students for algebra in high school. In general, students who take algebra in eighth grade are considered gifted or honors students. This becomes a major issue because once students are placed in a particular track (honors or non-honors) they are often stuck in that track through the end of high school (Spielhagen, 2006). Students who are not given the opportunity to take algebra until their freshmen year of high school often miss the opportunity to take upper-level math courses before they graduate. Students who take algebra in eighth grade would then take geometry and algebra II their freshman and sophomore year. This affords them the opportunity to take upper-level math courses during junior and senior year that may be of interest to them. If

schools ensure that all students take algebra by eighth grade, they can still offer algebra to their high ability learners in sixth or seventh grade (Spielhagen, 2006). Access to algebra in eighth grade provides an early base for student success in math courses and has shown to increase the amount of advanced math courses taken by students (Spielhagen, 2006). This can help to level the equity playing field for minority students and students with a low socio-economic status.

Enrolling all students in algebra in eighth grade may not be a realistic change that can be implemented. It may be easier for a unified district to change this course sequence than a non-unified district, however a change of this nature could take a couple school years to complete. High school teachers often have very little say in when courses are offered to students and at times are told which curriculum to use for their classes. Regardless of the course offerings in the district or the current curriculum, teachers need strategies to help students close the achievement gap and get students closer to grade level.

One model that has been studied to increase student learning in STEM classes is the model of peer-led learning. This is a model that can be implemented in the classroom regardless of the curriculum being used but does require a bit of logistics in student schedules. In a peer-led learning classroom, the teacher begins with a brief mini lesson that introduces the concept. Students are then tasked to work in groups that are facilitated by peer instructional leaders. These leaders are not experts, they are of similar ability but one grade level advanced compared to the student learners (Thomas, Bonner, Everson, & Somers, 2015). This means that the leaders took and passed the course the year prior and were able to demonstrate proficiency in the content. The leaders also attended training courses to learn how to lead their small groups. This model demonstrated success for both the student learners and the peer instructional leaders. It may be beneficial for high schools to consider this model for their math classes. It the district that was

considered earlier, freshmen students take Algebra 1 and sophomore students take Algebra 2. Freshmen who demonstrate mastery in Algebra 1 could then become peer leaders during their sophomore year. This means they would still be immersed in the Algebra 1 curriculum as they learn Algebra 2. Knowing that math is a subject that builds on previous concepts, this would make their experience in Algebra 2 easier to manage because the prerequisite skills of Algebra 1 would be reinforced as they lead their small groups.

Peer-led learning may not be a feasible plan in all districts based on student schedules. Engagement, alignment, and rigor are all elements that a teacher has more ability to control. They are also components that directly lead to increased test scores on standardized tests. It is apparent that student engagement in class is a major predictor of student achievement. Student engagement is often defined as students who are actively processing information or communicating information, but it is important to note that engagement comes in three forms: behavioral, emotional, and cognitive (Early, Rogge, & Deci, 2014). Participation and positive conduct are behavioral engagement, signs of students being interested in the content is emotional engagement, and mental effort is cognitive engagement (Early, Rogge, & Deci, 2014). A student who is engaged in all three forms would show interest in the content, be actively participating in the lesson, and show mental effort in the lesson. Ensuring that students are engaged also stems from the other two aspects which are alignment and rigor. Alignment simply states that teachers are providing content in the correct order and are on target with what students need to learn. If students do not see how the current lesson connects to prior lessons and the broader scope of the class, it is harder to convince them to engage in the material. Rigor suggests that all students are expected to achieve high levels which directly ties to cognitive engagement. If teachers ensure

that their lessons are aligned to state standards and hold all their students to rigorous standards, they will naturally get an increase in engagement within their classes.

Unfortunately, teachers know that it is not this easy, and engagement in the lesson will not come easily for all students. Since each student is unique, there is not a cookie cutter approach to increase engagement. Since we know engagement is a main driving force of student achievement, teachers, administrators, and school districts should be looking at ways to increase engagement. The district that was used for this study has recently implemented a new curriculum to attempt to address this engagement issue. When considering a high school math class, most people picture students taking notes that the teacher writes on the board and occasionally students will work on practice problems in class. This model does not lend itself to high engagement. A student may be behaviorally engaged by actively taking notes; however, it is easy to become disengaged emotionally and cognitively. Copying notes does not require a high level of effort and many students will not find interest in the notes they are copying. A different model called, experience first, formalize later, is being utilized in this district, through a curriculum called math medic (Gallas, 2021). The students are given a story problem at the beginning of class and are placed in small groups. Within their group they are expected to read the problem, discuss the problem, and then collectively come up with a response to the problem. Once they have had some time to experience the problem of the day and brainstorm potential ideas, the class comes together. Groups can share their brainstorming ideas for the entire class to hear. The teacher then takes those ideas and formalizes them into the official notes for the class period. This increases student engagement because it increases the cognitive demand at the beginning of the lesson while also encouraging students to learn how to work within a group. Engagement during the formalized notes is also increased because students have an interest in them to see if

their group responses were on target. This model is one idea of many that schools can utilize to see if it increases engagement within their classrooms.

Goal orientation is another area that should be addressed when it comes to students' performance. Goal orientation comes in two categories which are mastery goals and performance goals. Mastery goals reflect a concern with developing new skills and are dependent on effort while performance goals represent a concern about being judged and outperforming others (Gutman, 2006). It is important that teachers create an environment in their classroom that is mastery goal based instead of performance goal based. This means teachers should reward effort and improvement more than they reward correct answers and good grades. This is imperative to increase engagement in lower-level students. By the time students get to high school, they have already determined if they are good at math or bad at math. Students who have labeled themselves as bad at math will struggle to engage in a classroom that is performance based because they will feel that they will never be able to outperform their peers who are good at math. These students have a fixed mindset when it comes to their ability to learn math, but goal orientation can help to encourage a growth mindset in students. Shifting the goals to mastery based will allow more opportunities for all students to engage because the goal is no longer about who can get the correct answer the fastest or who can get the most correct answers, but it shifts to a focus on the students who put in the most effort and make the most improvement throughout the unit.

The experience first, formalize later model also lends itself to a mastery goal classroom. The goal of the group discussion at the beginning of class is not dependent on the group getting the correct answer and often some of the questions don't have a correct answer. The goal is for students to spend time problem solving together and discussing their prior mathematical

knowledge to see if anything they have learned previously can help them with the current problem of the day. The problems are often based on things that occur in everyday life such as ordering a pizza, subscribing to Netflix, and renting a car. Even students who do not feel like their math skills are strong can participate in the discussion because they have real life experience with the concept. Groups are recognized for ensuring that all their group members are participating, maintaining active participation throughout, and never giving up. Although math is a subject in which most questions have one correct answer, it is important that teachers highlight the importance of effort and mastering the problem-solving process instead of focusing on getting correct answers.

Conclusion

There are multiple transitions that we encounter in life that disrupt our flow of progress. The transition between middle school and high school has been considered by multiple scholars since it occurs during a rather vulnerable time in a teenager's life. Beginning high school, going through puberty, determining self-identity, as well as any home life disruptions, add a great deal of stress to students during this time. As a result, it is no shock that we often see a decrease in academic performance. After examining a cohort of students, it was rather shocking to see that this cohort did not follow that trend and saw an increase in academic achievement during the transitional period. Digging further into the data showed that there was an increase in overall scores, but not a significant increase in the number of students meeting standards. By the end of ninth grade, only 20% of this cohort met the standards for their grade. Further statistical analysis needs to be completed to find the root cause. Earlier data for this cohort's elementary and middle school years should be examined to determine if there is a significant loss in academic achievement at a specific point prior to the transition to high school. It also would be beneficial to consider this

cohort over the next two school years to determine if there is a setback in their achievement. High schools are judged based on the number of students who meet standards on the SAT their junior year and therefore teachers are often put under an immense amount of pressure to raise this number. Offering Algebra in eighth grade and implementing peer-led learning in math classes may help but also requires a vast amount of cooperation between teachers, administrators, school districts, and school boards. Engagement, alignment, rigor, and mastery goals are items that individual classroom teachers can focus on to increase the number of students meeting the standards. Although there is not a clear-cut solution for these, teachers should be aware that these categories directly relate to student achievement and can assess the implementation of each in their current classroom. It is not something that will transform overnight, but teachers can work slowly to make small changes in their lessons to address engagement, alignment, rigor, and mastery goals. As they make these changes, they should continue to assess the progress of their class to determine the effectiveness of the changes.

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