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Jessica Chiantera
St. Cloud State University

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Early Reading Analysis

By Jessica Chiantera

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Executive Summary:

Students take different tests in Pre-K and Kindergarten to track their academic progress. For literacy skills, these tests are the Teaching Strategies GOLD, which is taken in Pre-K, and the FastBridge earlyReading, which is taken in Kindergarten. The objective of this report is to find the relationship between the Pre-K and Kindergarten tests and find which tests are the most important predictors of students overall success in Kindergarten. This study looked at students in three school districts: Princeton, Sartell-St. Stephen, and Sauk Rapids-Rice. The main things found in this research are the following:

- Regression models comparing the four Kindergarten subtests to the Pre-K Literacy Domain that is most closely related show that there is not a moderate relationship between the two tests.

- Regression models comparing the four Kindergarten subtests to the Kindergarten composite score show that there is a strong relationship between each of the four subtests and the composite score, with Letter Names having the strongest relationship.

- Logistic regression models show that "Identifies and Names Letters" and "Uses Letter-Sound Knowledge" are the two most significant Pre-K Literacy Domains in predicting if a student will be in low risk in Kindergarten.

- Logistic regression models show that all four Kindergarten subtests are significant predictors in whether a student will be in low risk in Kindergarten.

With this research, schools using these tests will have better knowledge of what test in Pre-K and Kindergarten are important to keep students on track to be successful in their literacy skills.

Data and Demographics:

The data that was analyzed in this analysis looked at students who were four years old in Pre-K in the spring of 2017, who were in Kindergarten in the fall of 2017. The dataset included a total of 329 students from the Princeton, Sartell-St. Stephen, and Sauk Rapids-Rice school districts. The dataset included students' scores from their Pre-K literacy tests, the Teaching Strategies GOLD, and their Kindergarten literacy tests, the FastBridge earlyReading, as well as other demographic information.

The Teaching Strategies GOLD is an authentic, observation-based assessment that helps teachers and administrators focus on what matters most for students success. Teachers gave their students a score from zero to nine based on how well they believed the student was doing in each Literacy Domain. Nine Literacy Domains were looked at in this analysis in three categories:

1. Demonstrates phonological awareness, which includes Literacy Domains of "Notices and Discriminates Rhyme", "Notices and Discriminates Alliteration", and "Notices and Discriminates Smaller and Smaller Units of Sound".
2. Demonstrates knowledge of the alphabet, which includes Literacy Domains of "Identifies and Names Letters" and "Uses Letter-Sound Knowledge".
3. Demonstrates knowledge of print and its uses, which includes Literacy Domains of "Uses and Appreciates Books" and "Uses Print Concepts".

The FastBridge earlyReading is multiple subtests of essential reading subskills. Each subtest produced a raw score based on the number of items correct or the number of items correct per minute. Benchmark standards were built to help determine which students are at high, some, or low academic risk, where low risk is considered a success. This test included different literacy categories: "Concepts of Print", "Onset Sounds", "Letter Names", "Letter Sounds", and a composite score that was derived from the four literacy skill tests.

Research Problems:

The Princeton, Sartell-St. Stephen, and Sauk Rapids-Rice school districts wanted to find whether there is a relationship between the Teaching Strategies GOLD and FastBridge earlyReading tests. In this report, the following questions are answered:

1. How do the four Kindergarten subtests relate to the Pre-K Literacy Domains? Is there a strong correlation between the two tests?

2. How do the four Kindergarten subtests relate to the Kindergarten composite score? Which of the subtests has the strongest correlation to the composite score?

3. What score does a student need to receive in Pre-K to be considered low risk on the composite score in Kindergarten?

4. Which Pre-K and Kindergarten subtests are significant predictors in whether a student will be at low risk in Kindergarten?

Findings:

Figure 1: *Concepts of Print vs Uses and Appreciate Books Regression Model*
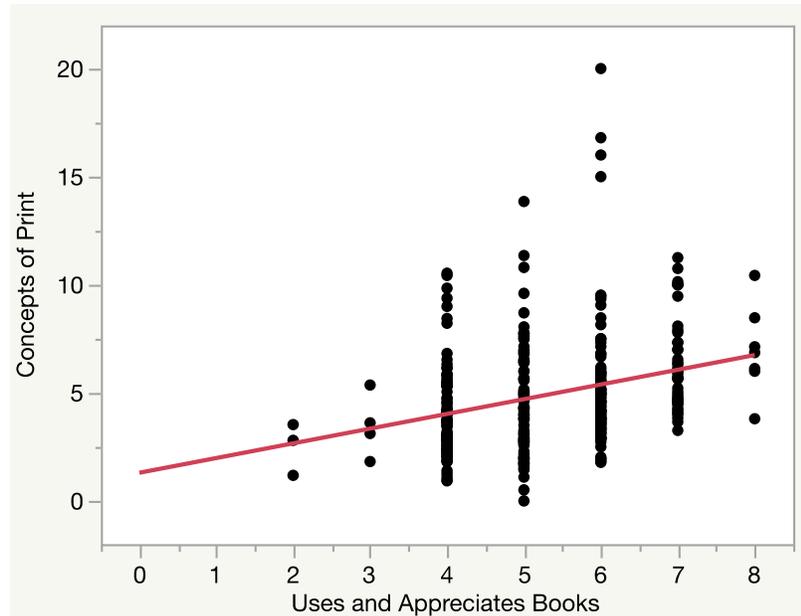
*Correlation = 0.30

The four Kindergarten subtests are similar to the multiple Pre-K Literacy Domains, where they are testing similar literacy content. Each of the four Kindergarten subtests was compared to the most similar Pre-K Literacy Domain to find whether there is a strong correlation between the Pre-K and Kindergarten literacy skills tests.

The Kindergarten "Concepts of Print" subtest was compared to the Pre-K "Uses and Appreciates Books" Literacy Domain (Figure 1). There was a moderate correlation found between these two tests, where a much stronger correlation would be expected because of the similar literacy content; however, the Pre-K Literacy Domains are a subjective test, being scored based on how the teacher thinks the students is doing on the Literacy Domain. This can cause biased results, affecting the overall correlation.

Figure 2: *Onset Sounds vs Notices and Discriminates Rhyme Regression Model*
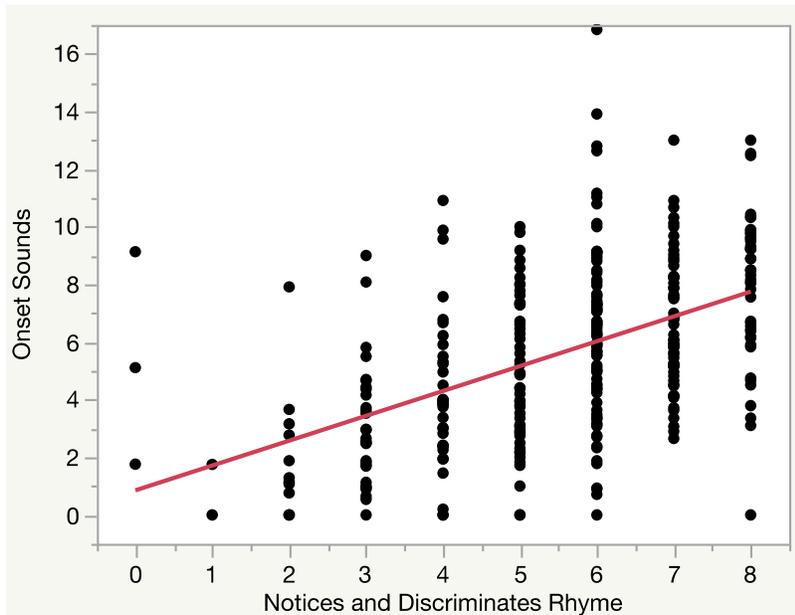
Correlation = 0.49

The Kindergarten "Onset Sounds" subtest was compared to the Pre-K "Notices and Discriminates Rhyme" Literacy Domain (Figure 2). This was a stronger correlation than the previous model; however, it is still only a moderate correlation. This correlation would have been expected to be stronger as well, but the subjective Pre-K scores may affect the correlation, including the students who received a zero on their Pre-K Literacy Domains. These students either improved greatly from the spring of 2017 to the fall of 2017, or the scores they were given in Pre-K were not a good indicator of their actual skill level.

Figure 3: *Letter Sounds vs Uses Letter-Sound Knowledge Regression Model*
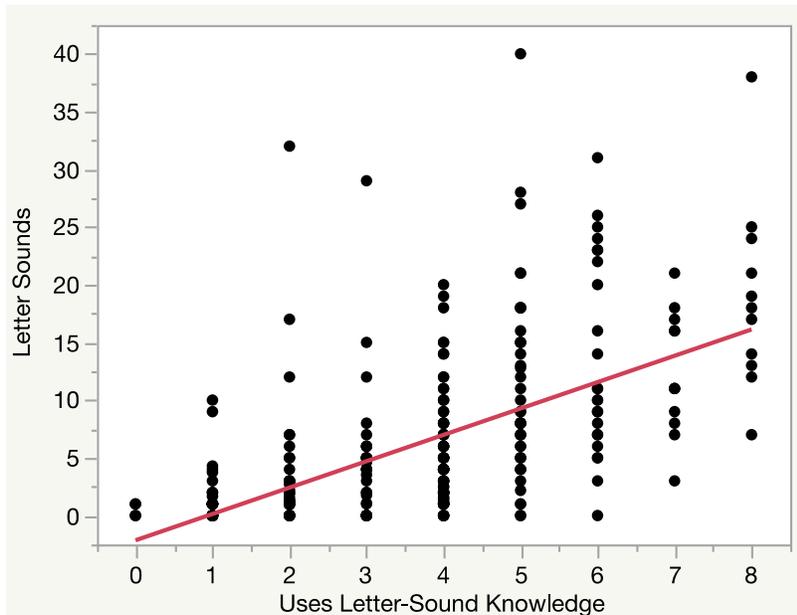
*Correlation = 0.59

The third regression model looked at the Kindergarten "Letter Sounds" subtest and the Pre-K "Uses Letter-Sound Knowledge" Literacy Domain (Figure 3). The correlation between these two tests was moderate, with a few outliers causing the correlation to be slightly weaker. Again, the Pre-K Literacy Domain scores are subjective, which is likely the result of the outliers shown at the top of the graph. The outliers in this model are all above the regression line, showing that students are either improving on their letter skills or their Pre-K teachers are not seeing some students letter knowledge.

Figure 4: *Letter Names vs Identifies and Names Letters Regression Model*
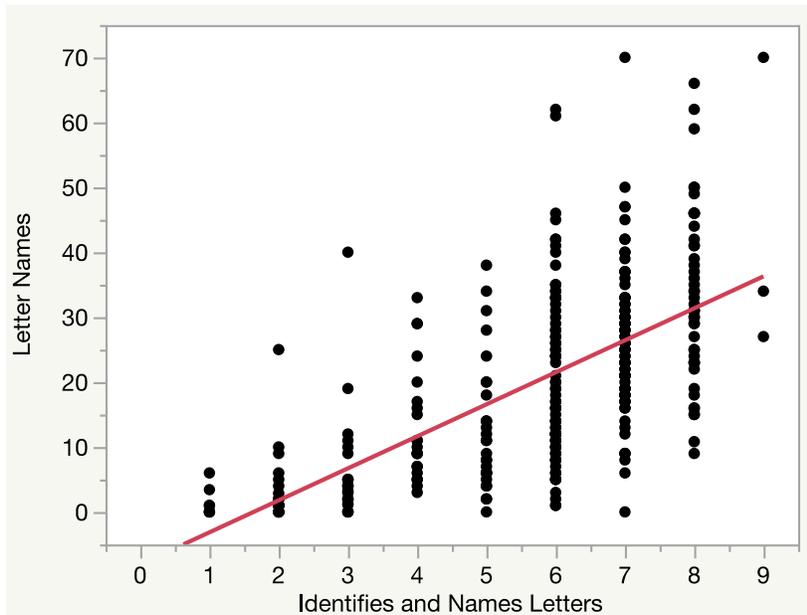
*Correlation = 0.65

The fourth Kindergarten subtest, "Letter Names," was compared to the Pre-K "Identifies and Names Letters" Literacy Domain (Figure 4). This was the strongest of the four correlations; however, this would still be considered a moderate correlation. There are a few outliers towards the top of the graph, which is likely why the correlation is not as strong as it would be expected to be.

Of the four regression models that were made, it was found that the correlations were not as strong as expected between the Pre-K and Kindergarten tests. This tells us that the two tests do not have a strong relationship with each other. Even though the two tests are looking at similar literacy skills, the difference between the subjective scoring in Pre-K and real testing scoring in Kindergarten may be causing biased results affecting the correlations.

Figure 5: *Concepts of Print vs Composite Score Regression Model*
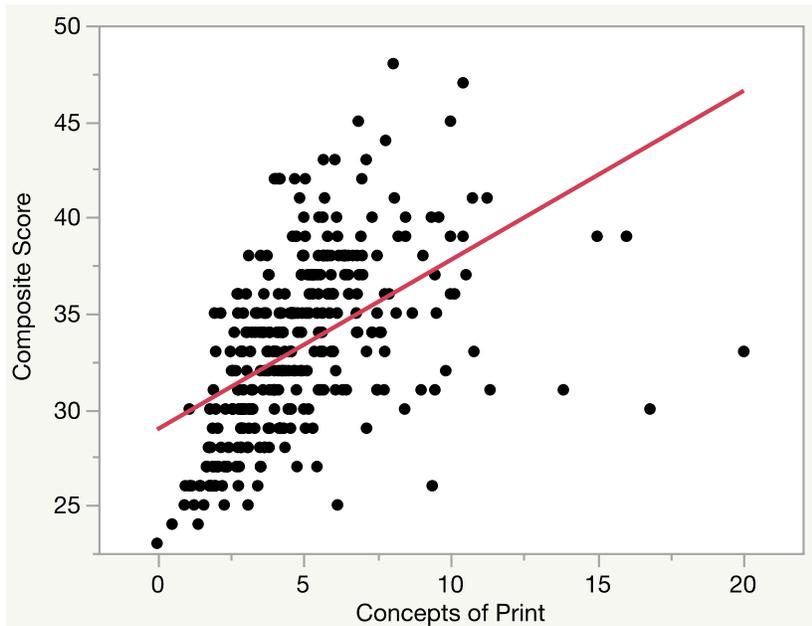
Correlation = 0.50

The next few models are finding the relationship between each of the four Kindergarten subtests and the Kindergarten "Composite Score." This was used to find if there was a relationship with how a student does on each subtest to how they do overall in Kindergarten.

The Kindergarten subtest "Concepts of Print" had the weakest correlation to the Kindergarten composite score; however, this is likely because of the outliers shown at the bottom of the graph (Figure 5). The Kindergarten subtests were scored differently than the Pre-K Literacy Domains, so there is no subjective scoring. This tells us that the outliers in this model are caused by student scoring and not because of biased results.

Figure 6: *Concepts of Print vs Composite Score Regression Model Excluding Outliers*
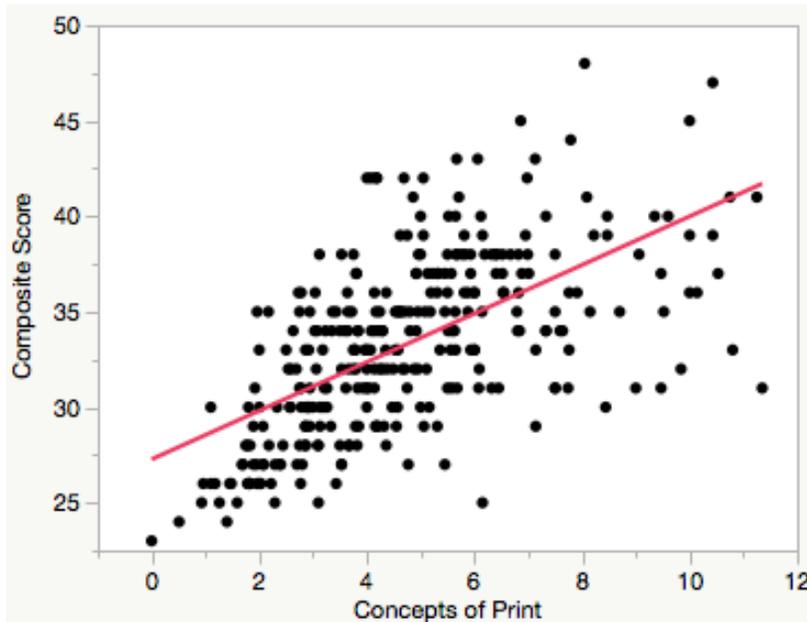
Correlation = .61

After excluding the outliers from the previous model, a new regression model was run comparing "Concepts of Print" and the composite score (Figure 6). This creates a stronger correlation; however, it is still the weakest correlation of the four Kindergarten subtests. Removing the outliers gives the line a better fit, where it looks like it follows the data better than the previous model. However, removing the outliers changes the regression line, which would affect any predictions that might be made using the "Concepts of Print" subtest. Removing the points can cause biased results because you are removing the students who scored high on "Concepts of Print" but did not have a high composite score. Therefore, the previous model is a more accurate representation of the student overall.

Figure 7: *Onset Sounds vs Composite Score Regression Model*
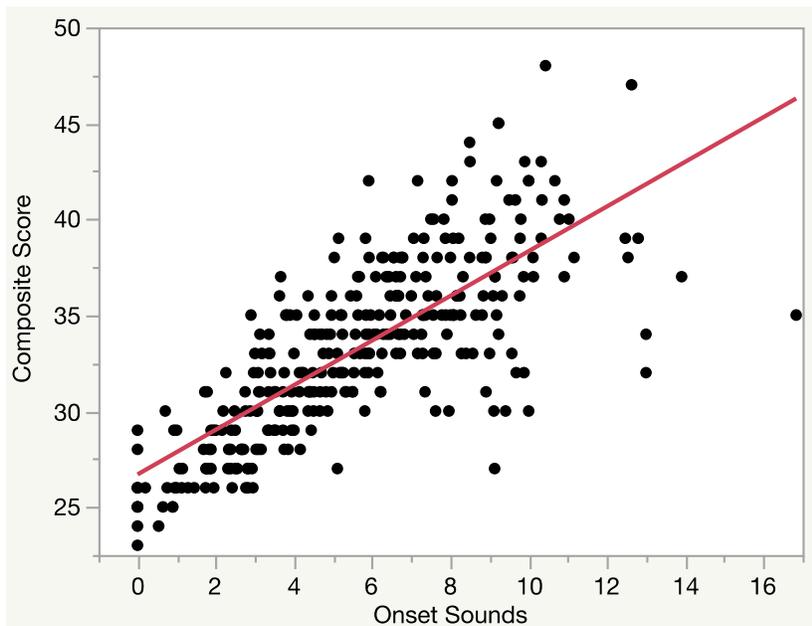
*Correlation = 0.76

Another correlation was run comparing the Kindergarten "Onset Sounds" subtest and the Kindergarten composite score (Figure 7). This correlation is considered a strong correlation, meaning that there is a relationship between the "Onset Sounds" subtest and the composite score. There are a few points in this model that could be considered outliers; however, there is still a strong correlation with them included.

Figure 8: *Letter Sounds vs Composite Score Regression Model*
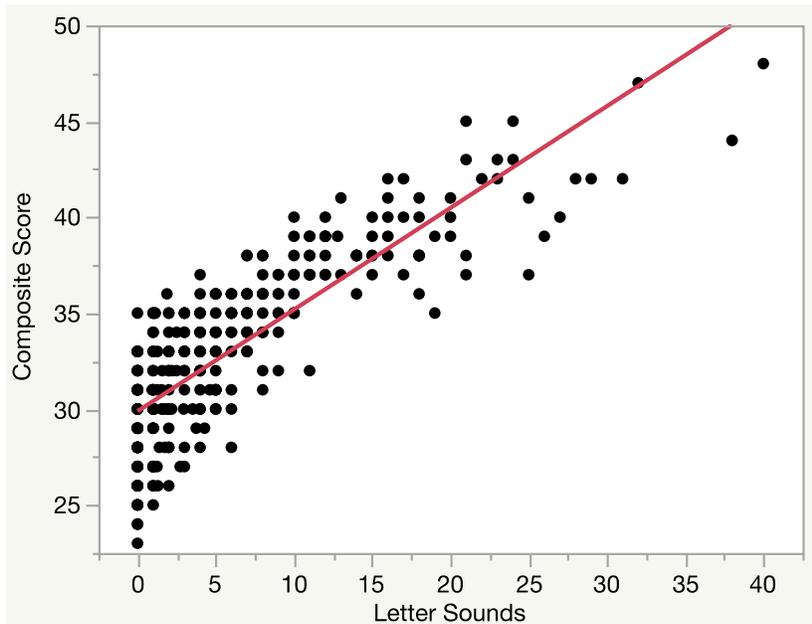
Correlation = 0.83

The Kindergarten "Letter Sounds" subtest was then compared to the Kindergarten composite score (Figure 8). This correlation is one of the stronger correlation, being very close to one. A larger number of students had a "Letter Sounds" score between zero and ten than higher scores. This could affect the correlation since those students had varied results on their composite score. This model has no large outliers shown, which is likely why the correlation would be stronger and showing that there is truly a strong relationship between the subtest "Letter Sounds" and the composite score. Students who score between a 25 and 40 on the "Letter Sounds" subtests are more commonly below the regression line, showing that even if the student scores high on a Kindergarten subtest, does not mean they will score high on their composite score.
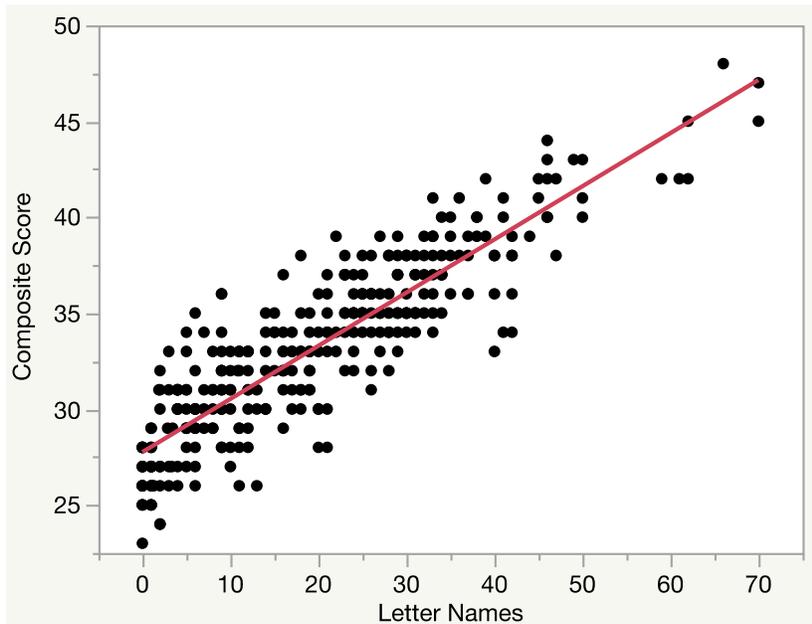
Correlation = 0.88

The final regression model that was run compared the Kindergarten "Letter Names" and the Kindergarten composite score (Figure 9). This is the strongest correlation of the four Kindergarten subtests, showing that there is the strongest relationship between how well students know their letter names and how well the student does overall.

Overall, the correlations between the four Kindergarten subtests and the composite score are fairly strong. These correlations are likely stronger than the Pre-K Literacy Domains because the Kindergarten subtests are not subjective scoring, so there is no bias. Taking out the biased scores looks at how well the student truly knows, not just how much the teacher sees that they know.

***Table 1:** Average Pre-K Scores for Risk Levels of Kindergarten Composite*

	Low Risk	Some Risk	High Risk
Scale Score	5.7	4.9	3.6
Identifies and Names Letters	6.9	5.3	3.6
Notices and Discriminates Rhyme	6.4	5.6	3.9
Uses and Appreciates Books	5.8	5.2	4.5
Notices and Discriminates Alliteration	5.6	4.8	3.5
Uses Print Concepts	5.3	4.7	3.6
Uses Letter-Sound Knowledge	4.8	3.3	2.0
Notices and Discriminates Smaller and Smaller Units of Sound	4.4	4.0	3.1

Using the Kindergarten composite risk levels, an average score for each of the Pre-K Literacy Domains was found (Table 1). The most important of the Literacy Domains looked at was the scale score, which was created from the average of the Pre-K Literacy Domains used in all three school districts. This shows that a student who has a scale score of 5.7 or higher is more likely to be at low risk on the composite score in Kindergarten.

Table 2: *Predicting Low Risk on Kindergarten Composite Score from Kindergarten Subtests*

	Estimates	P-value	Effect	Standard Error	Power
Onset Sounds	0.46	0.0001	11%	0.12	39%
Letter Sounds	0.29	0.0005	7%	0.08	67%
Letter Names	0.22	<.0001	6%	0.04	100%
Concepts of Print	0.14	0.0865	3%	0.08	70%

A logistic regression model was run to predict whether a student would be at low risk on their Kindergarten composite score based on their four Kindergarten subtests (Table 2). This model showed that all four of the subtests are significant predictors of students overall success. The effect shows how much the predicted probability will increase for a one-point increase on the subtests. So, for a one-point increase on the "Onset Sounds" subtest, the predicted probability that the student will be at low risk on their Kindergarten composite score increases by 11 percentage points. The statistical power is the likelihood that the study will detect an effect when there is an effect to detect. The size of the effect looked at in this analysis is 5 percentage points. A high statistical power means that the probability of making a Type II error, or predicting that a student will be at low risk when they are not, will go down.

Table 3: *Predicting Low Risk on Kindergarten Composite Score from Pre-K Literacy Domains*

	Estimates	P-value	Effect	Standard Error	Power
Identifies and Names Letters	0.64	<.0001	16%	0.14	30%
Uses Letter-Sound Knowledge	0.38	0.0055	10%	0.14	31%
Notices and Discriminates Rhyme	0.26	0.0775	6%	0.14	28%
Uses and Appreciates Books	0.12	0.4786	3%	0.16	23%
Notices and Discriminates Alliteration	-0.08	0.6056	-2%	0.15	27%

Another logistic regression model was run to predict whether a student would be at low risk on the Kindergarten composite score based on the Pre-K Literacy Domains that are used in all three school districts (Table 3). The Literacy Domains "Identifies and Names Letters" and "Uses Letter-Sound Knowledge" are significant predictors of a student being low risk; however, "Uses and Appreciates Books" and "Notices and Discriminates Alliteration" are not significant predictors. The Literacy Domain "Notices and Discriminates Alliteration" has a negative effect, but this is likely due to random variation. "Identifies and Names Letters" has the largest effect, so for every point increase, the predicted probability of being at low risk will increase by 16 percentage points. The statistical power is much lower than the previous model, so the probability of making a Type II error in this model is more likely.

Conclusion:

Students take tests in elementary school to track their skill levels. For literacy, these tests include the Teaching Strategies GOLD in Pre-K and the FastBridge earlyReading in Kindergarten. This report analyzed students' scores on these two literacy tests to find the relationship between the two tests. The key findings are the following:

- The relationship between the Pre-K and Kindergarten subtests that were closely related all had moderate correlations, showing that the Pre-K and Kindergarten tests are not very closely related. This is likely due to subjective scores on the Pre-K tests.

- The relationship between the four Kindergarten subtests and the Kindergarten composite score were all closely related. The strongest correlation was found between "Letter Names" and the composite score.

- A logistic regression model predicting a student being low risk on the Kindergarten composite score based on the four Kindergarten subtests shows that all four of the subtests are significant predictors of the students success.

- A logistic regression model predicting a student being low risk on the Kindergarten composite score based on the Pre-K Literacy Domains shows that "Identifies and Names Letters" and "Uses Letter-Sound Knowledge" are the two most significant predictors of student success.

This analysis shows where a student should be scoring on their Pre-K and Kindergarten literacy skill tests to be considered low risk. Further research can be done in different subject areas to find how students should be doing in other educational areas, and to find what skills students should know at this age to be successful in their education.

Appendix:

Methods and Solutions:

Problem 1: How do the four Kindergarten subtests relate to the Pre-K Literacy Domains? Is there a strong correlation between the two tests?

- Using the Fit Y by X in the program JMP, regression models were created between the four Kindergarten subtests and the Pre-K Literacy Domains that were closely related to them. A line was fit to the models to find how strong the correlation was. These models show whether the two tests are closely related to each other or not. It was found that they all had moderate correlations, meaning there is not a strong relationship between the two tests.

Problem 2: How do the four Kindergarten subtests relate to the Kindergarten composite score? Which of the subtests has the strongest correlation to the composite score?

- Using the Fit Y by X in the program JMP, regression models were created to find the relationship between the four Kindergarten subtests and the Kindergarten composite score. A line was fit to each of these models and correlations were found. One model, for the Kindergarten subtest "Concepts of Print", there were multiple outliers causing a weaker correlation, so the outliers were removed for a second model, which improved the correlation.

Problem 3: What score does a student need to receive in Pre-K to be considered low risk on the composite score in Kindergarten?

- Using an Excel pivot table, the average scores were found for each Pre-K Literacy Domain and the created scale score for the different risk levels of the Kindergarten composite score. These scores can be used to predict whether a student will be at low, some, or high academic risk in Kindergarten.

Problem 4: Which Pre-K and Kindergarten subtests are significant predictors in whether a student will be at low risk in Kindergarten?

- Using the program JMP, logistic regression models were created using Analyze, Fit Model. The first model used the four Kindergarten subtests to predict a student being in low risk on the Kindergarten composite score and the second model used the Pre-K Literacy Domains to predict a student being in low risk. These models show what subtests and Literacy Domains are the most significant predictors in student's success in Kindergarten.

Data Preparation:

The data used in this analysis included information on 329 students that were in Pre-K in the Spring of 2017 and who were in Kindergarten in the Fall of 2017. An indicator variable was added to this dataset for whether a student was in low risk on their English composite score: this variable assigned a 1 to students in low risk and a 0 to students in some and high risk. Another variable was created for a scale score for students Pre-K Literacy Domains. This variable was the average of the five Literacy Domains that were used in all three school districts: "Notices and Discriminates Rhyme", "Notices and Discriminates Alliteration", "Identifies and Names Letters", "Uses Letter-Sound Knowledge", and "Uses and Appreciates Books". All students given on the dataset were used in this analysis.

Type I and II Errors:

When doing statistical hypothesis testing, there are two types of common errors, type I and type II errors. A Type I error is when you reject the null hypothesis when the null is true, also known as a "false positive." This type of error often occurs when you jump to conclusions too early in the analysis. A type I error is fixed at 5%, which means that there is a 5% chance that the null hypothesis will be rejected when the null is actually true. In this analysis, a Type I error would be when a student is predicted to be in some or high risk when they are actually in low risk on the Kindergarten composite score. A Type II error is when you accept the null hypothesis when the null is false, also known as a "false negative." This type of error occurs when you are too conservative in the analysis. A Type II error will reject the alternative hypothesis when the alternative hypothesis is actually true. In this analysis, a Type II error would occur when a student is predicted to be at low risk in Kindergarten when they are actually in some or high risk.

P-value:

The p-value represents the level of significance of a statistical hypothesis that signifies the probability that a given event will occur. In most statistical analyses, a 0.05 significance level is the cutoff for significance. A p-value of less than or equal to 0.05 shows good evidence to reject the null hypothesis, and a p-value of greater than 0.05 does not give enough evidence against the null, so you would fail to reject the null. The p-values in this analysis were low in predicting student success from the Kindergarten subtests, where they were all below 0.10. In the second model, with Pre-K tests predictors, half of the variables were low, where "Uses and Appreciates Books" and "Notices and Discriminates Alliteration" were not significant predictors.

Power:

Power is the probability that you will reject the false null hypothesis, or "proving" your hypothesis. The statistical power is different from a Type II error, or power is one minus the probability of a Type II error occurring. When the statistical power is high, the likelihood that a Type II error occurs goes down. In this analysis, the model with the Kindergarten subtests as the predictors had high powers, meaning that there were lower probabilities of making a Type II error. However, the second model with the Pre-K Literacy Domains being the predictors had lower power, so the probability of a Type II error occurring was higher. There was a 5-percentage point effect used in this analysis, where the larger effects are easier to detect. This shows that there is likely to be very few Type II errors that occur in the first model, where there may be a few in the second.

Variable List:

Program – What program the student was in (School district)

Class – The class the student was in (how many days a week and time of day)

ChildID – Students ID number (3000 = Sartell-St. Stephen, 4000 = Princeton, 5000 = Sauk

Rapids-Rice)

Gender – is the student male or female

Birthdate – Students date of birth

Spring 2016/2017 Objective 15a – Notices and discriminates rhyme Literacy Domain

Spring 2016/2017 Objective 15b – Notices and discriminates alliteration Literacy Domain

Spring 2016/2017 Objective 15c – Notices and discriminates smaller and smaller units of sound

Literacy Domain

Spring 2016/2017 Objective 16a – Identifies and names letters Literacy Domain

Spring 2016/2017 Objective 16b – Uses letter-sound Knowledge Literacy Domain

Spring 2016/2017 Objective 17a – Uses and appreciates books Literacy Domain

Spring 2016/2017 Objective 17b – Uses print concepts Literacy Domain

Scale Score – Average of Objectives 15a, 15b, 16a, 16b, and 17a scores

Fall Early Reading English Risk Level – Risk level on composite score (high risk, some risk, or

low risk)

Early Reading Success – Indicator variable created for success on English composite score (1 =

low risk, 0 = some or high risk)

Fall Early Reading English Composite Score – Actual English composite score received

Fall Concepts of Print Risk Level – Risk level on Concepts of Print subtest (high risk, some risk,

or low risk)

Fall Concepts of Print IC per minute – Number of items correct on the subtest of Concepts of

Print

Fall Letter Names WRC per minute – Number of words read correct per minute on the subtest of

Letter Names

Fall Letter Names Risk Level – Risk level on Letter Names subtest (high risk, some risk, or low

risk)

Fall Letter Sounds WRC per minute – Number of words read correct per minute for the Letter

Sounds subtest

Fall Letter Sounds Risk Level – Risk level on Letter Sounds subtest (high risk, some risk, or low

risk)

Fall Onset Sounds IC per minute – Number of items correct per minute on Onset Sounds subtest

Fall Onset Sounds Risk Level – Risk level on Onset Sounds subtest (high risk, some risk, or low

risk)