Who is Likely to Achieve Kindergarten Readiness in Universal Pre-Kindergarten?

A Predictive Analytic Model

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Executive Summary

Early childhood education has been a focal point in the Rochester community for over 30 years. Beginning in 1992, RECAP came to be through a collaborative effort between the United Way of Greater Rochester, the Rochester Area Community Foundation, the Rochester City School District (RCSD), Action for a Better Community (ABC), Monroe County, and Children's Institute. The purpose of the RECAP project has always been to continuously promote and ensure the highest quality pre-kindergarten programming possible for Rochester's three and four-year old children.

RECAP provides a variety of services to the community to ensure classroom teachers and program administrators are provided with on-going professional development opportunities and interpretations of student and classroom quality outcomes.

The purpose of this study was to identify groups of children at universal pre-kindergarten (UPK) entry who have different probabilities of making a successful transition to kindergarten by the end of the UPK academic year by implementing a predictive analytics model. Findings from the study include:

1. Children's scores in *Creative Arts*, *Social-Emotional Development*, *Social Studies*, and *Language, Literacy, and Communication* content areas from the Child Observation Record-Advantage (COR-Advantage) were identified as predictors of school readiness.

2. *Assertive Social Skills*, a domain found within the Teacher-Child Rating Scale (T-CRS) was also determined to be a predictor of school readiness.

3. UPK has a substantial number of declining high achievers. Many of them screened as potentially gifted in the Brigance.

4. The greatest growth during UPK occurred for a small sample of students who were not identified by the Brigance as either potentially gifted or needing formal evaluation. Understanding how such great growth happened in UPK may be important to expand this group.

Based on the predictive analytic model outcomes reported, our recommendations to RECAP are:

1. Identify children in the 4 low performing groups and consider designing a success plan to improve those students' likelihood to achieve kindergarten readiness by the end of their UPK year,

2. Target declining achievers for increased growth. Improve, implement, and evaluate new approaches for gifted education for children in the Rochester community,

3. Study students for whom great growth happened, to discover lessons which may increase the size of this group in future cohorts.

Purpose of the Study

The purpose of this study is to discover subgroups of children at entrance into UPK who have different probabilities of being kindergarten ready by the end of the Universal Pre-K year using machine learning, predictive analytic models.

K-Readiness Criterion

Following COR+ scoring methodology, a child is deemed to have met kindergarten readiness standard at the end of the UPK year if the following conditions are met:

- 75% or more of the items in each content area are scored, and

- The average content area score for all the content areas is at or exceeds 3.75, and the overall average of all eight content areas is at or above 4.0 (HighScope, 2014).

Fifty-nine percent of the sample met the K-readiness criterion.

Predictive Analytic Model

K-Readiness Criterion Conditional Inference Tree Model

Figure 1 shows the conditional inference tree model estimated, which divided the UPK students into eight groups: four groups of various sizes that were likely to reach the kindergarten readiness standard and four groups that were unlikely to reach the kindergarten readiness standard.

Figure 1 –Conditional Inference Tree Model for Kindergarten Readiness Standard.

Conditional Inference Tree for Kindergarten Readiness at Exit from UPK
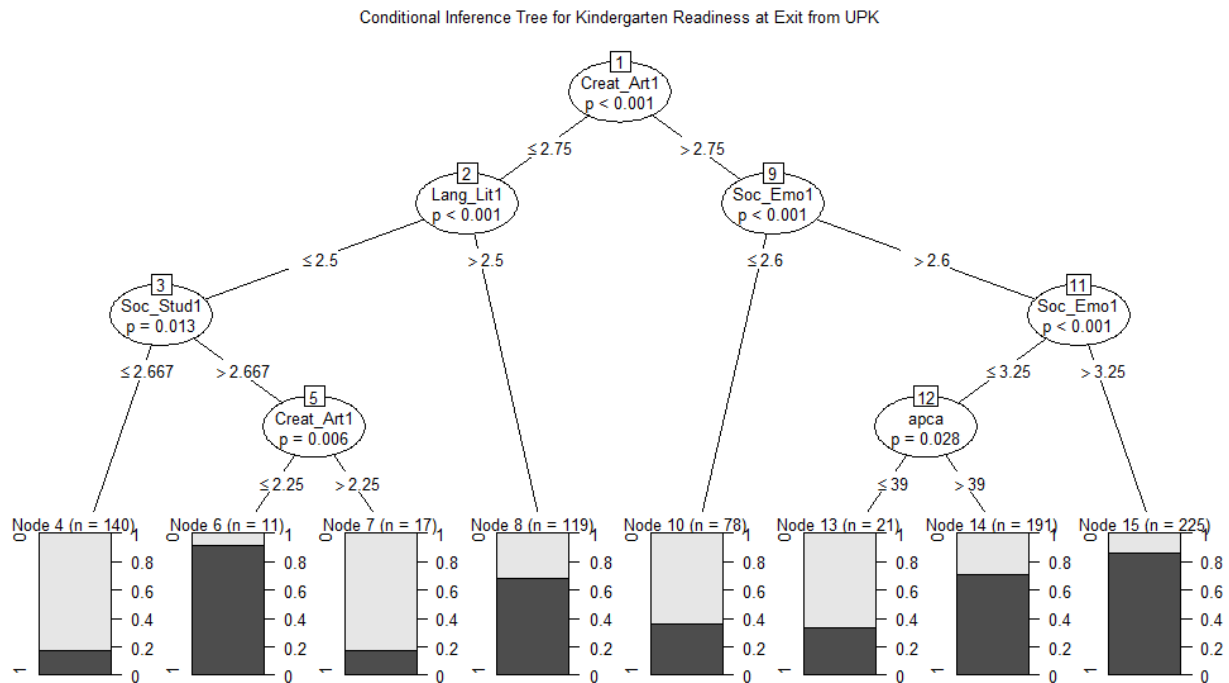
Note: Soc_Emo1: Social-Emotional Development score at time 1. Lang_Lit1: Language, Literacy and Communication score at time 1. Soc_Stud1: Social Studies score at time 1. Creat_Art1: Creative Arts score at time 1. APCA: Teacher-Child Rating Scale Assertive Social Skills percentile score at time 1. Time 1: early fall of the UPK year.

The figure shows that in the training data, several groups of children were relatively likely to achieve kindergarten readiness (listed in decreasing order by size):

- Node 15: Students whose Creative Arts score was above 2.75 and their Social-Emotional Development score was above 3.25.

- Node 14: Students whose Creative Arts score was above 2.75, their Social-Emotional Development score was between 2.6 and 3.25 (2.6, 3.25], and were above the 39 percentile in the Teacher Child Rating Scale Assertive Social Skills subscale.

- Node 8: Students whose Creative Arts score was at or below 2.75 and their Language, Literacy and Communication score was higher than 2.5.

- Node 6: Students whose Creative Arts score was at or below 2.25, their Language, Literacy and Communication score was at or below 2.5 and their Social Studies score was higher than 2.67.

There were four groups of students who were unlikely to achieve kindergarten readiness by the end of the UPK year (listed in decreasing order by size):

- Node 4: Students whose Creative Arts score was at or below 2.75, their Language, Literacy and Communication score was at or below 2.5 and their Social Studies score was at or below 2.67.

- Node 10: Students whose Creative Arts score was higher than 2.75 and their Social-Emotional Development was at or below 2.6.

- Node 13: Students whose Creative Arts score was above 2.75, their Social-Emotional Development score was between 2.6 and 3.25 (2.6, 3.25], and were at or below the 39 percentile in the Teacher Child Rating Scale Assertive Social Skills subscale.

- Node 7: Students whose Creative Arts score was between 2.25 and 2.75 (2.25, 2.75], their Language, Literacy and Communication score was at or below 2.5 and their Social Studies score was higher than 2.67.

As can be readily seen, the child's score in Creative Arts, Social-Emotional Development and Language, Literacy and Communication, and Social Studies content areas were the chosen predictors. The only subscale of the Teacher-Child Rating Scale (T-CRS) chosen was Assertive Social Skills. Other T-CRS subscales and COR+ content areas were available for selection into the model but were not actually selected, as their information was either already contained in the variables the model selected or irrelevant to the model.

Performance of the Eight Groups during the UPK Year

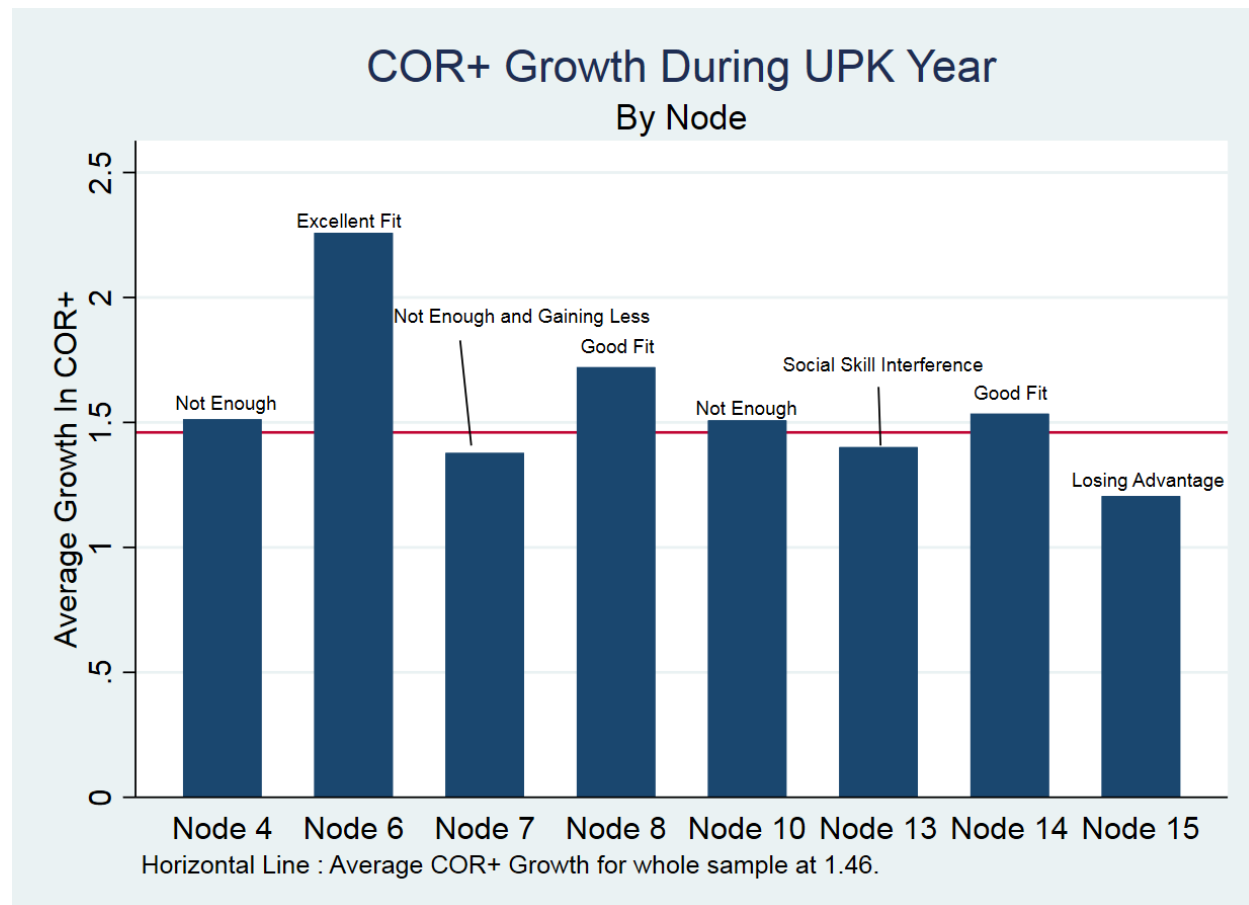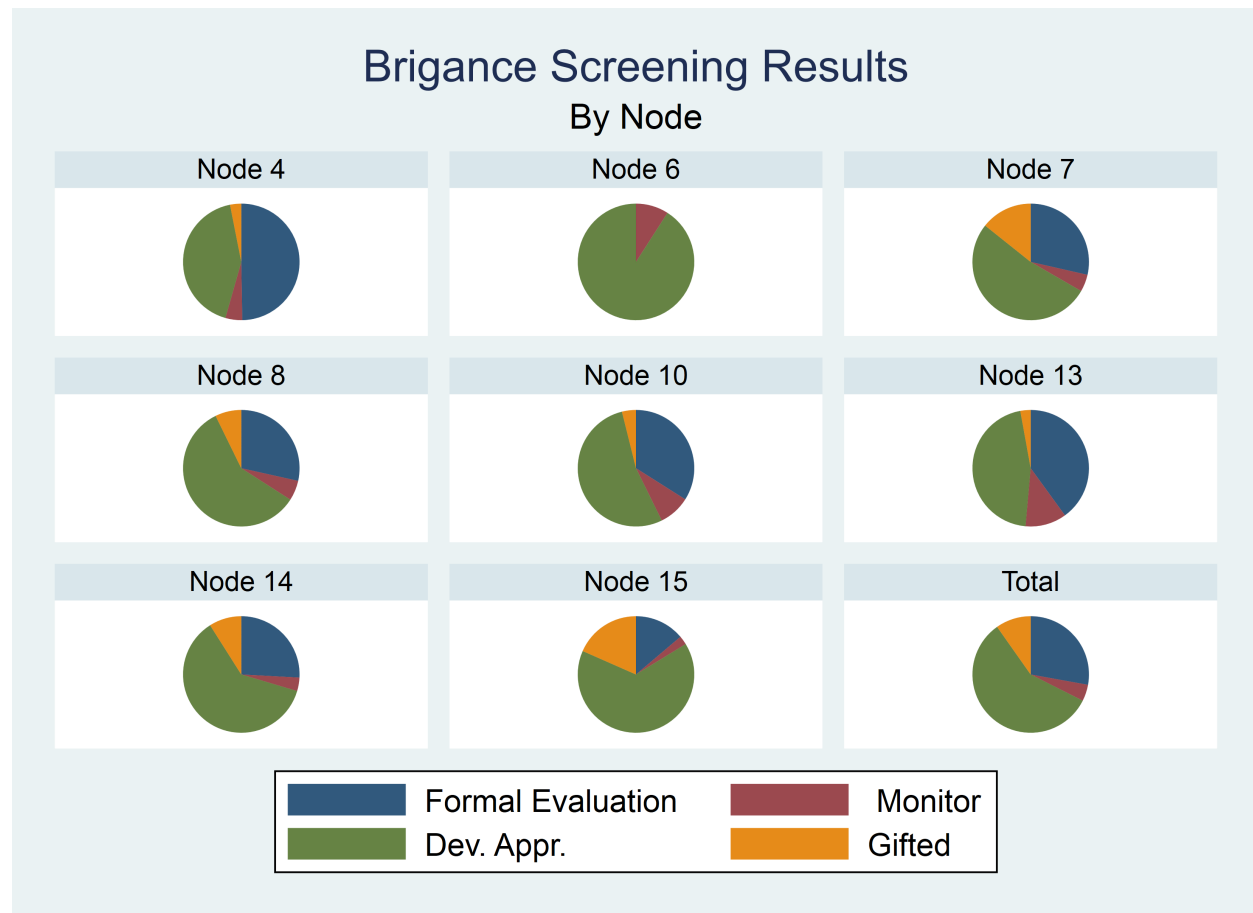Figure 2 –COR+ growth during the UPK year by node.

Figure 2 shows the overall change in the COR+ during the UPK year for members of each group. The findings will be discussed in context of the Brigance screening results shown in Figure 3.

Figure 3 –Brigance Screening Results by Node.

As can be readily seen, there are various patterns of growth:

- The members of Node 6 are the students most likely to grow the most in the areas measured by the COR+ during the UPK year. In some sense, the curriculum and instruction received fits these children particularly well, which is why even though their initial Time 1 scores are low they are extremely likely to achieve the kindergarten readiness standard. Thus Node 6 pattern could be labeled as *"excellent curricular and instruction fit"*. The Brigance screening results show no students in this group were referred for formal evaluation. Unfortunately this group is merely 1.4% of the UPK class.

- The majority of the students who reach the kindergarten readiness standard are in Node 15. This group performs well but had below average growth in the COR + during the UPK year thus it is labeled "losing advantage" in figure 2. The group contains a sizeable percentage of potentially gifted students as shown in the Brigance screening results. They are *declining high achievers.*

- Students in Node 14 and Node 8 have average growth and average or above average performance during the year. This large group of kids is in some sense the "representative UPK student" and it is labeled "good fit" in figure 2. About a quarter of this group were recommended for formal evaluation.

- Students in large group Node 4 had average growth in the COR+ , as did the 10% of students in Node 10; yet both of these groups have a low probability of reaching the kindergarten readiness standard. These 27% of students are the "not enough" students that have comprised the narrative of RECAP in past years, namely, the students grow in skills during UPK but not enough to reach the kindergarten readiness standard. The Brigance screening results in figure 3 show that a large percentage of these students were recommended for monitoring or formal evaluation.

- The 2% of students in Node 7, not only are unlikely to reach the kindergarten readiness standard but also grow less than other groups in COR+ during the UPK year. The program is not working well for these students.

- The 3% of students in Node 13 are also unlikely to achieve kindergarten readiness and have below average COR + growth during the UPK year. Almost half of this group was referred for formal evaluation or monitoring. They are relatively low in assertive social skills. Thus, their bar was labeled "social skill interference" in skill acquisition.

Table 1 summarizes these information.

Table 1. Summary of Properties of Nodes.

Node	Size	Performs	Growth During the year	Brigance	Status
Node 15	Large (28%)	Well	Below Average	Many Gifted	Declining High Achievers
Node 14	Large (24%)	Average	Average	Normal pattern	Good fit
Node 4	Large (17%)	Poorly	Average	Many Formal Eval.	Not Enough
Node 8	Large (15%)	Average	Above Average	Normal pattern	Good Fit
Node 10	Medium (10%)	Poorly	Average	Many Formal Eval.	Not Enough
Node 13	Small (3%)	Poorly	Below Average	Many Formal Eval.	Social Skill
Node 7	Small (2%)	Poorly	Below Average	Some Gifted	Not Growing
Node 6	Small (1%)	Well	Above Average	None needed Formal Eval.	Great Growth!

Note: Nodes sorted by size.

Conclusions

Based on the models outlined before, we conclude the following:

- UPK has a substantial number of declining high achievers. Many of them screened as potentially gifted in the Brigance.

- The standard narrative that "UPK is good growth but not enough" only applies to a fraction of the UPK group. Many of these students were referred for formal evaluations or monitoring.

- The greatest growth during UPK occurred for a small sample of students who were not identified by the Brigance as either potentially gifted or needing formal evaluation. Understanding how such great growth happened in UPK may be important to expand this group.

Recommendations

Based on the models outlined before, we recommend to the RECAP team the following:

(1) Identify children in the 4 low performing groups and consider designing a success plan to improve those students' likelihood to achieve kindergarten readiness.

(2) Target declining high achievers for improved growth. Improve, implement, and evaluate new approaches for gifted education in UPK.

(3) Study students for whom great growth happened, to discover lessons to increase the size of this group.

Technical Appendix

For the purpose of this study, de-identified archival data from the 2017-18 academic year was included. The dataset represented universal pre-kindergarten (UPK) students that would be transitioning to kindergarten the following school year. The overall sample size of UPK students was n=2281 (51% male). The Child Observation Record-Advantage (COR Advantage) is a cognitive and social-emotional anecdotal child assessment that is collected by the teacher at three times during the academic year (fall, winter, spring). At two times during the academic year the UPK teacher collects social-emotional information by using the Teacher-Child Rating Scale (T-CRS). The Brigance III, which is administered by the classroom teacher within 90 days of student enrollment, is included as well. Also included in the dataset is student demographic information (race, gender, IEP status, school location, and attendance information). Similarly, classroom quality outcomes are also included in the dataset, in which third party observer's measure classroom quality using the Classroom Assessment Scoring System (CLASS) and Early Childhood Environment Rating Scale-3 (ECERS-3).

Only UPK related de-identified RECAP data with complete pre-post COR+ was used in this study. The sample size was 1204. The data was randomly split into a training (2/3, n=802) and validation (1/3, n=402) subsamples. The accuracy of the model was 0.70. Sixteen percent of students who were ready for kindergarten were misclassified by the model. The model has specificity of 0.84 but sensitivity is only 0.51.

About the Authors

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