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A Multilevel Approach of Exploring the Predictors of High School Readiness

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ABSTRACT: Employing a two-level Hierarchical Generalized Linear Model (HGLM) technique, this paper predicted high school readiness derived from student's proficiency in reading and mathematics during middle school. The HGLM approach to predict high school readiness (i.e., student's status being high school ready) incorporated student and school level predictors in level-1 and level-2 models, respectively. This analysis included 7,115 students from 64 schools in one of the largest school districts in United States of America. The results found several academic, demographic, and behavioral predictors at student and school levels producing significant effects on high school readiness. The across-school variance for predicting the probability of high school readiness is also found significant.

Keywords: High school readiness, Hierarchical Generalized Linear Model, Student and school level predictors, Fixed and random effects, Across-school variance.

1. INTRODUCTION

High school readiness is an important component for graduating middle school students in terms of pursuing high school education. The school districts in United States of America (USA) are continuously attempting to increase middle school success rates and prepare the students for high school level courses. To serve the pertinent purpose, this paper identifies the significant student and school level predictors of high school readiness. Such kind of exploration would facilitate the school systems for implementing interventions on such predictors that may help increasing high school readiness rates. In this research, the high school readiness is defined as eighth grade student's proficiency in reading and mathematics. It is important to track those students who are not high school ready and search for determinants of their success for high school readiness. Improving the students academically by controlling selected indicators of future high school success is challenging as well as important endeavor for educators.

In order to improve the high school readiness rates for middle school graduating students, we need to identify and control the predictors of such outcome measure. The teachers need a focus on improving those students who are not high school ready. Such students are the target students who will be struggling for the success in early high school level courses. For this purpose, we have developed a rigorous statistical model that would enable to identify significant predictors at student and school levels impacting student's status being high school ready. The school systems will be able to increase students' probability of success in early high school level courses by controlling such significant indicators at appropriate grade levels. This study used student's high school readiness data (an outcome measure) for eighth graders during the school year 2018-2019. The analysis used student as well as school level predictors from the School District of Palm Beach County (SDPBC), Florida, USA.

As an important component of long-term objective in the SDPBC, the high school readiness is defined by student's status of being proficient (achievement level 3 or above) in Florida Standard Assessments (FSA) English Language Arts (ELA) or reading and mathematics. High school readiness, a binary response outcome, is predicted by employing a two-level HGLM approach incorporating student and school level predictors at level-1 and level-2 models, respectively. First, this paper identifies student and school level significant predictors of high school readiness and then estimates across-school variance while predicting such outcome measure. This research will benefit the school systems in USA and other countries for increasing students' high school readiness rates with appropriate interventions.

2. SEARCHING THE PREDICTORS OF HIGH SCHOOL READINESS

Several studies in past used academic, demographic, and behavioral predictors to predict reading and mathematics achievement which are the indicators of high school readiness. Such predictors include student academic achievement, participations in English language learner (ELL) and exceptional student education (ESE), out of school suspensions (OSS), student grade retention, and student mobility to predict student achievement related to high school readiness. Implementing an intensive reading program for experimental group using matched groups of middle school students with reading disabilities, significant differences were found between the experimental and comparison conditions on multiple measures of reading achievement with scores favoring the experimental condition (Hock, Brasseur-Hock, Hock, Duvel, 2017). Akbash, Sahin, and Yaykiran (2016) found positive effect of reading scores on mathematics achievement. Using California statewide assessment data, Liang, Heckman, and Abedi (2018) revealed that the seventh-grade (prior year) mathematics test scores account for 61% of the variance in eighth graders' algebra test scores, and Thomasson (2010) found prior year academic achievements such as seventh-grade mathematics scores as significant predictors of middle school mathematics achievement.

Past studies show negative effect of ELL on student's reading or academic achievement (Abedi & Gandara, 2006; Abedi, 2004; Kieffer, 2008; Subedi, Reese, & Powell 2015). For example, Subedi, Reese, and Powell (2015) found a negative effect of ELL on student's GPA Grade Point Average (GPA) using SDPBC data. Past studies show negative effect of ESE on student's academic achievement (Hampton & Mason, 2003; Subedi & Howard, 2017). An analysis showed significant negative effect on middle school reading achievement due to student ESE participation (Subedi & Howard, 2017).

Using nationally representative data, Ibrahim and Johnson (2020) found that suspended students scored lower in math 2 years after the suspensions occurred after controlling for student and school characteristics, and prior math achievement. Perry and Morris (2014) found a decreased student achievement due to the effect of suspension and expulsion independent of socio-demographic influences, and Arica (2006) found student suspension to be related with decreased achievement.

Based on the grade retention research, Bowman (2005) reported that retention does not typically increase student performance and Shepard and Smith (1990) argued that the retained children may appear to do better in the short term, but they are at much greater risk for future failure than their equally achieving, non-retained peers. Silberglitt, Appleton, Burns, and Jimerson (2006) revealed that retained students did not experience a benefit in their growth rate and made less progress compared to promoted students which showed an empirical evidence failing to support the effectiveness of grade retention. In later grades, some hold that retention can be a consequence for low achievement, forcing students to be accountable for their academic work (Frey, 2005). Past finding revealed that mobile students performed below non-mobile students, and mobility level of the school attended had a negative effect on the academic achievement of its students (Eddy, 2011).

3. METHODOLOGY

Data

This research used 2019 data that included eighth grade students' reading and mathematics proficiency flags in FSA ELA and FSA Mathematics for SDPBC students. After matching with the relevant predictors, the final analysis is performed that excluded (deleted) missing data. The final analysis included 7,115 students to predict reading and mathematics proficiency as the indicators of high school readiness incorporating student and school level predictors.

Research Questions

Following research questions are addressed through this study.

1. What are the significant student and school level factors predicting students' probability of being high school ready?
2. Does the probability of being high school ready vary across schools?

Variables

Outcome Variable

High school readiness: This is a dichotomous variable for student's proficiency (coded as 1) and non-proficiency (coded as 0) in reading (FSA ELA) and mathematics. The overall percentage of high school readiness was 32%.

Student Level Predictors

All of the following predictors, except pre-test scores, are used from grade eight for school year 2018-19 (the pre-test scores are used from grade seven) to predict high school readiness. The student and school level models were developed separately where the final models included only significant predictors given below.

Reading pretest scores. This is a continuous variable given by Florida Comprehensive Assessment Test (FCAT) Reading scores for seventh graders that ranged from 171 to 289 (with a mean score of 222.2).

Mathematics pretest scores. This is a continuous variable given by FCAT Mathematics scores for seventh graders that ranged from 179 to 289 (with a mean score of 228.9).

For the final analysis, both reading and mathematics pretest scores are used as standardized normal scores (with mean 0 and standard deviation 1).

English Language Learners (ELL). This is a dichotomous variable with 1 for student's ELL status and 0 for non-ELL status.[1] The overall mean percentage of ELL is found 10%.

Number of OSS (out-of-school) events. This is a continuous variable for a student with the total number of OSS events. This predictor ranged from 0 to 25 (with an overall mean event of 0.4).

Year-to-date retention. This is a continuous variable with number of grade retentions throughout their school life from grade K-8. This variable ranged from 0 to 2 (with an overall mean score of 0.17).

Student mobility. This is a dichotomous predictor if a student had transferred a school within the SDPBC (coded as 1 for mobility and 0 for not mobility) from previous year to the current year. The overall mean percentage of mobility is found 9%.

School Level Predictor

Average reading pretest scores. This is a continuous variable with school average reading pretest scores which is aggregated from student reading pretest scores for each school that ranged from 171 to 289.

[1]Based on the codes provided by the Florida Department of Education, LY (the student is Limited English Proficient, LEP and is enrolled in classes specifically designed for LEP students) and LF (the student is being followed up for a two-year period after having exited from the ESOL program) codes are considered as ELL in this study.

4. Developing HGLM Models

This paper employed a two-level HGLM technique in order to answer research questions 1 and 2. Student and school level predictors are included in level-1 and level-2 models, respectively. Only significant predictors are included in the final student and school level models as given below.

Assuming Y_{ij} as student's status being high school ready, the log of probability of students being high school ready can be predicted by the level-1 model for i^{th} student nested in j^{th} school as below.

$$\log(P(Y_{ij}=1)/(1-P(Y_{ij}=1))) = \beta_{0j} + \beta_{1j}(RDPRETST)_{ij} + \beta_{2j}(MTHPRETST)_{ij} + \beta_{3j}(ELL)_{ij} + \beta_{4j}(ESE)_{ij} + \beta_{5j}(OSS)_{ij} + \beta_{6j}(RET)_{ij} + \beta_{7j}(MOB)_{ij} \quad (1a)$$

As presented in Equation (1a), β_{0j} is the intercept. The coefficients β_{1j}, β_{2j}, β_{3j}, β_{4j}, β_{5j}, β_{6j}, and β_{7j} are student level effects for pretest scores in reading and mathematics, ELL status, ESE status, total OSS events, number of year-to-date retentions, and mobility status, respectively.

In level-2 model, the level-1 coefficients are assumed as outcomes and predicted in Equation (1b) as given below.

$$\begin{aligned}
\beta_{0j} &= \gamma_{00} + \gamma_{01}(AVGRDPRETST)_j + u_{0j} \\
\beta_{1j} &= \gamma_{10} \\
\beta_{2j} &= \gamma_{20} \\
\beta_{3j} &= \gamma_{30} \\
\beta_{4j} &= \gamma_{40} + \gamma_{41}(AVGRDPRETST)_j \\
\beta_{5j} &= \gamma_{50} \\
\beta_{6j} &= \gamma_{60} \\
\beta_{7j} &= \gamma_{70}
\end{aligned} \quad (1b)$$

Equation (1b) consists of fixed (γ terms) and random (u term) effects where the term γ_{00} represents the average high school readiness rate for all schools and u_{0j} represents the random effect at school level with multivariate normal distribution. The level-2 coefficients in Equation (1b) are defined as follows:
γ_{01} = Effect of school average reading pretest scores (on average probability of being high school ready),
γ_{41} = Interaction effect of student ESE status with school average reading pretest scores

The intercepts for level-1 slopes, defined below, represent the effects on predicting probability of high school readiness.

γ_{10} = Effect of average reading pretest scores,
γ_{20} = Effect of average mathematics pretest scores,
γ_{30} = Effect of student's ELL participation relative to that of non-ELL participation,
γ_{40} = Effect of student's ESE participation relative to that of non-ESE participation,
γ_{50} = Effect average number of OSS,
γ_{60} = Effect average number of retentions,
γ_{70} = Effect of student's mobility participation relative to that of non-mobility participation

The statistical analysis for multilevel analysis used PROC GLIMMIX procedure in SAS as illustrated by Ene, Leighton, Blue, and Bell (2015) to estimate fixed effects (intercepts and slopes) and random effects (variance components) at student and school levels.

5. RESULTS

The results based on final (model) analysis for predicting the probability of being high school ready are presented in Table 1 and Table 2. These tables contain the estimates of fixed effects of significant predictors (at .05 alpha level) and random effect (variance component) to address research questions 1 and 2.

As presented in Table 1, the results show that reading and mathematics pretest scores are found significant (p< .0001) at student level with positive effects for predicting student's status being high school ready. The results revealed that student participation in ELL (p = .0120), out of school suspension or OSS events (p< .0001), year-to-date retention (p = .0328), and mobility (p = .0231) are found significant with negative effects.

Table 1: Effect Estimates, Standard Error and p-Values for Predicting High School Readiness

Predictors (Fixed Effects)	Effect Estimate	Standard Error	p-Value
Reading pretest scores (standardized)	0.0857	0.0034	<.0001
Mathematics pre-test scores (standardized)	0.0633	0.0031	<.0001
ELL participation	-0.4226	0.1682	0.0120
Suspensions (OSS)	-0.1515	0.0315	<.0001
Year-to-date retention	-0.3087	0.1445	0.0328
Mobility	-0.3227	0.1420	0.0231
School average reading pretest scores	0.0199	0.0089	0.0254
ESE participation x School average reading pretest scores	-0.0114	0.0004	0.0026

At school level, average reding pretest scores is found significant (p=.0254) with positive effect. Further, the results showed significant interaction effects between student ESE participation and school average reading pretest scores (p=.0026) producing negative effect for predicting student's status being high school ready.

In order to answer the research question 2, the random effect or variance component (u_{0j}) at school level is estimated as presented in Table 2. The result shows that the across-school variance for predicting student's status being high school ready is found significant (p =.0014) at alpha level .01.

Table 2. School Level Variance for Predicting High School Readiness

Random Effect	Estimate of Variance Component	Standard Error	p-Value
Between-school variance	0.1740	0.0583	.0014

6. DISCUSSIONS

The study found positive effects of student reading and mathematics pretest scores on high school readiness which construct is derived from student's reading and mathematics proficiency. These findings are consistent with the results of past studies (Hock, Brasseur-Hock, Hock, Duvel, 2017; Liang, Heckman, and Abedi, 2018; Thomasson, 2010). These results imply that the educators should focus on seventh grade reading and mathematics subject preparations in order to improve the student academic achievement at the end of middle school for high school readiness.

Further, student's ELL participation showed significant negative effect on high school readiness. This result is supported by past studies (Abedi & Gandara, 2006; Kieffer, 2008; Subedi, Reese, & Powell 2015). Thus, being more proficient in English language would help students performing better in middle school reading and mathematics proficiency and being ready for high school. Similarly, out-of-school suspensions (OSS) showed a significant negative effect on reading and mathematics proficiency which are indicators high school readiness. This finding is supported by several research works in past (Arica, 2006; Ibrahim and Johnson, 2020; Perry and Morris, 2014). The intuitive perception of this finding is that students' behavioral problems hinder academic achievement which in turn will decrease the high school readiness rates.

This study found significant negative effects of student retention and mobility (from previous year to the current year) on high school readiness. These results imply that the student's grade retention and mobility in middle

schools are strong factors to impact negatively on student's proficiency in reading and mathematics resulting to the decreased rates of the high school readiness. These findings are support by several studies that found negative effect of retention (Bowman, 2005; Frey, 2005; Silberglitt et al., 2006) and negative impact of mobility (Eddy, 2011) on student academic outcomes.

Since a significant positive effect of reading pretest scores at student level is found on high school readiness, it intuitive and justifiable that school average reading pretest scores showed a significant positive effect on the same outcome measure (i.e., reading and mathematics proficiency which are the indicators of high school readiness).

Given the negative effect of student ESE (Hampton & Mason, 2003; Subedi & Howard, 2017) and positive effect of school average academic achievement (Hock, Brasseur-Hock, Hock, Duvel, 2017), it is intuitive that the interaction effect between these two predictors is negative on high school readiness. This implies that even though the students with disabilities score high in reading, it does not help in increasing their high school readiness rates which requires special reading intervention program for these students.

7. CONCLUSIONS

This paper employed a two-level hierarchical generalized linear model (HGLM) in order to predict students' probability of being high school ready. The study identified several significant academic, demographic, and behavioral predictors at student and school levels. The across-school variance for predicting the probability of students being high school ready is found significant.

This research would benefit middle school graduating students for their high school readiness by implementing appropriate intervention programs for those students who are not high school ready. Given the significant student level predictors of high school readiness, the interventions in proper directions on such factors may increase high school readiness rates. For instance, given the significant negative effects of suspensions and grade retentions, school systems might predominately be able to control such predictors in order to improve high school readiness rates. The educators and school administrators need to recognize such salient factors impacting high school readiness and emphasize the importance of appropriate interventions on such potential predictors related to discipline, retention, mobility, and equity.

Viewing the broader implications and benefits, the results of this study can be generalized to other school districts in USA and other countries with similar student populations. As a novel contribution to the research field, this study modeled high school readiness as an outcome measure which is rare. This study is limited to employing a two-level HGLM with predictors at student and school levels, and future explorations are recommended using a three-level HGLM incorporating potential student, teacher, and school level predictors. This would allow to explore significant teacher level predictors in addition to student and school level predictors of high school readiness.

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