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Identifying Scalable Policy Solutions: A State-wide Cross-classified Analysis of Factors Related to Early Childhood Literacy

Robert L. Vagi
Clarin Collins
Arizona State University
&
Terri Clark
Read On Arizona
United States

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Abstract: Given the critical role that literacy plays in children's academic and personal development, policymakers have increasingly focused on policies related to early childhood literacy, particularly among poor and minority students. In this study, authors use a census of data from Arizona, a state with a large and growing population of traditionally low-performing demographic groups, to identify school, district, and community health factors that plausibly influence third grade literacy rates. Authors find two independent measures of student attendance related to school-level reading achievement after controlling for a variety of factors that have been identified in previous studies of student achievement. The findings indicate that policies aimed at increasing school-level attendance rates may be effective and inexpensive approaches to increasing childhood literacy rates.

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Identificar soluciones de política: Un análisis de los factores de clasificación relacionados con la alfabetización en la primera infancia
Resumen: Dado el papel crítico que juega la alfabetización en el desarrollo académico y personal de los niños, los políticos han llegado a centrarse cada vez más en las políticas relacionadas con la alfabetización en la primera infancia, especialmente entre los estudiantes minoritarios y pobres. En este estudio, los autores utilizan un censo de datos de Arizona, un estado con una población grande y creciente de grupos demográficos tradicionalmente baja de rendimiento, para identificar los factores de escuelas, distrito y comunidad que plausiblemente influencia de las tasas de alfabetización de tercer grado. Los autores encontraron dos medidas independientes de la presencia en la clase de los estudiantes relacionados con el nivel de lectura después de controlar por una variedad de factores que han sido identificados en estudios previos de los logros de los estudiantes. Los resultados indican que las políticas para aumentar las tasas de asistencia escolar pueden ser métodos eficaces y viables para aumentar las tasas de alfabetización de los niños.
Palabras-clave: la instrucción; la primera infancia; la política educativa

Identificar soluções políticas: Uma análise de classificação de fatores relacionados à alfabetização na primeira infância
Resumo: Dado o papel crítico que a alfabetização desempenha no desenvolvimento acadêmico e pessoal das crianças, os formuladores de políticas têm vindo a concentrar-se cada vez mais nas políticas relacionadas à alfabetização na primeira infância, particularmente entre os estudantes de minoria e pobres. Neste estudo, os autores usam um censo de dados do Arizona, um estado com uma grande e crescente população de grupos demográficos tradicionalmente de baixo desempenho, para identificar fatores de escolas, distrito e comunidade que plausivelmente influenciam as taxas de alfabetização de terceiro grau. Os autores encontraram duas medidas independentes de presença em aula dos alunos relacionadas com o nível de leitura após o controle de uma variedade de fatores que foram identificados em estudos anteriores de realizações dos alunos. Os resultados indicam que as políticas destinadas a aumentar as taxas de frequência escolar podem ser abordagens eficazes e viáveis para aumentar as taxas de alfabetização infantil.
Palavras-chave: alfabetização; primeira infância; política educacional

Introduction

Early childhood literacy development is an essential foundation for learning and school success, and a critical skillset for functioning in and contributing to society. While much of literacy development occurs before children are of school-going age, early childhood literacy is often discussed within the context of formal schooling. Nearly 15 million children are enrolled in K-3 public school classrooms across the United States (Davis & Bauman, 2013). In these grades, children receive literacy instruction that will have a tremendous impact in their lives both academically and personally. Research indicates that children who gain proficiency in pre-reading skills during kindergarten are more likely to read successfully in later grades (McNamara, Scissons, & Gutknecth, 2011), when reading becomes integral to learning. From kindergarten through third grade, children are learning to read whereas curriculum from third grade on requires students to be strong readers in order to learn much of the content (Wanzek et al., 2013). Inability to read at grade level causes

students to fall further behind their peers academically with each passing grade level. Additionally, students who are proficient at reading in the third grade are more likely to graduate from high school (Hernandez, 2012; Wilson & Hughes, 2009). Therefore, early childhood literacy programs in schools play a vital role in the academic development of children and contributes to educational and professional success throughout their lives.

Given the critical role that literacy plays in children's academic and personal development, policymakers have increasingly focused on policies related to early childhood literacy. For instance, 17 states and the District of Columbia have policies that require students who do not demonstrate basic reading proficiency by the end of third grade to be retained (Heitin, 2016; Jacob, 2016). Although mandatory retention policies are hotly debated, they have become increasingly popular among state legislatures as a way of potentially improving literacy outcomes for students.

Early studies of grade retention suggested that retention negatively affects students' academic performance and persistence (Allensworth, 2005; Grissom & Shepard, 1989; Roderick, 1994). These studies, however, relied largely on retention decisions made subjectively by teachers and other school leaders making the task of identifying an adequate control group difficult, if not impossible. A recent series of studies have capitalized on the objective nature of test-based retention policies. Specifically, these studies benefit from the fact retention is determined by clear and measurable criteria (i.e. whether or not a student meets a certain performance goal). These studies show an increase in academic performance among retained students when compared to their socially-promoted and same-grade peers (Jacob & Lefgren, 2004; Schwerdt, West & Winters, 2015). However, these effects may decay over time and potentially disappear within six years of when a student was retained (Schwerdt et al., 2015). Taken together, these retention studies suggest that retaining students in third grade for not meeting certain test-based criteria likely results in at least short-term academic benefits but that retention has little or no effect on high school graduation rates.

Echoing these findings, states like Arizona, Florida, and others have acknowledged that retention alone is likely insufficient if students are to be successful throughout their academic careers (Miller, 2014). As a result, these states have passed mandatory retention laws that also require school districts to provide services like initial literacy screenings for K-3 students, placing struggling students with highly effective teachers, and developing a system for monitoring student progress over time (Heitin, 2016; Rose, 2012). Initial evidence suggests that these policies, when passed as a package of services and interventions, may be effective at improving student learning, particularly as it relates to literacy (Miller, 2014).

In light of this, it is important that policymakers and education practitioners understand the often complex systems in which literacy develops and design interventions accordingly. Specifically, successful interventions must acknowledge the rich ecologies in which students learn (Bronfenbrenner, 1976) both in and outside of school. A longstanding body of research supports Bronfenbrenner's ecological model of human development and suggests that there are many non-school factors that affect student learning (DeBaryshe, Binder & Buell, 2000; Green, Lilly & Barrett, 2002; Lonigan, Escamilla & Strickland, 2008), and early childhood literacy is no exception. In fact, research suggests that much of students' academic success is determined before they even start kindergarten by experiences and exposure to literacy related factors in their home and community environment (Lonigan & Shanahan, 2008; Whitehurst & Lonigan, 1998). However, much of the research related to student achievement, in general, and childhood literacy, specifically, has examined school and community factors separately.

Bronfenbrenner (1976, 1978, 1979) addresses the shortcomings of such a siloed approach in his ecological model of human development. Specifically, he points out that a variety of systems

affect how people change over time. For instance, children learn from people with whom they most closely interact, such as their families, as well as through relationships with others in their neighborhoods and schooling environments. Additionally, interactions and influence can occur across settings, such as when a student's home life impacts how they learn in school, or vice versa. Beyond children's immediate environments, governing rules or policies, as well as religious beliefs or ideologies can influence their development (see also Rosa & Tudge, 2013).

Research has linked early childhood learning to a variety of experiences outside of the traditional school day including family life (DeBaryshe et al. 2000; Green et al. 2002; Lonigan et al., 2008; Lonigan & Shanahan, 2008) and preschool settings (Barnett, 2008; Snow, Burns & Griffin, 1998). As a result, education policies aimed solely at children's experiences in school settings may miss important factors that affect whether or not a child is successful academically. We account for this interrelatedness in our study by examining factors from various systems in addition to school-related factors. Specifically, we examine relationships between school, district, and community factors and early childhood literacy. In this way, our analyses allow us to examine those factors that potentially have the strongest influence on childhood literacy while accounting for the complex systems in which children live. Further, it may give policymakers an indication of the systems that are most policy-relevant as it relates to improving early childhood literacy.

With regard to education policy implementation in the US, federal and state policies are often left to the discretion of individual school districts to determine how they should be implemented (Gunnarsson, Orazem, Sanchez & Verdisco, 2009). While there are pros with autonomy or local control for districts, it can also be burdensome for schools to come up with programs and the necessary resources (Dillon, 2011). Arizona is no stranger to local control of policy-driven education initiatives such as school choice and curriculum decisions. When it comes to early childhood literacy policy, Arizona has capitalized on a hybrid approach, maintaining the local control of individual agencies, schools, and programs, but collaborating state-wide to learn from, support, and build upon literacy best practices. Thanks to the leadership and coordination of Read on Arizona, Arizona is one of the leading states with efforts to identify, support, and improve early childhood literacy programs and outcomes.

Read On Arizona is a statewide, public/private partnership of agencies, philanthropic organizations, and community stakeholders committed to creating and supporting an effective continuum of services to improve language and literacy outcomes for Arizona's children from birth through age 8. Organized as a response to the Arizona state statutes on K-3 literacy and third grade reading retention[1], Read On Arizona offers a holistic approach by bringing together agencies to identify how each of their individual missions can contribute to the collective effort to support literacy outcomes of Arizona's children. While schools play a significant role in literacy (Hanushek & Rivkin, 2007; Thapa, Cohen, Guffey & Higgins-D'Allesandro, 2013), and literacy data is more readily available from schools (e.g., screening and assessment scores, grade promotion rates), schools

[1] Arizona State Statute 15-704 requires school districts and charters to provide effective reading instruction, with initial screening; on-going diagnostic and classroom based reading assessments, and a system to monitor student progress. Arizona's revised statute 15-211 requires all school districts and charters with a K-3 program to submit a comprehensive plan for reading instruction and intervention across grade kindergarten through grade 3. State funding is provided to schools to support the implementation of their K-3 reading plan. The goal is to have all grade three students in Arizona reading proficiently at grade level. Arizona Revised Statute 15-701 states that if data on the third grade statewide reading assessment is available and demonstrates that a student scored "falls far below" the student shall not be promoted from the third grade. There are two exemptions in Arizona Revised Statute 15-701.

cannot improve language and literacy outcomes on their own, and this work needs to start long before children enter formal schooling (DeBaryshe et al. 2000; Green et al. 2002; Lonigan et al., 2008). Read On Arizona and its partner organizations recognize this challenge and are leading an effort to promote early childhood literacy by examining the entire continuum.

For this study, agencies such as the Arizona Department of Education, Arizona Department of Health, First Things First, and Head Start collaborated by providing a diverse array of state-level data related to their work in order to better understand holistically how a variety of factors are related to childhood literacy. Such rich, representative data provides us with a unique opportunity to better understand how a diverse set of factors are potentially influencing childhood literacy across the state. To the extent that these factors can be influenced by legislation, our analysis will inform policy makers as they work to promote childhood literacy in Arizona and beyond.

Therefore, the purpose of this study is to identify policy-relevant community, district and school factors that are related to childhood literacy. Though the data in this study are specific to Arizona, it is important to note that Arizona has literacy challenges that also affect states across the country. For example, in 2015, 38% of Arizona's fourth graders fell below basic reading levels on the National Assessment of Educational Progress (NAEP) placing it only 6% below the national average (United States Department of Education, 2015). Further, Arizona is representative of the demographic shifts that are occurring in many states. For instance, Arizona is an ethnically diverse state with a large population of English language learners (Douglas, 2016), and 51% of all Arizona children are from low-income families (National Center for Children in Poverty, 2016). These challenges make Arizona an ideal case for understanding factors associated with childhood literacy, so that resources may be leveraged and strategies developed based on the identification and better understanding of such factors.

Specifically, with this study we ask the following research question: "What community-, district-, and school-level factors are related to third grade literacy, as measured by state reading assessment scores?" To do this, we make use of data collected from the Arizona Department of Education, First Things First, Head Start, and the Arizona Department of Health. Such rich data allows us to examine relationships between variables that, in many studies, have been examined separately. Further, it allows us to provide information that can be used by organizations and agencies serving children from birth to age 8 to strategically leverage resources, and to possibly identify effective policy solutions. In the following sections we give a brief overview of research related to childhood literacy, describe our sample and methods, present our results, and discuss the findings.

Literature Review

Long-standing research exists that examines the strong relationship between early childhood experiences and the development of literacy skills. Since the home is typically the first place in which a child is exposed to language, a significant body of research has focused on the influence of children's home environments on literacy development (DeBaryshe et al. 2000; Green et al. 2002; Lonigan et al., 2008; Lonigan & Shanahan, 2008). Perhaps the strongest home-related factor is parent-child interactions (Crain-Thoreson, Dahlin & Powell, 2001; Curenton, Craig & Flanigan, 2008). Researchers have found that children who experience child-directed speech from a parent or caregiver tend to develop complex vocabularies and efficient information processing. This, in turn, leads to greater cognitive gains throughout life (Lonigan et al., 2008; Lonigan & Shanahan, 2008; Whitehurst & Lonigan, 1998). Research also indicates that children's exposure to written language begins in the home which, depending on the amount and quality of the exposure, can influence their

literacy skills (Whitehurst & Lonigan, 1998). Additional early literacy skills like symbolic decoding and phonemic awareness develop through interactions with adults and play an important role in literacy preparation (Justice, 2006; Lonigan et al., 2008).

Although many literacy-related skills are first learned in the home, studies have shown that preschools and other early childhood education programs can play an important role in literacy development (Barnett, 2008). To this end, students who attend programs that teach skills like phonemic awareness, phonics, vocabulary, comprehension, and fluency are more likely to be prepared as they enter the first years of school than students who do not attend such early childhood programs (Snow et al., 1998). When children enter elementary school, they build on their previous experiences to further develop these skills. In school-based literacy programs, children learn to manipulate sounds, read novel words, and infer word meanings from context, all of which are critical literacy skills (Snow et al., 1998). Research suggests high-quality instruction that focuses on these skills can result in significant gains for students (Bursuck et al., 2004; Vaughn, Wanzek & Fletcher, 2007).

The effects of reading programs in elementary school can differ based on a child's early childhood experiences and the accumulation of literacy skills over time (Neaum, 2010; Snow et al., 1998). Studies indicate that children from low-income families are more likely to enter kindergarten with fewer of the prerequisite skills required for reading and, therefore, are in greater need of remediation when they enter school (Hart & Risley, 1995). This is likely due to lesser exposure to child-directed speech, oral and written vocabulary, and books than middle- and high-income families.

Less research exists on school- and district-level practices that are associated with literacy. However, a handful of studies indicate that distributed instructional leadership may promote student learning and, by extension, early childhood literacy (Gedik & Bellibas, 2015; Lee, Hallinger, & Walker, 2012). These studies conclude that when instructional leadership responsibilities are shared by multiple staff members (i.e. administration, teachers, coaches, etc.), instructional quality is better and, as a result, school-wide achievement is higher. Research also indicates that school-district alignment as it relates to classroom practices and strategic allocation of resources are associated with higher literacy rates at the school-level (Knapp, Copland, Honig, Plecki & Portin, 2014; Miles & Frank, 2008). In other words, students are more likely to learn when district policies are adhered to in the classroom and when resources are strategically devoted to improving student achievement.

Although districts, schools, and families play an important role in students' literacy development, several studies indicate that community-related factors matter as well. For instance, access to health and nutrition services can impact students' academic achievement, particularly when students have preexisting illnesses (Fiscella & Kitzman, 2009). Specifically, students whose families do not have access to resources that promote physical, psychological, and emotional health often perform below their peers, presumably because they are often absent from school due to untreated illnesses (Basch, 2011; Cohodes, Kleiner, Lovenheim & Grossman, 2014; Liberty, Pattermore, Reid & Tarren-Sweeney, 2012). Children's health at birth has also been linked to their academic achievement later in life (Hack et al., 1994; Hall, McLeod, Counsell, Thomson & Mutch, 1995; Islam, 2015). When children are born premature or if their birth weight is below average, they are less likely to perform well in school because of associated complications like learning disabilities and lower cognitive functioning (Litt, Taylor, Klein & Hack, 2005; Taylor, Klein, Minich & Hack, 2000). Finally, a long-standing body of literature suggests that access to high-quality preschools has a lifelong impact on children, which contributes to community-related factors such as college degree attainment, employability and higher earnings, as well as reduced crime and teen pregnancy (Yoshikawa et al., 2013).

Data

Data for this study were identified and provided by members of the Read On Arizona data taskforce which includes the Arizona Department of Education, the Arizona Department of Health Services, First Things First, and Head Start.[2] These data include statewide school-, district-, and primary care area-level (i.e. health-related outcomes) variables for 1,254 schools, 450 school districts, and 120 primary care areas (health care regions) spanning the 2010-2011 and 2013-2014 school years. Because of the large amount of data included in these datasets and the exploratory nature of this analysis, it was important to examine relationships between variables before deciding which variables would be included in the analyses. The complete dataset included a variety of factors that each agency had identified as being related to student learning. These included things like student demographics, enrollment, school-level benchmark scores, pre-school quality data, school letter grades, asthma-related hospital visits for youth in the region, and information related to pre-term and underweight births. Additionally, school- and district-level data were broken down by student subgroups. In total, the dataset included well over 100 variables across multiple years. Therefore, variables were chosen based on the following criteria: a) their degree of correlation with third grade reading scores on the state standardized reading exam, b) their degree of correlation with other variables[3], c) the completeness of the data for each variable, and d) whether or not the variable had been identified as likely contributing to student learning in previous research.

While it would have been ideal to include information related to all of the factors identified in our literature review, it is important to note that our analyses only include those variables which were available to us. Table 1 presents the final set of variables that were included in our analyses. Looking at these, several choices are worth noting. First, we chose to include second grade retention from the 2011-2012 school year (as opposed to the 2013-2014 school year) because second grade students who were retained in this year would have been third graders in the 2013-2014 school year. If there is a relationship between the percentage of students retained in the second grade and the percentage of students who later pass the third grade AIMS reading test, then choosing this year increases the likelihood that the same students are included in both the predictor and the outcome. Similarly, we chose to include kindergarten type from the 2010-2011 school year as kindergarteners in that year would be third graders in 2013-2014. We also chose to include data on pre-term, teen, and underweight births from 2007-2008 as this was the closest year to when third graders in 2013-2014 would have been born. Finally, our asthma data comes from the 2011-2012 school year because it was the most recent year available in which third graders in 2013-2014 would have been observed in that database.

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[2] The Arizona Department of Education is a state agency that oversees public education throughout the state. The Arizona Department of Health Services is a state agency that promotes and protects the health of Arizona's children and adults. Its mission is to set the standard for personal and community health through direct care, science, public policy, and leadership. First Things First is a state board that works to ensure that all children succeed in school and life by creating a family-centered, comprehensive, collaborative and high-quality early childhood system that supports the development, health and early education of all Arizona's children birth through age 5. Head Start is a program of the United States Department of Health and Human Services that provides comprehensive early childhood education, health, nutrition, and parent involvement services to low-income children and their families.

[3] Regression analyses, including the multilevel models used in this study, generate estimates of the relationship between each predictor and the outcome independent of all other predictors in the analysis. Therefore, it is important to select variables that are minimally correlated with each other to ensure that individual relationships can be detected.

Table 1
Variables included in the analysis

Variable	Description
School-Level	
3rd Grade % Passing State Standardized Reading Assessment in 2013-2014*	Percentage of 3rd grade students who scored at either the "Meets" or "Exceeds" achievement levels during the 2013-2014 school year.
Charter*	An indicator for whether a school was a charter or district school.
School Enrollment*	School enrollment on the last day of October during the 2013-2014 school year.
% FRL*	Percentage of students that qualified for free- and reduced-price lunch during the 2013-2014 school year.
3rd Grade Attendance Rate*	Average 3rd grade attendance rate during the 2013-2014 school year.
2nd Grade Retention Rate*	Percentage of 2nd grade students that were retained during the 2011-2012 school year. 2011-2012 was chosen because students retained during this year would presumably be in the 3rd grade in 2013-2014.
Chronic Absence Rate*	Percentage of students schoolwide who were absent for 18 or more days during the 2013-2014 school year.
Kindergarten Type*	Indicators for whether a school offered full-day, half-day, or mixed kindergarten during the 2010-2011 school year. 2010-2011 was chosen because this is the year in which 3rd graders in 2013-2014 would have been enrolled in kindergarten.
Number of Preschools in Zip Code***	Number of preschools in a given school's zip code in 2014.
District-Level	
District Enrollment*	Districtwide enrollment on the last day of October during the 2013-2014 school year.
% FRL*	Percentage of students throughout each district

	that qualified for free- and reduced-price lunch during the 2013-2014 school year.
3rd Grade Attendance Rate*	Average 3rd grade districtwide attendance rate during the 2013-2014 school year.
2nd Grade Retention*	Percentage of 2nd grade students that were retained during the 2011-2012 school year throughout each district. 2011-2012 was chosen because students retained during this year would presumably be in the 3rd grade in 2013-2014.
Chronic Absence Rate*	Percentage of students districtwide who were absent for 18 or more days during the 2013-2014 school year.
Primary Care Area	
Low Birth Weight**	Percentage of low birth weight births in each primary care area in 2007-2008.
Preterm Births**	Percentage of preterm births in each primary care area in 2007-2008.
Teen Births**	Percentage of teen births per 1,000 women in each primary care area in 2007-2008.
Asthma**	Rate of ER visits for 6 to 8 year olds with Asthma as the principal diagnosis per 10,000 ER visits in each primary care area in 2011-2012.

* indicates data provided by the Arizona Department of Education, ** indicates data provided by the Arizona Department of Health Services, *** indicates data provided by Head Start, data provided by First Things First were included in a separate analysis.

After excluding cases with missing data, the original sample of 1,254 schools was reduced to 758 schools (see Table 2). Despite this, the means and standard deviations of the variables in the final sample are nearly identical to those in the original dataset with the exception of the percentage of charter schools, the percentage of schools offering full-day and half-day kindergarten, school and district enrollment, and asthma rates. With regard to the change in the percentage of charter schools, charter schools are not required to report free-and-reduced price lunch data unless they participate in the federal free-and-reduced price lunch program. Therefore, many charter schools did not have this data and were excluded from the analysis. For school and district enrollments, schools were most often excluded because of masked data.[4] Consequently, the average school enrollment in our

[4] Data is masked when the number of students in a given category is small enough that these students might be identified individually. Masked data is most common among smaller schools as they are more likely to

final sample is slightly higher than in the original sample. Finally, differences in the percentages of kindergarten types and asthma rates could be related to the previously identified characteristics (i.e. if most of the small schools that were excluded also offered half day kindergarten), some unknown factor, or simply to chance. Regardless of the reason, it is important to note that results from these analyses are only applicable to schools that were included in the final sample.

Table 2
Descriptive Statistics

	All Elementary Schools		Elementary Schools in Final Sample	
Variable	*Mean*	*Standard Deviation*	*Mean*	*Standard Deviation*
% Passing State Standardized Reading Assessment	76.82	14.05	76.32	12.48
Charter	.24***		.10***	
Full Day Kindergarten	.77**		.83**	
Half Day Kindergarten	.08***		.04***	
Mixed Kindergarten	.13		.13	
School Enrollment	570.63***	272.46	631.27***	232.16
School % FRL	63.73	26.28	63.86	26.59
School 3rd Grade Attendance Rate	95.36	1.46	95.41	1.26
School 2nd Grade Retention	2.42	1.75	2.31	1.55
School Chronic Absence Rate	10.00	5.78	9.48	4.47
Number of Preschools in Zip Code	7.15	6.39	7.68	6.49
District Enrollment	17,329.35***	19,093.18	20,507.13***	19,350.34
District % Free and Reduced Lunch	62.74	20.82	61.57	21.30
District 3rd Grade Attendance Rate	95.32	1.19	95.37	.91
District 2nd Grade Retention Rate	2.29	1.58	2.13	1.23
District Chronic Absence Rate	11.75	5.99	11.54	4.76
Low Birth Weight	7.14	.97	7.13	.82
Preterm Births	10.24	1.16	10.26	1.07
Teen Births	56.02	7.07	55.74	6.13
Asthma	466.30***	167.94	492.89***	152.53
	N = 1,254		N = 758	

* indicates $p < .05$, ** indicates $p<.01$, *** indicates $p<.001$

Method and Findings

Because multiple schools may reside in the same school district, or primary care area, it is likely that schools in these regions have similar assessment scores due to the relationship between factors at the higher level. Therefore, this data is well-suited to an analysis using multilevel models (Snijders and Bosker, 2012). Specifically, cross-classified multilevel models were used since the

have only a handful of students in a given category (i.e. third graders passing state standardized reading test, retention in the second grade, etc.).

schools in the data set are nested within school districts and primary care areas (i.e. higher-level units) that do not precisely overlap in many cases (i.e. two schools may be part of the same district but different primary care areas). In each of these analyses, the outcome of interest is the percentage of students passing the state standardized reading assessment in the third grade in 2014 at the school-level. The statistical models used in our analyses take the following general form:

$$Y_{i(j,k)} = \gamma_{0ijk} + \sum_{a=1}^{q} \gamma_a x_{aijk} + \sum_{b=1}^{q} \gamma_b z_{bj} + \sum_{c=1}^{q} \gamma_c w_{ck} + U_{0j} + W_{0k} + R_{ijk}$$

Where $Y_{i(j,k)}$ is the percentage of students passing the state standardized reading assessment in the third grade at school *i* which is in district *j* and primary care area *k*, γ_{0ijk} is the fixed effect of the intercept, γ_a represents the fixed effect coefficient for school-level variable x_{aijk} , γ_b represents the fixed effect for the district-level variable z_{bj}, γ_c represents the fixed effect coefficient for primary care area variable w_{ck} , U_{0j} is the district-level random component, W_{0k} is the primary care area random component, and R_{ijk} is the school-level random component.

Table 3 presents the results of our analysis. As an initial step, it is important to determine the extent to which clustering is present in our data and whether or not the inclusion of random effects are appropriate. To do this, we ran an "empty" or intercept-only model. Using the random effects of the empty model, we can calculate a series of intra-class correlations (ICC) (Snijders & Bosker, 2012). The ICC gives us an indication of the extent to which clustering is occurring in our data and whether or not the use of multilevel modeling is appropriate. Cross classified models are different from traditional multilevel models in that they produce multiple ICCs (Snijders & Bosker, 2012). In this instance, we calculate an ICC for schools in the same district but different primary care areas, schools in the same primary care area but different districts, and schools that are in the same district and primary care area. The ICC is .36 for schools in the same district but in different primary care areas, .15 for schools in the same primary care area but in different districts, and .51 for schools in the same districts and same primary care areas. Chi square tests comparing a completely empty model to a model with a random district effect, and also comparing a model with a random district effect to one with a random district and primary care area effects indicate that the inclusion of both random effects is necessary (χ^2= 252.7 and 24.48, respectively, $p < .001$).

In addition to the parameter estimates from the empty model, Table 3 shows estimates from two additional analyses using the complete model. As Enders and Tofighi (2007) point out, the choice of centering is important. When level 1 variables are grand-mean centered, they are allowed to correlate with level 2 variables. Consequently, results from grand-mean centered analyses show relationships that are independent of *all* other variables in the analysis. In contrast, when level 1 variables are centered at their group means, level 1 and level 2 variables are uncorrelated. Table 3 includes the results of both grand- and group-mean centered analyses. In the grand-mean centered analysis, school-level variables are allowed to correlate with district and primary care area variables. In contrast, the group-mean centered analysis includes school-level variables that are centered within their respective districts making them uncorrelated with district variables and only slightly correlated with primary care variables.

Table 3
Results of empty, grand-mean centered, and group-mean centered analyses

	Empty Model	*Grand-Mean Centered*	*Group-Mean Centered*
Fixed Effects			
Intercept	76.86***	94.88***	74.96***
	(1.04)	(2.96)	(2.20)
Charter		6.34***	6.81***
		(0.33)	(1.51)
Half Day Kindergarten		-0.69	0.65
		(2.02)	(3.20)
Mixed Kindergarten		0.89	-0.54
		(1.43)	(1.98)
School Enrollment		-0.00	-0.00
		(0.00)	(0.00)
School % FRL		-0.30***	-0.31***
		(0.02)	(0.02)
School 3rd Grade		1.49***	1.36***
Attendance Rate		(0.33)	(0.34)
School 2nd Grade Retention		0.23	0.21
		(0.31)	(0.31)
School Chronic Absence		-0.27*	-0.31*
Rate		(0.12)	(0.14)
Number of Preschools in		-0.00	0.08
Zip Code		(0.07)	(0.08)
District Enrollment		0.00	0.00
		(0.00)	(0.00)
District % Free and		-0.04	-0.35***
Reduced Lunch		(0.04)	(0.03)
District 3rd Grade		-0.04	1.35*
Attendance Rate		(0.72)	(0.68)
District 2nd Grade		-0.75	-0.48
Retention Rate		(0.45)	(0.33)
District Chronic Absence		0.29	0.07
Rate		(0.17)	(0.15)
Low Birth Weight		-0.34	-.40
		(0.59)	(0.60)
Preterm Births		-13.67	-15.83
		(47.32)	(47.86)
Teen Births		-4.91	-6.13
		(9.62)	(9.98)
Asthma		0.00	0.00
		(0.00)	(0.00)
Random Effects	*Variance*		
τ^2_W	27.59**	0.00	0.00
	(10.28)	(0.00)	(0.00)
τ^2_U	68.11***	28.40**	33.53***

	(16.32)	(8.25)	(8.84)
σ^2	90.83***	57.55***	57.31***
	(5.46)	(3.59)	(8.84)
Log Likelihood	5824.64	5368.93	5377.86
n	758	758	758

* indicates $p < .05$, ** indicates $p<.01$, *** indicates $p<.001$

The analyses in columns 2 and 3 estimated τ^2_W to equal zero. This presents estimation problems related to the Hessian matrix. As a result, our final estimates did not include τ^2_W although we include the initial estimates of zero here to aid in the interpretation of the results.

Looking at the grand-mean centered analysis, four coefficients are statistically significant at $p < .05$. These four variables are whether or not a school was a charter school, the percentage of students in poverty (FRL), third grade attendance rate, and the schoolwide chronic absence rate. The charter school coefficient indicates that, on average, charter schools had roughly 6% more students pass the state standardized reading assessment than traditional district schools after controlling for all other factors (such as poverty, enrollment, etc.). The coefficient for percent FRL shows that for every 1% increase in the percentage of students in poverty, there is an average decrease of .3% in the number of students passing the state standardized reading assessment. With regard to attendance rates, a 1% increase in attendance rate is associated with an average increase of 1.5% of students passing the state standardized reading assessment. Finally, the coefficient for chronic absence rate indicates that a 1% increase in chronic absenteeism is associated with a .3% decrease in the number of students passing the state standardized reading assessment.

As previously mentioned, when variables are centered about their grand means, level 1 (e.g., schools) and level 2 variables (e.g., districts and primary care areas) are allowed to correlate. Therefore, level 2 variables will only be statistically significant if their relationships with the outcome are independent of level 1. However, in the first analysis, only school-level variables were statistically significant. Therefore, the district- and primary care-level variables included in our analysis are not significantly related to school-level reading scores after accounting for school-level variables. Despite these non-significant results, it may be useful to know if any of the district- or primary care-level variables are related to reading achievement independent of school-level variables. To do this, we conducted an analysis where school-level variables are centered at their group means (in this case, their respective districts). As mentioned before, this ensures that school-level variables are uncorrelated with district- and primary care-level variables. However, it is important to note that since districts and primary care areas are both considered level-2 variables, they are correlated with each other making the regression coefficients partial, but still uncorrelated with school-level variables.

As shown in Table 3, the results of the group-mean centered analysis are similar to those of the grand-mean centered analysis with two notable exceptions: district percentage of FRL and district third grade attendance rates. Much like we saw at the school-level, the coefficient for district percent FRL indicates that a 1% increase in the district-level poverty rate is associated with .4% decrease in the number of students passing the state standardized reading assessment reading at the school-level. Similarly, a 1% increase in district-level attendance rates is associated with a 1.4% increase in the percentage of students passing the state standardized reading assessment at the school-level. These results are not surprising given the strong relationships observed in the grand-mean centered analysis.

Discussion

First and foremost, it is important to point out that the relationships described in this study are correlational, not causal. In other words, one cannot conclude with any degree of certainty that these variables caused changes in school-level reading scores. Further, this analysis is exploratory in nature, meaning that the theoretical underpinnings of these relationships can only be speculated. That said, four school-level variables consistently showed a statistically significant relationship across all of the analyses: whether or not a school is a charter school, percentage of poverty, third grade attendance rates, and chronic absenteeism.

With regard to charter schools, this relationship should be interpreted in light of two caveats. First, a significant number of charter schools were excluded from the final sample, due mostly to missing free-and-reduced price lunch data and masked data due to the fact that many charter schools often have smaller enrollments than district schools. In speculation, it is likely that the charter schools in the sample, on average, serve higher percentages of low-income students since only schools that participate in the federal free and reduced price lunch program are required to report this data. Although this does not affect the results of the analysis, it is important to remember that the findings only apply to the schools in the final sample. If all charter schools were included in the analysis, a different relationship might be observed. Second, charter schools are subject to a rigorous review process where low-performing schools are routinely closed by the state. It should come as no surprise, then, that charter schools in the sample perform higher, on average, than district schools simply for the fact that consistently low-performing charter schools are not allowed to enroll students. Still, the difference between charter and district schools in the sample is quite large and is likely due to factors other than those mentioned above, which is worthy of further research.

It should come as no surprise that our analysis found poverty to be negatively correlated with student achievement. A substantial, long-standing body of research indicates that children from low-income families perform below their non-low-income peers. Although the exact mechanisms that link poverty to lower academic achievement are the topic of much debate, the relationship is strong and well-documented.

Finally, our analysis showed that third grade attendance rates and chronic absenteeism are strongly related to third grade reading scores even after controlling for poverty. Because the correlation between poverty and student achievement is so high in this data set (r = -.71) and because poverty is correlated with both attendance and absenteeism (r = -.35 and .49, respectively), the fact that these remain statistically significant is noteworthy. Again, it is important to state that these relationships may not be causal in nature. For instance, a third unobserved variable might be driving both higher attendance rates and higher student achievement. However, it seems logical that students who spend more time in school are more likely to benefit from teachers' instruction and therefore perform better on assessments. In light of this, increasing attendance rates may prove to be a low-cost effort for schools, districts and policymakers to focus on that may substantially improve student achievement.

While research examining the impacts of attendance and chronic absenteeism on student academic outcomes is scarce, a growing body of research suggests that increasing attendance rates may be a critical first step in efforts to improve student achievement, particularly for poor and minority students. For instance, multi-year studies in Chicago Public Schools and Baltimore City Schools show that chronically absent preschoolers are less likely to read proficiently by the end of third grade and more likely to be retained in later grades (Connolly & Olson, 2012; Ehrlich et al., 2014). Further, students with persistent absenteeism in the sixth grade are at risk for not graduating from high school (Balfanz, Herzog & Mac Iver, 2007), and even for those students who are able to

graduate from high school, chronic absence makes them less likely to enroll and persist in college. The findings from Baltimore also showed that school-wide attendance rates have an impact on academic outcomes, meaning even those students who are not chronically absent will likely suffer academically as teachers struggle to cover curriculum for those who are present while also revisiting content for those who were absent (Connolly & Olson, 2012).

Our analyses suggest that attendance likely affects the achievement of all students, regardless of demographics, and others have found a strong relationship between absenteeism and family background characteristics such as socioeconomic status, race and ethnicity (Bloom, Jones, & Freeman, 2013; Case, Lubotsky, & Paxson, 2002). The state of Utah has investigated chronic absenteeism more deeply than most states and researchers discovered factors such as low income, special education, English proficiency, and racial minority served as significant predictor variables for chronic absenteeism (Utah Education Policy Center, 2012). Low income was the strongest predictor, showing that students who received free or reduced lunch were 90% more likely to be chronically absent than students who do not receive free or reduced lunch (Utah Education Policy Center, 2012). These findings are valuable in that districts and individual schools can use their chronic absenteeism data to strategically plan outreach to target at-risk students in their communities.

As a result of the findings from our study and those just mentioned, organizations and agencies that serve families with children age birth through 8 should consider how their work can specifically target the at-risk needs of their communities. Likewise, districts and schools can partner with such agencies to target the specific needs of the communities served by their schools to tackle chronic absenteeism (see Race Matters Institute, 2013). While many organizations that serve families living in poverty are already doing their best to address poverty's adverse effects on student learning, communicating the importance of school attendance and reducing chronic absenteeism may be a low-cost intervention that organizations and schools could more easily take on. While independent local and national initiatives are committed to reducing chronic absenteeism and increasing school attendance, they do not often make the direct connection between attendance and academic achievement. This analysis shows evidence, albeit speculative, that increasing attendance is related to increased state standardized reading assessment scores and may be an effective and cost-effective intervention for increasing childhood literacy.

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About the Authors

Robert L. Vagi
Arizona State University
rvagi@asu.edu
Robert Vagi is a Ph.D. candidate in the Educational Policy Analysis and Evaluation program at Arizona State University. His research interests include teacher labor markets, teacher mobility, and applied policy analysis.

Clarin Collins
Arizona State University
clarin.collins@asu.edu
Clarin Collins is a research professional in the Mary Lou Fulton Teachers College at Arizona State University. Her research interests include national and state policy implementation and implications at the local level, education evaluation and accountability systems, and making academic research applicable and accessible for the public community.

Terri Clark
Read On Arizona
tclark@readonarizona.org
Terri Clark is the Arizona Literacy Director for Read On Arizona, a public/private partnership focused on improving outcomes for children birth through age 8.

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