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Effects of Student Displacement in Louisiana During the First Academic Year
After the Hurricanes of 2005

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Abstract

The combined impact of Hurricanes Katrina and Rita in 2005 left the education system in the Gulf Coast region of the United States with tremendous challenges to rebuild infrastructure, reestablish services, and accommodate the movements of students that occurred as result of the storms. This article focuses on Louisiana's public school students, of whom one fourth were displaced as a result of the storms. It explores the experiences of students and the effects of student movements on student achievement and on the state's public education system during the first academic year following the hurricanes. Results suggest that, overall, the education system handled the disruptions of the disaster relatively well. However, more detailed examinations show that some displaced students had problems such as non-enrollment or poor attendance, mental health or behavioral problems, and academic setbacks. Negative achievement effects, which were small overall, were most pronounced among students who remained displaced for the duration of the academic year, and appeared to be mitigated by students' tendency to enroll in schools with higher student performance than their original schools. Additional results show that the negative effects were associated with both the number of schools attended and the amount of school time lost. However, these analyses do not include the displaced students who did not reenroll in a Louisiana public school. These students constitute more than a quarter of displaced students and tended to be those who are most at risk for poor academic outcomes.

Introduction

Hurricanes Katrina (in late August 2005) and Rita (in late September 2005) caused the largest displacement of students in U.S. history. In Louisiana alone, the hurricanes displaced nearly 26% of the 740,000 pre-kindergarten through Grade 12 students enrolled in the state's public schools prior to the storms. Anecdotes and broadcast news suggested that the storms created serious and long-lasting negative consequences for some students and conventional wisdom might suggest that a disruption of this magnitude to a school system could have a substantial negative impact on student achievement. However, anecdotes and conventional wisdom often fail to provide an accurate picture of complex events like the recovery of a state from a massive hurricane.

This article provides, in three parts, a careful analysis of the experience of students in the Louisiana public school system in the school year following Hurricanes Katrina and Rita. First it reviews the literature on student mobility and the effects of natural disasters on student educational outcomes to determine what past evidence suggests the consequences of the disruptions caused by the hurricanes might be. Next, it summarizes the results from our recent report (Pane, McCaffrey, Tharp-Taylor, Asmus, & Stokes, 2006) on students' schooling experience and school responses to the hurricanes. Finally, it studies the effects of the hurricanes on student outcomes.

Effects of Student Mobility and Natural Disasters on Student Outcomes

More than 196,000 Louisiana public school students had school disruptions including changing schools in response to Hurricanes Katrina and Rita. Although movements of this magnitude and due to such devastating events are unprecedented, there is a literature on student mobility and natural disasters and their relationship to student achievement

that can provide insights into the potential effects of these storms and subsequent disruptions to schooling. We consider this literature and its implications for the possible effects of the hurricanes on student achievement.

Student Mobility and Student Outcomes

In the literature on mobility, school mobility is defined as the non-promotional change of schools (Rumberger, 2003). Non-promotional moves include school changes due to residence relocation or expulsion, for example, but exclude graduation from elementary school and enrollment into the continuing middle school. American children, in particular, have high rates of school mobility compared to other western countries (Long, 1992).

Conventional wisdom suggests that this high rate of mobility negatively affects students' lives, from their academic achievement to their self-esteem and peer acceptance. It also suggests a negative impact on the classroom and the school as a whole by increasing teacher workload, weakening the social bonds between students, and interrupting the curriculum. Although there is some truth to this, a range of studies indicate that the effects of student mobility are much more complex and depend on several factors, including family background, socioeconomic status, reasons for and timing of the move, and teacher and school preparedness.

Characteristics of Student Mobility

Estimation of the effects of student mobility on achievement is challenging because students with higher mobility rates tend to be at greater risk for low achievement than students with lower mobility rates, for reasons other than the mobility itself. Studies must distinguish between the effects of mobility and the differing backgrounds of students who

do or do not transfer schools. Moreover, students transfer schools for a variety of reasons and the effects of mobility could be sensitive to the impetus for the move; studies that fail to account for the motivation behind a move might provide distorted estimates of the effect of mobility.

Overall, mobility is most common among students from low-income families (Engec, 2006; Kerbow, 1996; Long, 1992; Mao, Whitsett, & Mellor, 1998; Mehana & Reynolds, 1995; Paredes, 1993; Rumberger, 2003; U.S. General Accounting Office, 1994). Mobility is also higher among African American, Native American, and Hispanic American students (Kerbow, 1996; Mao et al., 1998; Rumberger, 1998; U.S. General Accounting Office, 1994) and among students from single-parent, step-parent, and other types of non-nuclear families (Engec, 2006; Kerbow, 1996; Rumberger, 1998; Teachman, Pasch, & Carver, 1996; Tucker, Marx, & Long, 1998). Mobility also differs by age, with younger students being more mobile than older students (Engec, 2006; Ingersoll, Scamman, & Eckerling, 1989; Mao et al., 1998). This may be in part because younger children often have younger parents: According to U.S. Census data, adults aged 20 to 35 are the most geographically mobile group (U.S. Census Bureau, 2004). Parents may also be less willing to disrupt the education and social structure of older children with roots in a school or community. Importantly, studies indicate that several of these factors are highly correlated (e.g. income and ethnicity; Paredes, 1993) and many students fall into multiple categories. Indeed, the highly mobile student is likely to be poor, to come from a single-parent family that has difficulty securing stable employment or housing, and to attend an urban school (Long, 1992).

Causes and directions of mobility. Students change schools for a variety of reasons. Most commonly, it is because of residential changes (Rumberger, 1998, 2003). Rumberger's survey of the parents of students who changed schools in California revealed that the second most common reason was because students asked to change schools. The least common reason was because the school asked the student to leave; for example, due to disciplinary or academic problems (Rumberger, 2003).

A critical, but rarely answered, question underlying the first two reasons for moving is: why? First, why did families change residence? Perhaps their socioeconomic status improved and they sought better educational opportunities for their children. They may have moved because of unstable housing, or perhaps they experienced changes in their family structure such as death or divorce. Second, why did students ask to change schools? They may have sought courses, programs, and opportunities offered at other, better schools. Alternatively, they may have had academic or personal difficulties at their previous school and sought a new school to escape these problems. These questions illustrate a fundamental difference between reasons for school change: Some students and families change schools in pursuit of positive opportunities and environments; others change schools in response to negative activities and atmospheres. As we discuss later, the literature suggests that these antecedents to mobility are significant indicators in the outcome of mobility. Understanding them is therefore critical.

Impact of Mobility on the Student

Mobile students must cope with a number of new challenges. Changing to a different school breaks up students' existing social structures, and they face the often-difficult challenge of forming new relationships in new peer groups. It also requires students to

adjust to new teachers, new buildings, and new school rules and regulations. The academic pace, teacher expectations, and curriculum may also differ. In sum, school changes can be emotionally and academically demanding; indeed, the Coddington Life Events Record suggests that changing schools is as stressful for children as parent hospitalization or having a parent in jail (Johnson, 1987). Therefore, it would not be surprising to find that mobility has a significant negative impact on emotions, behavior, and academic performance. Nevertheless, the literature reveals mixed and inconclusive results.

Emotional and behavioral impact. Many studies suggest that increasing rates of mobility correlate with increasing incidence of emotional and behavioral problems, although most find that these differences are only significant for highly-mobile students (Simpson & Fowler, 1994; U.S. General Accounting Office, 1994; Wood, Halfon, Scarlata, Newacheck, & Nessim, 1993). For example, Simpson and Fowler examined data from the 1988 National Health Survey on Child Health and found that students who had moved three or more times between the ages of 6 and 17 were more than twice as likely to have emotional and behavioral problems and to have received psychological help. They were also nearly twice as likely to be suspended or expelled from school. Overall, children in this bracket were 1.6 times more likely to be in the top 10th percentile of scores on the Behavioral Problems Index, which includes factors such as hyperactivity, depression, and immaturity. Meanwhile, there was no significant behavioral difference between students who moved infrequently and those who did not move at all (Simpson & Fowler, 1994). Using the same data, Wood et al. (1993) found that these differences persisted even after controlling for confounding factors such as income, ethnicity, parent

education, and family structure. Specific effects of frequent moves include violence and poor health. Ellickson and McGuigan (2000) found that multiple changes in elementary schools predicted a 20% greater chance of violence during high school after controlling for social variables. The U.S. General Accounting Office (1994) study also associated frequent mobility with poor health and hygiene, but this study did not control for confounding variables.

On the other hand, Engec (2006) reported that even a single school change during the school year increased the likelihood of suspension, but the relationship between suspension and school changes during the summer between school years was not examined. Similarly, Swanson and Schneider's (1999) study of high school students found that a single school change in the later years of high school significantly increased behavioral problems even when other variables were controlled. However, school changes occurring early in high school had no discernible effect on behavior.

Academic impact. Most studies also find that higher mobility is highly correlated with lower achievement. Several studies report that highly mobile students perform poorly on standardized tests and have poorer grades in comparison to more stable students (Engec, 2006; Mehana & Reynolds, 1995; Rumberger, 2003; Strand & Demie, 2006). For example, in the U.S. General Accounting Office (1994) study, 41% of third-grade students who moved three or more times were low achievers and performed below grade level in reading, compared to only 26% of their peers who had never changed schools. Similarly, mobility positively predicts grade retention, and frequent movers may be twice as likely as non-movers to be held back (Simpson & Fowler, 1994; Wood et al., 1993).

Mobility is also associated with dropping out of school (Rumberger, 1998; Swanson & Schneider, 1999; Teachman et al., 1996). Teachman et al. (1996) found that high mobility between 1st and 8th grade increased the likelihood of dropout between 8th and 10th grade; however, they did not report on dropout rates between 10th and 12th grades. Rumberger (1998) found that even a single instance of mobility during high school doubled the likelihood of dropout by 12th grade. However, the results of other studies are more nuanced. Swanson and Schneider's (1999) longitudinal study of high school students revealed that, compared to non-mobile students, those who changed schools between 8th and 10th grades were more likely to drop out by 10th grade, but those students who did not drop out by 10th grade were less likely to drop out thereafter. Moreover, these early-transfer students made greater academic gains than those students who had not moved. The authors suggested, "Transfer students who can weather the transition to the new school environment and who maintain a commitment to obtaining their high school diplomas through this period of adjustment are likely to benefit in the long term from their changed educational circumstances" (Swanson & Schneider, 1999, p. 62). However, those students who changed schools later in high school were more likely to drop out than both students who changed schools earlier in high school and students who had never changed schools.

Unfortunately, few of these studies demonstrate a causal relationship between mobility and achievement because they do not consider confounding factors such as socioeconomic status, ethnicity, and family structure. Studies that do control for these other factors indicate that the relationship is inconclusive.

Strand and Demie (2006) and Temple and Reynolds (1999) found that the impact of student mobility on achievement was reduced by half when family and economic factors were taken into account, and Strand and Demie (2006) further determined that the impact was eliminated completely when the students' prior achievement was also considered. Similarly, Alexander, Entwistle, and Dauber (1996) traced elementary school students and concluded that the differences between mobile and nonmobile students were statistically insignificant once prior performance and background were controlled.

However, Mehana and Reynolds' (1995) study of elementary school students found that mobility did predict lower reading achievement but not math achievement after controlling for first-grade performance. This research suggests that mobile students were performing poorly even before they became mobile, and their poor performance both before and after the move may result from confounding factors of poverty, unstable families and divorce, unsafe neighborhoods, or other factors.

Finally, there is a strong counterexample to the correlation between high mobility and poor performance. Schools for the children of military personnel have turnover rates of nearly 40% (Smrekar & Owens, 2003), comparable to the most highly mobile urban schools. Yet several studies demonstrate that higher mobility is not correlated with lower achievement or increased behavior problems among military children (Marchant & Medway, 1987; Smrekar & Owens, 2003). Indeed, Plucker's (1999) study of gifted children in the military indicates that high mobility may actually result in better academic performance. In sum, mobility does not always correlate with poor performance or increased emotional and behavioral problems, and it certainly has not been shown to cause them.

Summary of the impact of mobility on individual students. Although the literature is equivocal about the outcome of mobility when considered alone, one can draw inferences if one focuses on the few studies that also consider the precursors to mobility. The authors of one of these studies asserted that “the reason a pupil moves school, rather than the change of school itself, is probably the most important factor in relation to attainment” (Strand & Demie, 2006, p. 564). Specifically, research suggests that mobility with positive antecedents has positive outcomes, while mobility with negative antecedents has negative outcomes (Alexander et al., 1996; Hango, 2006; Hanushek, Kain, & Rivkin, 2004; Rumberger, Larson, Ream, & Palardy, 1999; Strand & Demie, 2006; Warren-Sohlberg, 1992). Rumberger et al. (1999) noted, “Interviews with students revealed why the impacts of student mobility on academic achievement were hard to predict: Students who made ‘strategic’ school changes to seek a better educational placement, in general, reported positive academic impacts, while students who made ‘reactive’ school changes due to intolerable social or academic situations were more likely to report negative academic impacts from changing schools” (p. 3). Similarly, studies show that frequent moves within a district are reactive and result in poor academic performance (Alexander et al., 1996; Hanushek et al., 2004); moves outside a school district (which are typically made by wealthier, better educated families) often secure higher quality schools (Hanushek et al., 2004). Moreover, Smrekar and Owens (2003) hypothesized that children of military personnel are not negatively affected by mobility because moves are structured and proactive and because schools for children of military personnel are prepared for high mobility. The conclusion is also consistent with research indicating that early high school changes (which might be triggered by the

search for better education) are associated with positive performance, while later high school changes (which are more likely triggered by negative events) are associated with negative outcomes (Swanson & Schneider, 1999).

In short, we cannot say that mobility itself causes gains or losses in achievement; nevertheless, we can say that the causes of mobility can predict gains or losses.

Impact of Mobility on Schools

Mobility not only has a potential effect on the students who move but might also affect the schools and non-mobile students. Research suggests that schools with high mobility perform worse on average than schools with low mobility (Mao et al., 1998; Rumberger et al., 1999) and have a slower pace of learning (Smith, Smith, & Bryk, 1998). However, as with research on the effect of mobility on individual performance, the correlation must be considered cautiously, because many students in highly mobile schools come from poorer families, live in the inner city, and have less educated parents, which are confounding factors. Moreover, high mobility may be an indication of explicit and implicit school policies and environments that encourage high turnover (Rumberger et al., 1999).

Nevertheless, studies that control for confounding factors such as income, ethnicity, teacher experience, class size, and individual student performance suggest that mobility has a causal negative impact on school quality (Hanushek et al., 2004). This causal relationship is supported anecdotally by interviews of teachers and administrators on the impact of mobility. These interviews indicate that new students disrupt the academic environment by interrupting a class that has an existing social structure, common curriculum and knowledge base, and familiarity with the school rules and

teachers (Lash & Kirkpatrick, 1990). New students are also a financial burden as they require extensive record keeping and evaluation and often do not return books and materials to schools (Rumberger et al., 1999).

Yet proper preparation and resources for mobile students may go a long way toward mitigating these problems. In particular, schools run by the Department of Defense (DoD) for children of military officers do not experience significant class disruption or overburdened teachers and staff because of targeted educational policies such as a strong and stable teaching force, a well-staffed school, the synchronization of curriculum and achievement goals, the timely transfer of academic records, and small school size (Smrekar & Owens, 2003). Indeed, a number of studies examining the impact of mobility on public schools suggest the adoption of strategies similar to those used in DoD schools, including advance notification and preparation for new students, long-term assimilation programs, and accurate academic record keeping (Rumberger et al., 1999).

Natural Disasters, Children, and Mobility

In this section, we first describe the range of experiences of children and their families during and after a disaster, paying particular attention to their experiences of mobility. Second, we examine the research on the mental, behavioral, and academic impact of these experiences.

Children's Experiences of Natural Disasters

Natural disasters such as hurricanes, floods, tornadoes, and earthquakes can completely overwhelm a community with severe infrastructure and property damage, huge financial losses, and human casualties. Although these losses often traumatize adults, they can have an even more profound impact on children and adolescents, who are often unable to

understand the event itself and are particularly helpless in its aftermath. Researchers at the University of Illinois, as cited in Black (2001), observed:

Children who live through a disaster usually have two life-changing experiences. First, they endure the trauma itself, which might forever alter their sense of security and their ability to cope with life's problems. Second, they face ongoing disorder and dishevelment in their day-to-day lives. (p. 54)

The first experience, called *event trauma* in the research literature, is limited in time and space. The second experience, known as *process trauma*, can continue for months and years and may have much graver consequences in the long-term than the disaster event itself (Shaw, 2000). In this section, we explore both of these life-changing experiences.

Experiences before the disaster. For a disaster such as a hurricane, the negative experience begins prior to any actual storm damage, with preparation in response to storm warnings. The anticipation of a storm can cause hyper-vigilance, anger, denial, and withdrawal as the event approaches (Zenere & Lazarus, 1999).

Experiences during the disaster event. The disaster itself can be highly traumatic. Hurricane victims, for example, compare the thunder and wind to freight trains and describe how their homes shake violently for hours as doors are torn off their hinges, windows break, and roofs blow away (Provenzo & Fradd, 1995). A study by Shaw et al. (1995) of children in a high-impact area during Hurricane Andrew revealed that 82% had experienced a door or window breaking, 56% experienced a blown-away or caved-in roof, 87% feared that a loved one would be killed or injured, and 24% reported a pet getting hurt or dying. Children can have strong physical and emotional responses to these experiences, including sweating, increased blood pressure, vomiting, involuntary urination, extreme terror, and frenetic activity (Zenere & Lazarus, 1999).

Experiences after the disaster event. The process trauma in the wake of the disaster can last much longer than the event itself as families try to deal with loss and rebuild their lives, and children often experience the aftermath right alongside the adults. Negative experiences include the loss of personal property, loss of infrastructure and shortage of basic resources (sometimes including food and water), increased rates of looting and violence (Provenzo & Fradd, 1995; Townsend, 2006), high mobility, and unemployment. Children may additionally become victims of their parents' own trauma and stress. Research shows that natural disasters lead to increase rates of familial violence and child abuse. Keenan, Marshall, Nocera, and Runyan (2004) studied rates of traumatic brain injury (TBI) among babies aged less than 24 months in North Carolina after Hurricane Floyd. They found that rates of inflicted TBI (where medical records documented that the TBI was caused by another person) and non-inflicted TBI were 5 and 10 times higher, respectively, in the six months after the hurricane than they had been a year earlier. Similarly, Curtis, Miller, and Berry (2000) found that reports of child abuse increased dramatically after Hurricane Hugo and the Loma Prieta earthquake, although they found no significant increase after Hurricane Andrew. However, the Miami Herald reported that immediately after Hurricane Andrew, instances of familial violence and discord rose to the point where additional judges had to be appointed to deal with the flood of complaints (Swarns, 1992).

Mental, Behavioral, and Academic Impact

It is not surprising that natural disasters can have a profound emotional, behavioral, and academic impact on children.

Mental and behavioral impact. Several studies have shown that many children experience post-traumatic stress disorder (PTSD) from a variety of natural disasters, including earthquakes (Asarnow et al., 2000; Chen & Wu, 2006), hurricanes (Garrison et al., 1995; La Greca, Silverman, Vernberg, & Prinstein, 1996; Shaw, Applegate, & Schorr, 1996; Vernberg, La Greca, Silverman, & Prinstein, 1996), tornadoes (Evans & Oehler-Stinnett, 2006), wildfires (Jones, Ribbe, Cunningham, Weddle, & Langley, 2002), and floods (Durkin, Khan, Davison, Zaman, & Stein, 1993). La Greca et al. (1996) studied third- to fifth-grade students after Hurricane Andrew and found that approximately 54% suffered at least moderate PTSD three months after the hurricane, and, of those students, over half suffered from severe to very severe PTSD. Moreover, after 10 months, 34% of all students still had at least moderate PTSD, although the number of most severe cases fell by half. Their subjects' symptoms included difficulty sleeping or concentrating, mentally re-experiencing the event, and emotional detachment. Similarly Evans and Oehler-Stinnett (2006) found that about 40% of students who had experienced a severe tornado had symptoms of PTSD. In addition to avoidance, re-experience, and detachment, these students reported a range of physical symptoms and feelings of a foreshortened future. Initial reports following Hurricane Katrina are consistent with these findings and indicate that PTSD may be widespread among affected children (Weisler, Barbee, & Townsend, 2006). Several studies have indicated that the incidence and severity of PTSD are correlated with proximity to the event and, in turn, the magnitude of loss experienced (Chen & Wu, 2006; Jones et al., 2002; Shaw et al., 1995). Others have also suggested that PTSD is higher among the poor and minorities (Garrison et al., 1995; La Greca et al., 1996), but this is not always the case (Evans & Oehler-Stinnett, 2006).

Finally, one study showed that the anticipation of a natural disaster was enough to bring on mild PTSD, even when the event did not occur (Kiser et al., 1993).

Research also indicates that children may experience other behavioral problems, such as increased aggression or delinquency (Durkin et al., 1993; Shaw et al., 1996). In the most extreme cases, the trauma of natural disasters can lead children to suicide. The *Miami Herald* reported that in the months following Hurricane Andrew, more than a dozen elementary school students had attempted suicide; some were as young as seven or eight years old (Donnelly, 1993).

Academic impact. A common consequence of disasters is the disruption of children's schooling in the days, weeks, and months following disasters because of the damage to schools and the relocation or displacement of families. Although disruption to schooling is common following many disasters (Cook, 2006; Holmes, 2002; Provenzo & Fradd, 1995), there is very little concrete research about the academic impact of natural disasters. In a 2002 study, Holmes (2002) modeled and compared North Carolina elementary school performance on standardized tests in the year after Hurricanes Floyd and Bonnie with previous years. The study revealed that some 60 schools did not meet their performance goals but would have if the storms had not occurred. However, it was unclear whether this was due to missed days in particular or to a broader effect of the hurricanes. The study also suggested that those schools that had performed poorly in the past were most affected.

Smilde-van den Doel, Smit, and Wolleswinkel-van den Bosch (2006) studied the school performance and behavior of students affected by a fireworks disaster in the Netherlands in 2000 and found the opposite results. They compared the performances of

three groups: students who attended schools in the affected area and were exposed to the disaster, students in the same schools who were not exposed, and students in other control schools. They reported that, over the three years following the disaster, children exposed to the disaster performed as well as, and sometimes better than, all other groups tested, and also compared to the national average. Indeed, shortly after the disaster, they found that exposed boys and girls outperformed non-exposed students in math and language, respectively. The authors hypothesized that cognitive impairment may have been avoided because exposed students received extra attention by special care teachers and participated in a range of intervention programs. Last, Shannon, Lonigan, Finch, and Taylor (1994) surveyed children about their emotional reactions to Hurricane Hugo and their subsequent academic performance. Using self-reported data, they found that 29% of students reported decreases in performance, 56% experienced no change, and 15% reported increases in performance. Thus, the impact of natural disasters on academic performance is inconclusive.

Nevertheless, research into the relationship between PTSD, trauma, and academic achievement may provide additional insights. Beers and DeBellis (2002) compared healthy children to others who suffered from maltreatment-related PTSD. They reported that the children with PTSD performed relatively poorly on a range of tests, from abstract reasoning to problem solving to organization. Giaconia et al. (1995) reported similar results among adolescents. Other researchers have attempted to distinguish the academic impact of trauma from the impact of PTSD. In their study of children affected by Hurricane Hugo, Shannon et al. (1994) further compared the performances of students who exhibited PTSD symptoms to those who did not. They found that 51% of PTSD

students experienced a performance decrease compared to 28% who did not, and the average decrease in performance for the former group was three times greater than for the latter group. Similarly, Delaney-Black et al. (2002) examined IQ and reading ability in children exposed to violence, some of whom developed trauma-related symptoms while others did not. They found that exposure to violence alone predicted both lower IQ and reading deficiencies; levels of PTSD additionally predicted reading deficiencies (but not IQ deficiencies). In another study, Saigh, Mroueh, & Bremner (1997) examined three groups of adolescent students: students who had traumatic experiences and developed PTSD, students who had similar traumatic experiences but did not develop PTSD, and students who did not have traumatic experiences. In contrast to the previous two studies, they found that the students with PTSD performed significantly below either of the other groups of students on a range of academic tests, while there were no significant differences between the non-PTSD groups. In sum, these findings suggest that traumatic experiences alone may be enough to impair academic achievement, and that subsequent experiences can play a significant role in determining the degree of that effect.

Implications for Louisiana

The children of Hurricane Katrina experienced the worst natural disaster in U.S. history. Of the more than 196,000 public school students in Louisiana who changed school following the hurricanes, many were out of school for over a month or longer. Many of these students not only missed schooling and transferred schools, but also lost their homes and communities, relocated several times, faced extreme familial stress, and were in and out of school. How did this affect their academic performance? Most of the research on student mobility and PTSD supports the hypothesis that their performance

suffered. First, the school transfers were caused by a negative event, and the literature suggests that negative antecedents to mobility are correlated with negative academic outcomes. Second, high rates of mobility almost always result in poor performance. Third, absenteeism caused by natural disasters (e.g., Hurricane Andrew) has also been shown to reduce performance. Fourth, the schools to which students transferred often did not have access to academic records to place them in appropriate classes. Finally, many of the students affected by Hurricane Katrina suffer from PTSD and trauma, which also predicts poor achievement.

On the other hand, as hypothesized by the study of the fireworks disaster in the Netherlands, school and community intervention can mitigate these negative outcomes and possibly improve performance. If the students displaced by Hurricane Katrina received special attention and care at their new schools (which were almost certainly aware of the circumstances of their displacement), they may not have experienced a performance decline, or may have experienced a lesser decline than if they had not received the special attention. This possibility is further supported by the example of Department of Defense schools, which routinely deal with high student mobility but do not experience academic decline because they are prepared for the mobility. Thus, the impact of Hurricane Katrina on student performance may be more nuanced and depend on the schools to which students went, the response of the other students and teachers, and the types of interventions in place to assist them.

Experiences of Louisiana Public School Students and Schools

This section provides a summary of the results presented in Pane et al. (2006) of an analysis of administrative data on student enrollment and survey responses about the

2005-2006 year for Louisiana public schools. It describes experiences of displaced students in terms of time out of schools and the number and duration of their school enrollments during that school year. It also provides summary statistics on the background characteristics of students with different experiences following displacement. The survey results describe the response of schools to the challenges displaced students presented and more details on the experiences and outcomes of displaced students. It first reviews the enrollment data and then reviews the survey responses.

Enrollment Experience of Students Affected by the Hurricanes

Following the convention used in Pane et al. (2006), we use the term *displaced students* to refer to students who entered or exited Louisiana public schools as a result of the hurricanes. A subset of the displaced students is defined as *relocated students* while they are enrolled in Louisiana public schools other than their original schools.

Administrative records from public schools in the state contain information on more than 196,000 students who were displaced.¹ Over 81% of the displaced students came from three parishes (counties): Orleans, Jefferson, and Calcasieu; five additional parishes account for nearly all of the remaining displaced students: St. Tammany, St. Bernard, Plaquemines, Vermilion, and Cameron. Displaced students enrolled in other schools in every parish of Louisiana and in 48 other states.

The school-enrollment patterns of these displaced students were complex and changed throughout the 2005-2006 school year, as shown in Figure 1. For each day from

¹ The dataset used for analyses reported in this article contains records on 172,108 students, after excluding students who were not enrolled in Louisiana public schools prior to the hurricanes. We excluded students from out of state or from private schools, as well as other students with anomalous records or no records prior to the hurricanes. Details of the exclusions and data cleaning are provided in Pane et al. (2006).

August 26, 2005² until the end of the school year, the figure shows the percentages of displaced students who were in their original schools (medium gray at the bottom), relocated within their original parishes but not in their original schools (dark gray), relocated to Louisiana public schools outside their original parishes (very light gray), and not in Louisiana public schools (light gray at the top).

As shown in Figure 1, displaced students left the public school system when the two hurricanes forced them to evacuate or forced their schools to close. Students displaced by Katrina immediately began to reenroll in schools outside their original parish, and the number of these relocated students grew over the next few weeks until Rita struck in late September, causing a second wave of student displacement. In early October, a large group of students returned to their original schools when Jefferson Parish schools reopened, and another large group returned to their original schools when Calcasieu Parish schools reopened in late October. However, at that time, a substantial number of students remained relocated or out of the Louisiana public school system.

From November forward, there was a slow but steady increase in the proportions of students returning to their original schools or to other schools in their original parishes; many of the latter were returning to Jefferson and Orleans Parishes. Otherwise, the proportions of students in each of the four categories were generally stable, with the largest portion consisting of students who had returned to their original schools, and the second-largest portion consisting of students who were not enrolled in any Louisiana

² August 25, 2005 was the last school day before students began to exit schools because of the hurricane.

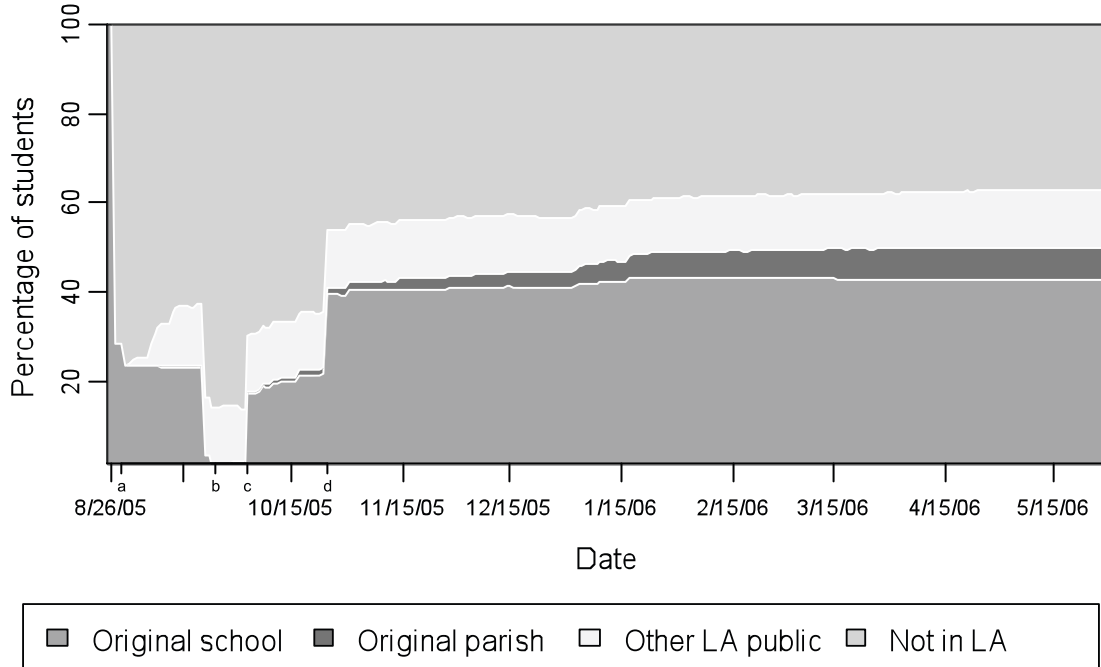


FIGURE 1. Evolution of the locations of displaced students. For all displaced students who were enrolled on August 25, 2005, before the hurricanes, the figure shows the daily proportions of students in each of four categories throughout the 2005-2006 school year. The medium-gray area at the bottom of the figure represents the proportion of students in their original schools. The dark-gray area above this represents the proportion of students in their original parishes but not in their original schools. The very light-gray area represents students enrolled in Louisiana public schools outside their original parishes, and the light-gray area at the top represents students not enrolled in any Louisiana public school. Point A denotes the date Hurricane Katrina made landfall. Point B denotes the date Hurricane Rita made landfall. Point C is the date that Jefferson Parish schools reopened, and Point D is the date that Calcasieu Parish schools reopened. *Source:* Pane et al., 2006.

public school. This latter group included students who enrolled out of state or in Louisiana private schools, as well as students who were not enrolled in any school. No existing data source enables the tracking of these students, making it impossible to determine exactly how many students did not reenroll; however, anecdotal reports from media and other sources in Louisiana suggest that at least some of these students did not reenroll in school at all during the 2005-2006 school year.

The relative stability in the proportions displayed in the figure masks a continued movement of students. For example, after their initial reenrollment, many displaced students continued to change schools, and a substantial number left the public education

system entirely. At the end of the school year, 10,000 students who had reenrolled at some time after the hurricanes were no longer enrolled in Louisiana public schools.

As suggested by this figure, many students missed a substantial amount of schooling following the storms. Among students who returned to Louisiana public schools, the median amount of time out of school until the first reenrollment was five weeks. Twenty-five percent missed less than three weeks of school, and 20% missed more than seven weeks. Additional school transfers after the first reenrollment often caused students to lose additional school time.

To summarize the experiences of individual displaced students, Pane et al. (2006) classified students into four groups according to their yearlong enrollment patterns (see Table 1). Thirty-eight percent of displaced students were out of their original schools temporarily and then returned to the same school without enrolling in any other Louisiana public school (Group A). Another 31% relocated, including 7% who returned to their original schools after temporary relocation (Group B) and 24% who did not return to their original schools for the duration of the 2005-2006 school year (Group C). Finally, more than 31% of displaced students, including the majority of Orleans Parish students, did not enroll in any Louisiana public school for the remainder of the school year, either relocating to other states or to Louisiana private schools or not enrolling in any school (Group D).

Table 2 shows that nearly 65% of the displaced students were members of racial/ethnic minority groups. This compares to 59% in the overall enrollment of the eight parishes listed above and 52% statewide. Blacks were the largest minority group, at 58% in the displaced-student population, 53% in the eight parishes, and 48% statewide. The group of

TABLE 1. Counts of Displaced Students Overall and by Four Student-Experience Groups and the Proportions Originating in Six Source Parishes

	Number of Students	Parish of Origin						
		Orleans (%)	Jefferson (%)	Calcasieu (%)	St. Tammany (%)	St. Bernard (%)	Plaquemines (%)	Other (%)
All	172,108	33.5	28.8	19.3	5.5	4.9	2.9	4.9
Group A	65,397	2.7	39.7	44.6	4.2	0.0	2.1	6.7
Group B	11,863	12.1	57.0	6.9	14.1	0.0	4.7	5.1
Group C	41,870	51.4	15.7	5.6	4.1	12.8	5.0	5.5
Group D	52,978	62.3	19.3	1.8	6.5	5.9	1.9	2.3

Note. Student-experience groups are based on data through the 2005-2006 school year. Table excludes students who were not enrolled in Louisiana public schools prior to the hurricanes. Percentages indicate the proportion of students in each group that originated in the parish. *All* = All displaced Louisiana public school students in the analysis sample. *Group A* = Students who returned to their original schools without relocating. *Group B* = Students who returned to their original schools after relocating temporarily. *Group C* = Students who relocated and ended the school year outside their original schools. *Group D* = Students who did not reenroll in any Louisiana public school for the remainder of the school year. Source: Pane et al., 2006.

students who did not enroll in any Louisiana public school for the remainder of the school year included a disproportionately large percentage of Black students and students who were achieving poorly before the hurricanes—characteristics of risk for academic failure.

Summary of Student Displacement

The majority of displaced students missed at least five weeks of school and 31% of these students relocated for at least part of the school year. It is important to understand if these

TABLE 2. Racial/Ethnic Characteristics and Average Test Scores of Displaced Students by Experience Group Following the Hurricanes

Group	Percentage Minority	Prior-Year Achievement*
Group A	44.6%	52.4
Group B	56.9%	51.4
Group C	73.4%	43.4
Group D	85.0%	42.0
<i>All displaced students</i>	<i>64.9%</i>	<i>47.0</i>

Note. *Group A* = Students who returned to their original schools without relocating. *Group B* = Students who returned to their original schools after relocating temporarily. *Group C* = Students who relocated and ended the school year outside their original schools. *Group D* = Students who did not reenroll in any Louisiana public school for the remainder of the school year. * Based on 2005 ITBS NCE scores. Includes only the 58,567 students with test score data from 2004-2005, the year prior to the hurricanes. Source: Pane et al., 2006.

large disruptions to schooling negatively affected student learning that year. The potential for negative impact is of particular concern, because displaced students were disproportionately low-achieving and minority students. On the other hand, relocated students were likely to come from schools where performance was generally low, and these students often relocated to better performing schools. It is possible that the change in the school environment might offset the potential for negative outcomes resulting from lost schooling and relocation.

The Hurricane's Effects On Schools and Responses By Schools

Pane et al. (2006) also presented the results of a survey of Louisiana school principals, which was conducted to obtain greater detail than available in administrative records on the experiences of schools following the hurricanes and to determine schools' responses to challenges presented by enrolling displaced students. The survey inquired about topics such as the number of displaced students enrolled; how displaced students compared with the school's preexisting students on demographic characteristics and achievement; the experiences of the displaced students in terms of attendance, social adjustment, and disciplinary incidents; effects on resources, activities, and the hiring and training of staff; and the effects on services provided by the school.

For the analyses of survey responses, Pane et al. (2006) divided schools into two groups by whether they had a high or low percentage of enrollment by displaced students (PEDS). Together the groups make up 99.7% of Louisiana public schools serving at least one displaced student. The average total enrollment in both high-PEDS and low-PEDS schools was approximately 510 students in January 2006, four months after the hurricanes. Displaced students, including those who were enrolled pre-hurricane and who

returned afterward, accounted for at least 84% of enrollment in the high-PEDS schools. These schools tended to be schools that had closed for some period because they were directly affected by the hurricanes and later reopened. They accounted for 77% of displaced students in our dataset who were enrolled and 45% of relocated students. However, because many of the original students from these schools relocated to other areas, high-PEDS schools experienced enrollment declines from the prior year averaging 10%. High-PEDS schools were concentrated in a few parishes: 46% in Jefferson, 33% in Calcasieu, and 6% in Orleans.

In low-PEDS schools, displaced students accounted for less than 36% of enrollment. These schools were more likely to be outside of the areas directly affected by the hurricanes, with the displaced students relocating from other schools and joining more-stable populations of preexisting students who were not displaced. Low-PEDS schools experienced an average enrollment increase of 4%.

A goal of the survey was to be able to understand how the enrollment of relocated students affected school operations and to compare relocated students with the preexisting student populations in schools. We were concerned that the experiences and meaning of survey responses might differ among principals from low-PEDS and high-PEDS schools; hence, we report most responses by these two groups. The responses are based on principal reports. Principals were asked to respond to the survey to the best of their knowledge, referring to sources such as attendance records only if they were readily at hand. We instructed principals that we did not intend to burden them with data gathering, and that approximations were acceptable.

Behavior and Mental Health

The survey asked principals to report on attendance and other behaviors, disciplinary issues, and mental health needs of displaced students compared with those of preexisting students. Most principals reported that displaced students attended school regularly, often more consistently than did preexisting students in the schools. However, a substantial proportion of schools reported that, among at least some of their displaced students, there were high levels of absenteeism. Principals most frequently endorsed such explanations for absenteeism as expectations to return home soon, trips home to check the condition of property, relocation to another school district, family fragmentation, parental problems such as those related to employment, and transportation problems.

Overall, the majority of principals reported that the social behaviors of displaced students were similar to those of preexisting students in the schools. However, when principals did report differences, displaced students were judged more likely than preexisting students to engage in negative behaviors, such as fighting, violating school rules, arguing, bullying, playing in isolation, or eating in isolation; they were also judged less likely to engage in positive behaviors, such as participating in before or after school clubs or activities, school-sponsored social events outside the school day, or sports teams. Principals also frequently reported that displaced students were more likely than preexisting students to need mental health counseling.

Many principals, particularly in high-PEDS schools, reported increases in the rates of disciplinary problems, including student tardiness, fights, verbal abuse of teachers, bullying, cutting class, and theft (Figure 2). However, for each of these

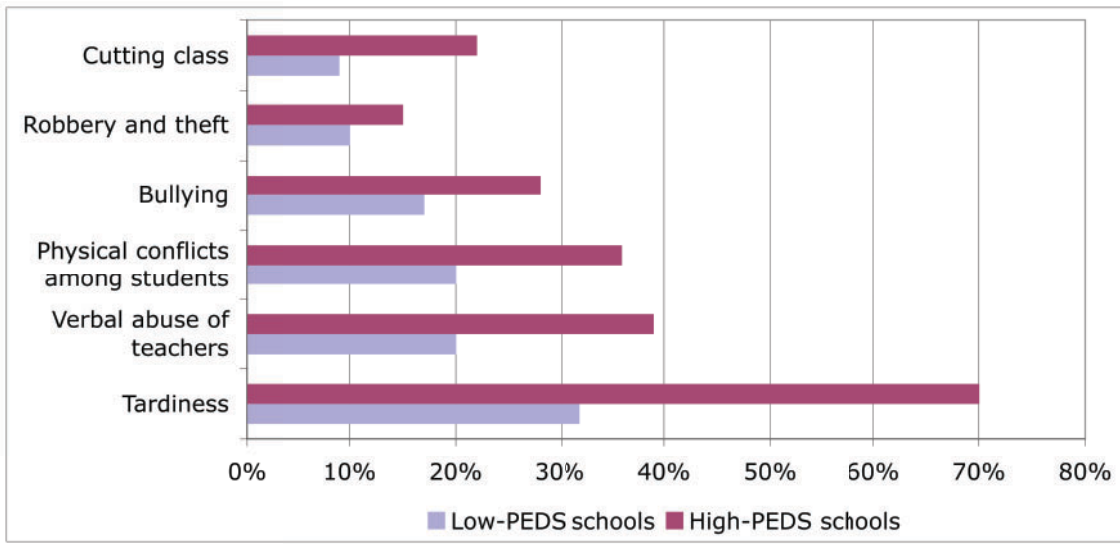


FIGURE 2. Principals' reporting of increases in the rates of disciplinary problems.

disciplinary problems, fewer principals reported increases in the frequency or severity of these problems than did those who reported that there was no change.

Steps Taken to Meet the Needs of Displaced Students

Schools took a variety of actions in response to the needs of displaced students, including increasing the delivery of mental health counseling and tutoring and undertaking efforts to improve attendance. Businesses and volunteers also contributed by providing funding, services, or supplies to help the schools. With the increased demand for services came a need to expand staffing; however, most schools were not able to hire more staff, and lack of resources or funding was often cited as the reason.

Although school-admissions policies, such as residency requirements, were adjusted to be more lenient, every principal was faced with the challenge of determining the best grade, classroom, and course placements for displaced students. Principals sought a variety of data to help in the transitioning and placement of students. Ranked as most essential were documentation of special education needs, current grade-level

placement, and prior-year grades and test scores; however, the availability of this information was generally reported to be quite low. Principals infrequently cited previous school districts or the state as the sources of this information; instead, they primarily relied on parents and guardians or the students themselves to provide this information.

Finally, some principals noted that the pressures of policies related to state testing and accountability added to the hurricane-induced stresses in their schools.

Effects on Staff and Resources

Enrolling displaced students strained school resources in a variety of ways. Class sizes increased in more than a third of the schools, and more than half of schools needed additional classroom teachers and other types of staff, such as substitutes, special education or resource teachers, teachers' aides, support staff, and counselors or social workers. The need for teachers and other staff was greater in high-PEDS schools, and these schools also reported that the pool of applicants was smaller than in prior years. Principals frequently reported that these staffing needs went unmet, due primarily to a lack of funding but also, in some cases, to the lack of qualified applicants. Among schools that did hire additional staff, it sometimes took considerable time to fill the positions. However, hiring standards were apparently not compromised: The new hires were reported to be similar to preexisting teachers in their qualifications. The school district was the most common source of funding for additional hires. Principals also reported that rapidly fluctuating enrollment numbers complicated their analysis of staffing needs and, ultimately, the decisions to hire.

In many schools, principals reported that teachers showed higher levels of stress than in prior years. Principals reported increased frequencies of work fatigue, job

frustration, and absenteeism among teachers, particularly in high-PEDS schools.

Principals noted that teachers hired to fill vacant positions were often displaced teachers who were struggling with their own personal problems resulting from the hurricanes.

The needs for additional resources went beyond staff to include books and supplies, furniture, transportation resources, and classroom space. In many schools, these needs were met, sometimes by donations from outside sources; however, in a substantial number of schools, the resource needs persisted throughout the school year.

Recovery efforts and the strain of serving displaced students had a notable effect on teachers' professional development, particularly in high-PEDS schools. Principals reported that issues related to displacement created new needs for professional development; yet they found it more difficult than in the past to provide release time for teachers to attend. Similarly, principals reported that issues related to displacement diverted their attention from other activities and issues in their schools and caused them to postpone activities that already had been planned.

Summary of the Hurricane's Effects On Schools and Responses By Schools

The survey data suggest that many schools were able to respond well to the hurricanes and the changes in student enrollment that followed. On most survey questions, there were substantial portions of principals endorsing each response option, indicating that issues and problems were not encountered uniformly across schools. Most principals reported that the attendance and behavior of displaced students was similar to other students, although in many schools a portion of the displaced students had poor attendance. When difference existed between displaced and other students, displaced

students were faring more poorly than other students. In particular, displaced students were more in need of counseling than other students.

The effects of the hurricane on resources and staffing could potentially have a large impact on student achievement if schools could not provide qualified teachers or the necessary materials. Some schools reported difficulty in hiring necessary staff or procuring needed resources. Moreover, principals in high-PEDS schools reported increased rates of stress and fatigue among teachers compared to prior years. They also reported that the hurricanes created greater teacher absenteeism and greater needs for professional development, which they had difficulties meeting. These challenges were in contrast to the low-PEDS schools where principals were substantially less likely to endorse statements about negative teacher experiences.

Effects on Student Achievement

Given the literature on mobility and disasters, the large numbers of Louisiana public school students who experienced traumatic events and transferred schools during the 2005-2006 school year were clearly at risk of experiencing negative effects on their achievement. The extensive testing of students by the state in the 2005-2006 school year and earlier years provided data enabling us to study the nature of these effects. Using this data, we address the following research questions about the effects of the disasters on student achievement:

- Did the hurricanes affect student achievement?
- Did students' experiences following the hurricanes differentially effect achievement?

- Did the performance of the schools that students entered or left in the wake of the storms affect achievement?
- Did school conditions or policies mediate the influence of the hurricanes on student achievement?

The remainder of this section is organized into three sections on data sources, statistical models, and results of student achievement analyses.

Data Sources

This study makes use of standardized tests administered by the Louisiana Department of Education (LDE). Beginning in 1999, the Louisiana Educational Assessment Program (LEAP) exams have been administered to students in Grades 4 and 8 to measure whether they have adequate knowledge and skills to progress to the next grade. The LEAP exams cover four topics: mathematics, English language arts, science, and social studies.

Students are not promoted if they do not perform sufficiently on the mathematics and English language arts LEAP exams. Scaled scores on the exams are classified into five proficiency levels: *unsatisfactory*, *approaching basic*, *basic*, *mastery*, and *advanced*; however, the LEAP scaled scores are used in the analyses reported in this article.

Through the 2004-2005 academic year, LDE administered the Iowa Test of Basic Skills (ITBS) from Riverside Publishing, Inc. to students in grades not covered by LEAP – Grades 3, 5, 6, 7, and 9. The primary goal of these norm-referenced tests was to provide data for evaluating Louisiana students' performance in comparison to the performance of students across the nation. The ITBS exams cover four topics: mathematics, language, social studies, and science. The ITBS reports results in several formats: scaled scores,

national percentile ranks, national stanine, and normal curve equivalent. The scaled scores are used in the analyses reported in this article.

Beginning with the 2005-2006 school year, LDE replaced the ITBS exams with a new assessment program to satisfy requirements of the federal No Child Left Behind Act. This new series of tests is the Integrated Louisiana Educational Assessment Program (iLEAP). The iLEAP tests include items from the ITBS supplemented with new test items specifically developed to measure the state's content standards and grade-level expectations. Like the LEAP, iLEAP reports proficiency levels for mathematics, English language arts, science, and social studies. However, the ITBS components of iLEAP are also used to calculate nationally-normed scaled scores for mathematics, English language arts, and reading; these scaled scores are used for analyses reported in this article.

Because the analyses in this report span the 2004-2005 and 2005-2006 school years, all three of these exams are used in analyses. Figure 3 illustrates the exams used in each grade level in these two years, and the arrows depict pairs of exams that are available on cohorts of students pre- and post-hurricanes. In no case is the same exam available for both pre- and posttest. For two cohorts of students (those in Grades 3 or 7 in 2004-2005), the pretest is the ITBS exam and the posttest is the LEAP exam. For two cohorts of students (those in Grades 4 or 8 in 2004-2005), the pretest is the LEAP exam and the posttest is the iLEAP exam. Finally, for two cohorts of students (those in Grades 5 or 6 in 2004-2005), the pretest is the ITBS exam and the posttest is the iLEAP exam.

	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9
Spring 2005	ITBS	LEAP	ITBS	ITBS	ITBS	LEAP	ITBS
Spring 2006	iLEAP	LEAP	iLEAP	iLEAP	iLEAP	LEAP	iLEAP

FIGURE 3. Configuration of LDE standardized exams in the years spanning the hurricanes. Arrows indicate pre- and posttests available for six cohorts of students.

This configuration of tests does not enable analysis of pre-post gains directly. Statistical models are performed separately for each cohort of students, using pretest scores as covariates and posttest scores as outcomes. Students for whom either the pretest or posttest score was missing were excluded from analysis, as were a small number of students with anomalous scores, for example those that indicated testing irregularities.

To facilitate comparisons across the variety of tests, each set of test scores³ is scaled to have a standard deviation of 1.0. Effect size estimates reported in the third section of this paper are in standard deviation units. Results of one analysis can be readily compared to another (e.g., math vs. reading). However, to attach meaning to the sizes of the effects, a reference point is desirable. For this, we used available data to estimate the difference in scores on the iLEAP exam from one grade level to the next (across cohorts), in standard deviation units. A three-cohort series of 2005-2006 iLEAP scores in Grades 5, 6, and 7 provides data on the differences in scores between Grades 5 and 6, and between Grades 6 and 7, on three exams: mathematics, English language arts, and reading. In this data, the average difference in scaled scores from one grade level to the

³ By “set of test scores,” we mean scores for a particular year, grade level, and subject area.

next was calculated to be approximately 0.4 standard deviation units.⁴ This should be considered a very rough estimate of grade-to-grade growth because these calculations were performed across cohorts, and growth on this scale may vary across subject areas and grade levels. Nonetheless, this value may be useful when interpreting results in the third section of this paper.

School Performance Measures

As discussed, displaced students came primarily from a small number of parishes in the state. As a result, the performance of the schools serving the displaced students often differed from other schools. For example, many of the schools in Orleans Parish were among the lowest performing schools in the state, according to the state's performance measures. To estimate the effects of the hurricanes, we need to account for differences in the educational experiences of displaced and other students prior to the hurricanes. We did this by including school performance measures in our models. We used average performance of the students within a school as the measure of school performance. Clearly this is not an accurate measure of the school's input to learning because it combines the inputs of the students and the schools. However, for the purposes of controlling for prior educational experiences, the school and peer effects are both likely to be important, so we chose to use average performance. We conducted exploratory

⁴ The differences in average scaled scores from Grades 5 to 6 were 0.53, 0.43, and 0.48 standard deviation units in Mathematics, English Language Arts, and Reading, respectively. The differences in average scaled scores from Grades 6 to 7 were 0.38, 0.26, and 0.47 standard deviation units in the three subject areas. In both cases, the standard deviation of the higher grade level was used in the denominator. Averaging across the two grade levels, the one-grade-level differences in scaled scores were 0.45, 0.34, and 0.48 standard deviation units in the three subjects. Averaging across subjects, the one-grade-level difference in scaled scores was 0.42.

analyses with school performance measures based on the average residuals from a linear regression model for test scores that controlled for schools' aggregate demographics. These measures were less predictive and the models were less stable than those that defined performance as the average student outcomes.

Louisiana creates performance measures, but these were unavailable for some schools in our sample. Consequently, we created school performance measures that were similar to the state's performance measures. For each school, we obtained the aggregate performance measures for LEAP and ITBS for each grade. These measures were standardized to have a mean of zero and a standard deviation one by grade, subject, and year. We then averaged the standardized values by school and grade to create grade-specific performance measures. These measures were then standardized by grade to have a mean of zero and a standard deviation of one among schools. We retained grade-level measures so that, across schools, the performance measures would be comparable for students in our models, which were all grade-specific.

We assigned to each student the grade-level performance of the school in which they started the 2005-2006 school year as their entry school's performance. We also assigned to each student the grade-level performance of the school in which they were tested in the 2005-2006 school year as their tested school's performance. We use the entry school performance as a proxy for students' prior schooling experience, and the pair of measures enables examination of how transfers to schools of different performance levels was related to the achievement effects of the hurricane.

Statistical Models

We fit a series of statistical models to explore the effects of the hurricanes on student achievement and to determine how particular features of students' experiences following the hurricanes contributed to their achievement.

Summary of Student Outcomes

We first compared the overall achievement of displaced students to the achievement of other students. We used a hierarchical linear model to account for the clustering of students in schools at the time of testing. Given the pre-existing differences between displaced and other students described earlier, this analysis is purely descriptive. The remaining analyses attempt to separate pre-existing differences from the actual effects of the hurricanes in student outcomes.

We fit a three-level model. Level 1, the student level, includes an indicator for the whether or not the student was displaced, a school specific intercept and a random residual error term:

Model 1

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \gamma d_{ijk} + \varepsilon_{ijk}$$

where y_{ijk} is the score for the k th student, in school j of district i , α_{ij} is the school specific intercept, γ is the difference between outcomes for displaced and other students, d_{ijk} is an indicator that equals one if the student was displaced and zero otherwise, and ε_{ijk} is the student specific residual error term. Level 2, the school level, includes district-specific intercepts and random school-level residual error terms. Level 3, the district level, includes an overall mean and random district-level residual error terms:

$$\text{Level 2: } \alpha_{ij} = \eta_i + \xi_{ij}$$

$$\text{Level 3: } \eta_i = \mu + \zeta_i$$

The residual errors at each level are treated as random normal variables with zero mean and unspecified variance that are estimated from the data. The models are fit separately for each subject (mathematics, English language arts, reading, science, and social studies) and grade (4, 5, 6, 7, 8, and 9).

Overall Effects of Displacement

Because displaced students' demographics and achievement prior to the hurricanes differed from other students, the displaced student parameter of Model 1 is likely to be confounded. To remove this confounding parameter, we controlled for individual student ethnicity, gender and prior achievement. Ethnicity was coded as American Indian, African American (the hold out group in all our models), Asian, Hispanic, and non-Hispanic White.

Exploratory analyses suggested that the relationship between current year and prior year scores was nonlinear and that the third order polynomial provided the best fit in terms of no residual nonlinearities in the fitted models. Hence our models include third-order orthogonal polynomials of all the available prior test scores for each model as defined by grade and subject. For outcomes at each grade level, the prior year scores included are:

- *Grade 4.* Grade 3 reading, English language arts (ELA), and mathematics
- *Grade 5.* Grade 4 ELA, mathematics, science, and social studies;
- *Grade 6.* Grade 5 reading, ELA, and mathematics;
- *Grade 7:* Grade 6 reading, ELA, and mathematics;
- *Grade 8:* Grade 7 reading, ELA, and mathematics;

- *Grade 9.* Grade 8 ELA, mathematics, science, and social studies.

Orthogonal polynomials transform the square and cubic terms of prior year scores so that they are nearly uncorrelated with the linear term. This does not change the overall fit of the model, but can improve the stability of the estimated model.

The model also accounts for the performance of students' prior schooling through the inclusion of an entry school performance measure. We again fit a three-level model, where the school and district level models are the same as in Model 1. Throughout, we use similar notation for model parameters across the different models even though some of the components of the models differ. These changes to the models change the meaning of the parameters and we use common notation to reduce the notation in the article. The shared notation should not be interpreted as meaning the components are equal across models.

Model 2

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \beta^3 z_{ijk} + \delta^3 x_{ijk} + \gamma d_{ijk} + \varepsilon_{ijk}$$

where, as in Model 1, y_{ijk} is the score for the k th student, in school j of district i , α_{ij} is the school specific intercept, γ is the difference between outcomes for displaced and other students, d_{ijk} is an indicator that equals one if the student was displaced and zero otherwise, and ε_{ijk} is the student specific residual error term. The new terms in this model, $\beta^3 z_{ijk}$ and $\delta^3 x_{ijk}$, respectively denote the third-order orthogonal polynomials for prior test scores and the student demographics and entry school performance.

Effects of Displacement by Student Experience Group

As discussed in the first section, displaced students had a variety of experiences following the hurricanes that we classified into four broad categories. We tested for

differences among these groups while controlling for the students' background of prior year scores, prior schooling, and demographics. We cannot test for Group D (students who did not re-enroll in Louisiana public schools following the hurricanes) because we do not have 2005-2006 test scores for these students. The model for testing for difference among groups of displaced students is similar to Model 2 except that, instead of including a single indicator for being displaced, the model includes indicators for membership in Groups A, B, or C.

Model 3

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \beta' z_{ijk} + \delta' x_{ijk} + \gamma_A d_{Aijk} + \gamma_B d_{Bijk} + \gamma_C d_{Cijk} + \varepsilon_{ijk}$$

where d_{Aijk} , d_{Bijk} , and d_{Cijk} are indicators that equal one if the student was displaced and is in Group A, B, or C, respectively, and zero otherwise. The corresponding parameters measure differences between each group of displaced students and students who were not displaced. The remaining terms are the same as they were in Model 2, and Levels 2 and 3 are the same as they were in the earlier models.

The Effect of Relocating to Schools with Higher or Lower School Performance than Students' Original Schools

As noted above, many displaced students were attending low-performing schools prior to the hurricanes, and often these students attended better performing schools following the hurricanes. To understand how changes in school performance moderated the effects of hurricane displacement, we modeled the outcomes of Group C students and included an indicator variable for students who attended a better performing school at the time of the test than the school they were enrolled in prior to the hurricanes. We used this model to estimate the difference in mean outcomes between groups and then to estimate the means

of the two groups. Again, the model contained the same factors as Model 2 except that there was no term for displaced students and there was a term for being a Group C displaced student who moved from a lower to higher performing school as a result of the hurricane. Levels 2 and 3 are again the same as in other models.

Model 4

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \beta^2 z_{ijk} + \delta^2 x_{ijk} + \varphi u_{ijk} + \varepsilon_{ijk}$$

where as u_{ijk} equals one if the student was enrolled in higher performing school at the time of testing than prior to the hurricane and equals zero otherwise. The parameter φ equals the difference between students whose schools' performances improved and those whose did not. The sum of this parameter and μ equals the average outcome for students whose relocation resulted in an improvement in school performance, and μ equals the mean for students whose relocation did not result in an improvement in school performance.

Effects of Time Out of School and High Mobility Among Schools

The experiences of displaced students differed in terms of the amount of time that students were out of school and the number of different schools students attended. To understand how these factors affected student achievement, we fit additional models that included (a) a term for the length of time in months that a student was out of the Louisiana public school system before enrolling again for the first time after the hurricanes and (b) a term for number of schools attended after the hurricanes in the 2005-2006 school year. For these models, we consider only Group C students since group A and B students returned to their original schools. The model is similar to Model 2, with the exceptions that it is fit only to Group C students, so there is no indicator for displaced

status; and there are terms for months until re-enrollment, number of schools attended, and the performance of the school where the students were tested.

Model 5

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \beta^1 z_{ijk} + \delta^1 x_{ijk} + \theta m_{ijk} + \omega s_{ijk} + \varepsilon_{ijk}$$

where m_{ijk} equals the time in months until the student first re-enrolled in a Louisiana public school following the hurricane and s_{ijk} is the number of Louisiana public schools the student attending during the 2005-2006 school year following the hurricanes. The remaining terms are the same as they were in Model 2, and Levels 2 and 3 are the same as in the earlier models.

Relationship Between School Conditions and Policies and the Performance of Displaced Students

One of the research questions of this study is whether student outcomes were correlated with school conditions or actions they took due to the hurricanes and the influx of displaced students. We explored these relationships through a series of models in which a variable measuring a facet of school climate or a school action, as reported by principal survey responses, was entered into a model for student outcomes. We used only data from displaced students in this analysis to understand how variations in schools correlated with the outcomes of displaced students.

Model 6

$$\text{Level 1: } y_{ijk} = \alpha_{ij} + \beta^1 z_{ijk} + \delta^1 x_{ijk} + \varepsilon_{ijk}$$

where the terms correspond to those in Model 2 except that there is no overall displaced indicator in the model. Because factors of interest in this analysis are school-level variables, the school factors are included in our Level 2 model.

$$\text{Level 2: } \alpha_{ij} = \eta_i + \lambda w_{ij} + \xi_{ij}$$

where w_{ij} is a measure of a school climate or practice as reported by the principal. A different variable was included in each model, with a total of 28 models for each subject and grade combination, corresponding to the 28 school-level measures we created from the principal survey. Level 3 remains the same as in all of the previous models.

School-Level Variables Derived from Principal Survey Responses

The following school-level variables were developed from principal survey responses and tested in Model 6.

- *Disruption.* This is a survey scale developed from six survey items related to the hurricanes diverting time, attention, and resources from other school activities, creating professional development needs, or resulting in higher teacher absenteeism ($\alpha = 0.81$).
- *Changes to the frequency or severity of disciplinary problems.* Three survey scales were formed from survey items related to disciplinary problems: minor infractions, for example, tardiness, cutting class, theft, vandalism, racial tension, bullying, fighting, or verbal abuse of teachers ($\alpha = 0.81$); substance abuse, for example, the use of alcohol, drugs or tobacco ($\alpha = 0.86$); and more serious infractions, for example, physical abuse of teachers, possession of weapons, or gang behavior ($\alpha = 0.61$).
- *Attendance problems.* Two dichotomous variables were tested in models: one was set if principals indicated displaced students had high absentee rates or higher absentee rates than other students in the school; the other was set if principals indicated they had taken steps to increase attendance among displaced students.

- *Staffing needs.* Dichotomous indicators of staffing needs were tested for four types of school staff: classroom teachers, special education or resource teachers, substitute teachers, and counselors, psychologists or social workers. The first indicator in each pair was set if principals reported that they needed more staff due to the influx of displaced students; the second was set if principals reported that they needed more staff and would have hired more if additional funding or additional qualified applicants had been available.
- *Resource needs.* Dichotomous indicators of resource needs were tested for four types of resources: classroom space, desks or chairs, books or supplies, and transportation. The first indicator in each pair was set if principals reported they needed the resource immediately following the hurricanes; the second was set if principals reported they needed the resource at the time they completed the survey.
- *Class size.* A factor variable was created for principal reports of whether student displacement resulted in a significant increase or decrease in class sizes.
- *Teacher stress.* A measure of teacher stress was formed by counting how many of the following changes were reported by principals: teachers expressed more work fatigue, teachers expressed more job frustration, and teachers expressed less job satisfaction relative to the prior school year.
- *Utilization of school services.* A measure of service utilization was formed by counting how many of the following services were reported to have an increase in utilization relative to the prior school year: group counseling, weekly/monthly

- one-to-one counseling, drop-in one-to-one counseling, mental health service referrals, and Project SERV (School Emergency Response to Violence).
- *Staffing of school services.* A measure of staffing changes for programs or services was formed by counting how many of the following items were reported to receive an increase in staffing relative to the prior school year: group counseling, weekly/monthly one-to-one counseling, drop-in one-to-one counseling, mental health service referrals, and Project SERV.
 - *Principal experience.* Two continuous scales were created as measures of principal experience in the current school and in prior schools, formed by recoding ranges of experience reported by principals (e.g., the survey response 3-5 years was recoded as 4).

Sensitivity Analyses

We conducted an extensive number of auxiliary analyses to explore the sensitivity of our results to modeling choices and other factors of our analyses. These included using propensity score weights (McCaffrey, Ridgeway, & Morral, 2004) to control for differences between displaced students and other students. These also included an alternative model formulation that included random slopes in Model 2. These analyses did not produce any meaningful differences from the results reported below.

Student Achievement Analysis Results

This section presents the results of analyses addressing the following questions: How did displaced students perform on the Spring 2006 state exams, compared to non-displaced students? How did the effects differ for students with varying displacement experiences?

Among displaced students, what was the relationship of the following factors to student achievement:

- Relocating to schools where average achievement was higher or lower than students' original schools;
- Time out of school until first reenrollment; and
- Number of schools attended during the 2005-2006 school year?

What were the relationships between school conditions and policies, as reported on the principal survey, and displacement effects on achievement?

Each of these analyses controls for students' prior year achievement scores, race/ethnicity, and gender, as well as average achievement in the schools students attended at the start of the 2005-2006 school year (prior to the hurricanes). Nonetheless, a limitation of this analysis is that these covariates might not sufficiently control for all differences between student groups that may affect achievement.

Overall Effects of Displacement

Model 1 found that, on average displaced students tended to score worse than other students in all subjects and at all grade levels. These differences were statistically significant in all cases, corresponding to effect sizes from -0.09 to -0.22, with half of the cases between -0.15 and -0.22. However, as discussed previously, displaced students were at greater risk for low achievement even if they had not been displaced.

Consequently, Model 2 tests for an overall effect of displacement, controlling for students' prior-year test scores, race/ethnicity, gender, and the school performance score of their 2005-2006 school prior to the hurricanes. Figure 4 displays the results. The horizontal axis represents the grade level of the students in 2005-2006, and the vertical

axis represents the effect size of displacement for all students in the data set who were displaced but remained in Louisiana public schools (Groups A, B, and C). The letters represent the subject areas of the exams: “M” for mathematics, “L” for English language arts, “H” for social studies (history), “S” for science, and “R” for reading. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

In this model, effects for displacement are larger at lower grade levels, and significant only in some subject areas at the lower grade levels. The magnitude of the significant effects ranges from about -0.03 to -0.09. An effect size of -0.06 is about one-seventh the grade-to-grade differences calculated in the third section of this paper; not a large effect.

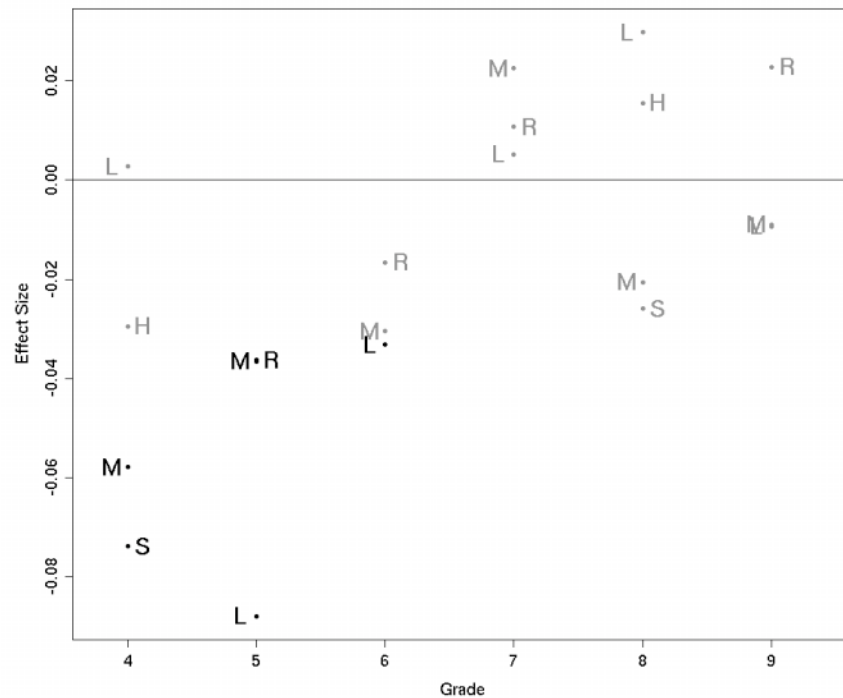


FIGURE 4. Overall effect of displacement for Groups A, B, and C combined. Letters represent the subject areas of the exams: “M” for mathematics, “L” for English language arts, “H” for social studies (history), “S” for science, and “R” for reading. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

Tables containing the full results of these models, as well as those described below, are available in a supplemental publication (Pane, McCaffrey, Kalra, & Zhou, 2008).

Effects of Displacement by Student Experience Group

Among displaced students in our data set, those in Groups A and B returned to their original schools by the end of the 2005-2006 school year. Group A students returned to their original schools without enrolling in any other Louisiana public school, while Group B students returned to their original schools after enrolling in one or more other Louisiana public schools. Group C students were displaced from their original schools and did not return to their original schools for the duration of the school year. Figure 5 displays the displacement effects in mathematics for each of these groups, controlling for students' prior-year test scores, race/ethnicity, gender, and the school performance score of their 2005-2006 school prior to the hurricanes. The letters represent the student experience groups: A, B, and C. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

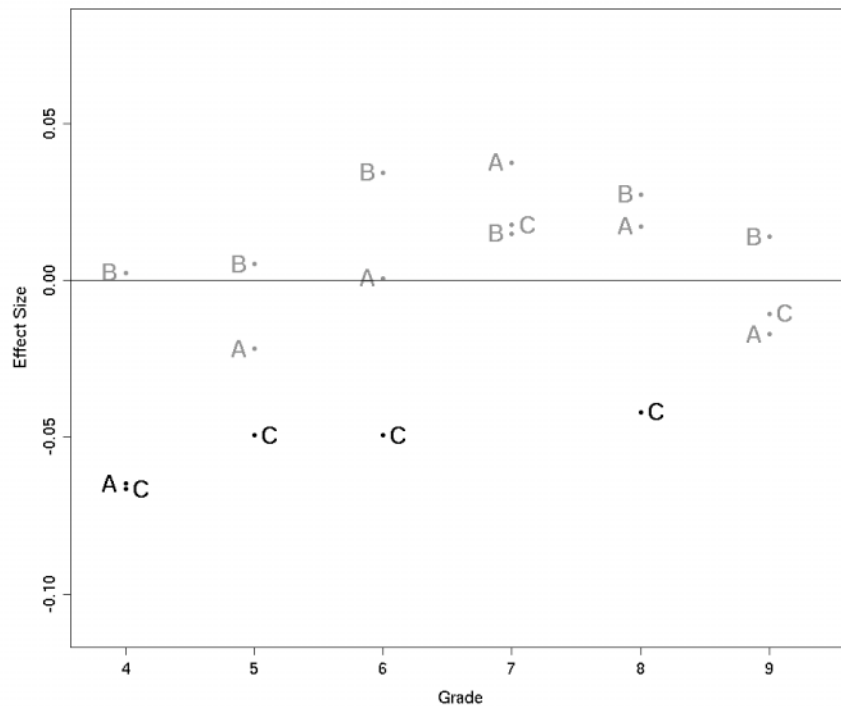


FIGURE 5. Effects of displacement on mathematics achievement, by student experience group. Letters represent the student experience groups: A, B, and C. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

The negative effect of displacement is primarily confined to students in Group C, where the effect is significant in four of the six grade levels and the effect size ranges from about 0.04 to 0.07, with larger effects at lower grade levels. The effects in other subject areas were similar.

The Effect of Relocating to Schools with Higher or Lower School Performance than Students' Original Schools

Many displaced students originated in schools that were very low performing prior to the hurricanes. Those who enrolled elsewhere in the state may have gone to schools that were higher performing than their original schools. Figure 6 examines the effects of changes in school performance pre- and post-hurricanes among Group C students (those who did not return to their original schools for the duration of the 2005-2006 school year). Arrows

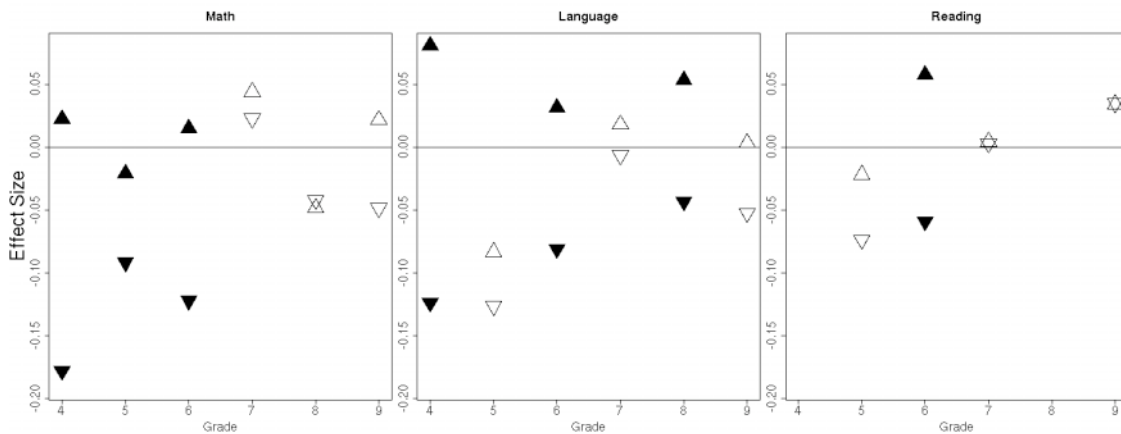


FIGURE 6. Effects of changes in school performance from pre- to post-hurricanes among Group C students. Arrows pointing up represent those students whose displacement moved them to higher-performing schools; arrows pointing down represent those students who moved to lower-performing schools. At any grade level, the pair of arrows is filled (black) if the difference between the two groups is statistically significant; otherwise the arrows are unfilled.

pointing up represent those students whose displacement moved them to higher performing schools. These students took their 2005-2006 exams in a school that was higher performing than the school in which they began the year pre-hurricanes. Arrows pointing down represent those students who moved to lower performing schools. At any grade level, the pair of arrows is filled (black) if the difference between the two groups is statistically significant; otherwise the arrows are unfilled.

The results show that school performance is a factor in how displaced students performed, particularly at lower grade levels. Most of the up-arrows are near zero, while most of the down-arrows are below zero. These results suggest that negative effects of displacement, which can include emotional turmoil and loss of schooling, might be offset by improvements in the educational environment, which can include both school quality and the influence of a higher performing peer group. Conversely, movement into a lower performing educational environment might exacerbate the effects of displacement. The effect sizes for those students experiencing a downgrade in school performance range as

large as -0.18, about 40% of the grade-to-grade differences calculated earlier in this paper.

Effects of Time Out of School and High Mobility Among Schools

As noted in the first section of this paper, displaced students missed a considerable amount of school before re-enrolling in Louisiana public schools after the hurricanes. The median amount of time out of school until the first reenrollment was five weeks. Twenty-five percent of displaced students who reenrolled missed less than three weeks of school, and 20% missed more than seven weeks. More than 14,400 of these students missed at least three months of school before their first reenrollment. In addition, many students continued to change schools, with the attendant disruptions and losses of additional school time. More than 25,500 students enrolled in at least three schools and more than 4,700 enrolled in at least four schools. This section examines the role of these two factors in any effects of displacement among Group C students.

Figure 7 shows the effects of missing one month (30 days) of school. Here significant effects are most consistent on the English language arts exams, with effect sizes ranging from about -0.03 to -0.08. These effects are cumulative; so, for example, students who missed three months of school might have negative effects over 0.2, or half of the grade-to-grade differences calculated earlier. It is also notable that the grade levels in which effects are seen beyond the English language arts exams are Grades 4 and 8, the grades in which the high-stakes LEAP exams are administered.

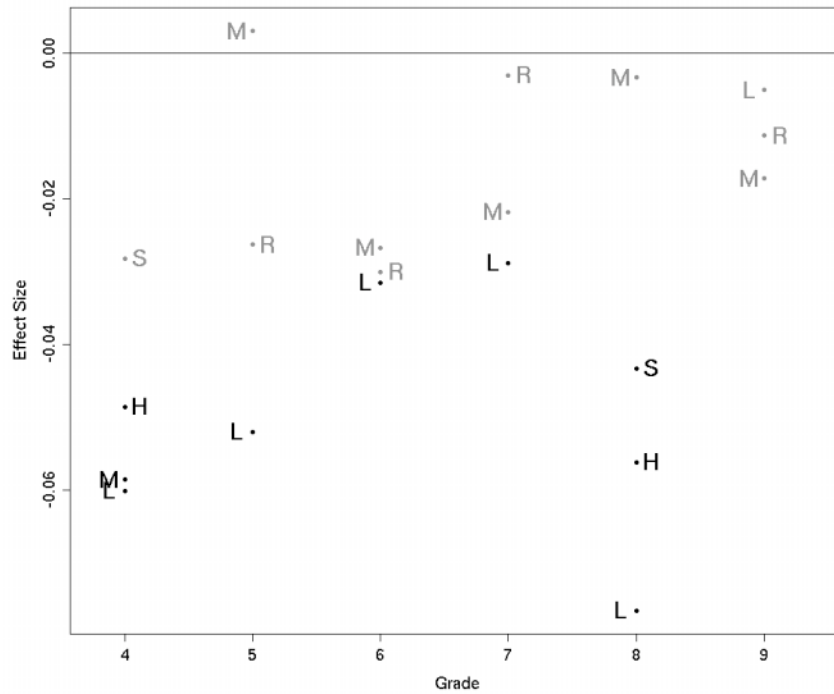


FIGURE 7. Effects of Group C students missing one month (30 days) of school. Letters represent the subject areas of the exams: “M” for mathematics, “L” for English language arts, “H” for social studies (history), “S” for science, and “R” for reading. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

Figure 8 shows the effects of changing schools, per school. Here significant effects appear in many different subject areas, and unlike most of the prior results, the effects appear to be larger at higher grade levels. Significant effects range from about -.04 to -.1. These effects are also cumulative; so, for example, displaced students who enrolled in four different schools might have negative effects approaching -.4, about as large as the grade-to-grade differences calculated earlier.

Relationship Between School Conditions and Policies and the Performance of Displaced Students

Finally, we examined the relationship of school conditions and policies, as reported by principals in our survey, to the effects of displacement. We used statistical models to test whether principal responses were related to students’ achievement

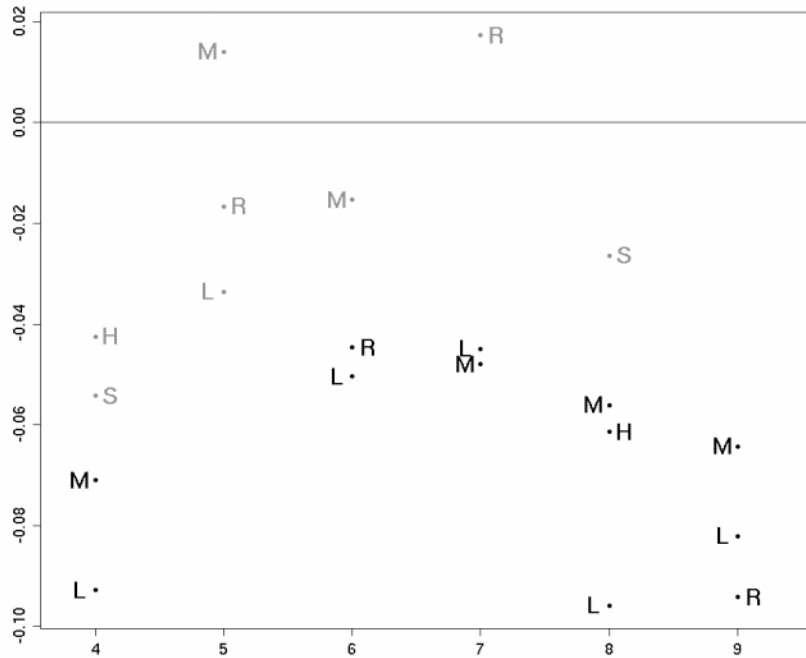


FIGURE 8. Effects of Group C students enrolling in additional schools, per school. Letters represent the subject areas of the exams: “M” for mathematics, “L” for English language arts, “H” for social studies (history), “S” for science, and “R” for reading. The letters are printed in black if the effect is statistically significantly different from zero; otherwise the letters are printed in gray.

outcomes for the survey items and scales described earlier in this article. None of these factors showed strong consistent relationships to the achievement of displaced students.

Conclusions

Rich data collected by the Louisiana Department of Education on students in the state’s public schools, supplemented with information collected in a survey of the state’s principals, enabled us to document the movements of students due to Hurricanes Katrina and Rita and analyze the effects of these movements during the 2006-2006 academic year. Results suggest that the education system handled the disruptions of the disaster relatively well. However, more detailed examinations show that some displaced students exhibited problems such as non-enrollment or poor attendance, mental health or behavioral problems, and academic setbacks.

Analyses of achievement results for students who enrolled in Louisiana public schools pre- and post-hurricanes suggest that negative effects of displacement on achievement were small overall, but most pronounced among students who changed schools as a result of the hurricanes and did not return to their original school for at least the duration of the 2005-2006 academic year. These negative achievement effects appear to have been mitigated by students' tendency to enroll in schools with higher student performance than their original schools. Not surprisingly, larger negative effects were associated with both larger numbers of schools attended and greater amounts of school time lost.

Because the school changes we observed were caused by the external shock of the disaster rather than students' personal circumstances, our results provide information about the effects of changing schools that is not confounded by factors that often affect observational studies on mobility, in particular the family circumstances that motivate the move. Using a measure of school performance that includes effects of both peers and schooling, we find that among students who transferred schools, those transferring to higher performing schools had higher achievement. These results might indicate that student achievement is sensitive to school performance, even in the short term, which would have important policy implications for improving schools and school assignments. Our results are also consistent with other studies that find that student mobility need not be related to poorer student outcomes, especially if the changes are associated with positive changes in schooling or other factors. Rather, our results suggest that negative effects of displacement may be dominated by two simple factors: how much schooling time is lost and how many school transitions the student experiences.

This finding has potential implications if effects on student achievement are to be factored into preparedness for future disasters. Ideally, families would relocate to areas with good schools, enroll their children in schools immediately, and minimize subsequent moves that require additional school changes. This is easier said than done, because geography and transportation play major roles in the immediate relocation of disaster victims, the best schools may have limited capacity to accept students, and social, economic, and other factors may compel families to relocate after their first move. Nonetheless, these facts, along with counseling and ready access to information about school performance, might help families make decisions that are beneficial to their children.

An important component in such decision-making is an understanding of the likely duration of the displacement. Principals rated expectations of returning home soon as the factor most likely to affect poor attendance by students (Pane et al., 2006, p. 82). Policymakers should seek ways to disseminate information to help parents form realistic expectations of the duration of the disaster and realize the importance of settling their children in schools quickly and with few transitions. Such information might help parents who recognize they are in unsustainable situations, but who are “waiting it out,” to make the necessary changes expediently and with a mind toward solutions that can be sustained for the long-term.

It is important to recognize that these analyses do not include the displaced students who did not reenroll in a Louisiana public school. These students constitute more than a quarter of displaced students and they tended to be those who were most at risk for poor academic outcomes. If these students were disproportionately affected by

the displacement, either because of their backgrounds, experiences after the storms, or because they spent the entire school year without reenrolling, this would not be reflected in our analyses.

This limitation not only prevents researchers from gaining a full understanding of what happened to all displaced students, but also has implications regarding state data systems and national policy for sharing of student-level information. A complete solution to this problem requires not only for each state to create student information systems for its public school students with a comprehensive array of data similar to Louisiana's, but also for students in non-public schools to be tracked by equally comprehensive systems, and for policies and mechanisms to be established that support the sharing of complete and accurate student information across state boundaries and between the public and private education systems.

Our study has shown that the shock of the hurricanes to the Louisiana public school system was enormous, disrupting the education or relocating nearly 200,000 students from many school districts including the state's largest districts. The system proved surprisingly resilient to this shock, with principals reporting generally limited negative experiences for displaced students and other students in schools hosting those students, and achievement analyses showing only modest short-term effects among students who were temporarily out of school or changed schools as a result of the hurricanes. As time goes on, additional studies of the long-term effects of the hurricanes could provide useful information on how the system continues to evolve and on long-term academic outcomes such as high school graduation and matriculation in post-secondary education for students directly affected by these storms. Such studies would

help the state support its public school system and to ensure that the nation does its best to provide full and long-term recovery to the victims of its largest natural disaster, as well as other students facing similar disasters in the future.

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