The Effect of Natural Disasters on Student Learning: A Case Study of Hurricane Harvey and Texas School Districts

**Abstract**

To date, little research has been done on the effects of student learning and overall achievement at the secondary level after a natural. Hurricane Harvey hit in late August of 2017, damaging regions from the southern Gulf Coast of Texas all the way to the borders of Louisiana. Post Hurricane Harvey, students eventually returned to schools but remained in a state of recovery in rebuilding their family homes and acquiring new belongings. While much psychological work has been done school-age children and post-natural disaster recovery, far fewer investigations have looked at how these ramifications have impacted student achievement in the classroom. The scope of this project seeks to fill that gap in identifying any significant decreases in student learning and achievement in areas affected by Hurricane Harvey along the Gulf Coast of Texas, using the State of Texas Academic Assessment of Readiness results as a proxy for student achievement.

**Introduction**

Hurricane Harvey (‘Harvey’) made landfall on August 25th, 2017 on the Texas coast, creating $125 billion in damages and displacing nearly 336,000 Texans. While high winds were not a prominent source of damage during Hurricane Harvey, record breaking rainfall collected in and around the city of Houston and southeast coast of Texas inflicting unprecedented flooding. The widespread flooding lead to business and school closures across the gulf coast for much of September as communities cleaned up and recovered from the disaster. Families affected by Harvey lost some or all possessions due to stagnant flood waters, and were often displaced during the recovery period.

Amidst a natural disaster like hurricanes, there are anticipated economic and social consequences, but a much less researched topic is the impact natural disasters can have on education. Doyle et al. (2017), among other studies, notes the link between natural disasters and the negative externalities they can create with children and young adults. Of these externalities, academic achievement in schools can decrease after children experience a natural disaster (Doyle et al., 2012; Holmes, 2002). Differing from other super storms hitting the United States coast, Harvey affected not only inner city Houston, but severely flooded wealthier suburbs surrounding the city. These suburbs house some of the largest and highest achieving school districts in the state of Texas, making Hurricane Harvey an interesting platform to study the effects a natural disaster, such as a hurricane, can have on student achievement in a high school setting. Prior studies analyze this link from a cognitive and emotional development standpoint in elementary and college age students, but there are no studies to date observing these abnormalities in high school aged students. The current study seeks to bridge the gap in the literature and use Hurricane Harvey as a case study to expand the association between natural disasters and student achievement using the State of Texas Assessment of Academic Readiness (STAAR) campus scores.

**Literature Review**

An abundance of studies attempt to discern the effects a natural disaster can have on a child. Many of these studies argue academic achievement may be a side effect from stressors children experience, such as compromised mental health and post-traumatic stress disorder (PTSD) (Gibs et al., 2019). Apart from mental stressors, a 2002 study over Hurricane Floyd and a major snow storm in North Carolina pointed out even a random event that disrupts a child’s everyday routine can create harmful effects in the future (Holmes, 2002). Expression of these stressors, however, are also dependent on the age of the child, and are heterotypic over time (Weems, Scott, Taylor, and Cannon, 2013).

Apart from emotional distress, Spencer, Polachek, and Strobl (2016), researchers in the Carribean, claim excessive absences from school due to a natural disaster are a driving factor in decreasing academic achievement. However, they also found a discontinuity in these results across different subjects, specifically English and Math, which the authors revealed were not dependent on missing school days. Baggerly and Ferretti (2008) have supporting evidence to this postulate finding no impact in the standardized Florida state exam for Math and Reading. On the contrary, a 2013 study suggested the opposite was true in Mississippi after Hurricane Katrina in “non-poor and rural areas” (Lamb, Gross, and Lewis, 2013). Overall, it is likely several of these factors have the ability to diminish academic achievement. Effects from a natural disaster on youth may be manifested differently, depending on the students age, experience during the natural disaster, and academic days missed. However, there is a clear need to establish the main actors in decreasing student achievement after traumatic events to better establish necessary policies to assist students after an event at the state and federal level.

**Methodology and Work Flow**

Two datasets originating from the Texas Education Agency (TEA) STAAR Test Database were downloaded as a measure for student achievement. The two raw data sets report on the campus level aggregate variables for the 2016-2017 school year English I STAAR, and the 2017-2018 school year English II STAAR. Within these datasets, four performance levels specified by the state are reported as a percentage of students in that performance level in comparison to all students who took that specific STAAR exam at a given campus. These four progress measures are listed below in **Table 1**.

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| **STAAR Performance Levels** | |
| *Performance Level* | *Description* |
| Masters Grade Level Performance | Meets standards and will likely excel with little to no intervention at the next grade level. |
| Meets Grade Level Performance | Meets postsecondary readiness scores and will likely be successful at the next grade level. |
| Approaches Grade Level Performance | Meets minimum scores but likely will need intervention at the next grade level. |
| Did Not Meet Grade Level Performance | Did not pass and unlikely to succeed in the next grade level. |
| Table 1. Performance levels as indicated by the State of Texas (www.tea.gov) | |

Merging the English I (2017) and English II (2018) data sets by their campus unique ID number disallows any campuses or districts with identical names to be confused. Once merged, the dataset reports on 3,100 campuses, though this was drastically reduced to 1,953 campus after deleting any campus with missing data in either year or across performance level. Breaks in the data are often due to poor reporting of scores by the campus or from the opening of a new school in 2018 leaving nothing to report for the prior year. This dataset was further reduced to 845 campuses after eliminating any data from a campus residing in a single school, school district as the data is already aggregated and further statistical testing cannot be done one a lone campus school district.

We chose to use the English I and II STAAR results because we are interested in conducting a longitudinal study of high school aged students. The English I STAAR in 2017 serves as a pre-disaster benchmark, whereas the English II STAAR in 2018 captures approximately the same group of students after a disaster—Hurricane Harvey. Finally, we chose the subject English as the content tested is less factual, but a more mechanical assessment on reading and writing. Given this, this research is under the assumption that an increase in content rigor from English I to English II is not a major factor in student scores.

To determine the significance of score changes from the pre-disaster and post-disaster STAAR test, we conducted a paired means T-test at a 95% confidence interval for each performance level using the percentage of students within that category at a high school campus for the English I and English II tests, and further grouped all campuses by their school district (see **Table 2** for an example of Katy Independent School District).

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| **Campus Name** | **English I- Did Not Meet Grade Level Performance (2017)** | **English II- Did Not Meet Grade Level Performance (2018)** |
| Katy High School | 17 | 20 |
| Taylor High School | 15 | 16 |
| Mayde Creek High School | 28 | 26 |
| Cinco Ranch High School | 11 | 9 |
| Morton Ranch High School | 38 | 37 |
| Seven Lakes High School | 6 | 6 |
| Raines High School | 64 | 73 |
| Tompkins High School | 7 | 7 |
| Table 2. Performance level campus data for Katy ISD. | | |

After running a paired means T-test for all districts and all four performance levels in the data set, each district received a score as determined by the significance or non-significance of the test. Given a significant change in a positive direction, for example if the category for ‘not meeting grade level performance’ decreased in 2018 as compared to 2017, a negative one (-1) was assigned for that performance level for that district. Likewise, If there was a significant change in a negative direction, for instance if a significant decrease in the “master[ing] grade level performance” category for the year after Harvey occurred, a positive one (+1) was assigned for that district at that performance level. Because approaching and met grade level performance fall in the middle, there is no intuitive method to determining a positive or negative significant change, so every significant change was scored as a ‘1’ and a ‘0’ if it was not significant. An overview of this scoring system is shown in **Table 3**. After scoring each performance level, every district received a ‘final score’ by summation of each performance level score. Final scores for districts ranged from negative one to positive two. Given this, a higher number indicates decreased academic achievement, zero indicates no change in academic achievement, and a negative number indicates increased academic achievement.

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| **Scoring for STAAR Performance Levels** | | | | |
|  | **Did Not Meet Grade Level Performance** | **Approaching Grade Level Performance** | **Met Grade Level Performance** | **Masters grade level performance** |
| **Significant in (+) Direction** | -1 | 1 | 1 | -1 |
| **Significant in (-) Direction** | +1 | +1 |
| **Not Significant** | 0 | 0 | 0 | 0 |
| Table 3. Scoring criteria for results of paired T-tests in each performance level. | | | | |

District scores were then mapped onto the state of Texas by merging the current districts shapefile provided by the Texas Education Agency (dataset found at: <http://schoolsdata2-tea-texas.opendata.arcgis.com/datasets)> with district scores and using qGIS software for data visualization.

The second dataset downloaded was created by the National Hurricane Center Tropical Cyclone Report on Hurricane Harvey, which reports on the amounts of rainfall received in the state of Texas (Blake and Zelinksky, 2018). This dataset was used qualitatively to compare the areas of heavy rainfall, and subsequently heavy flooding, to districts that experienced significant decreases in student achievement. We generated an additional dataset reporting on the final score of each district and coordinates of the 185 district central offices. Rainfall amounts and coordinates for both districts and rainfall amount locations were applied to ArcGIS as a means to visualize areas that received substantial rainfall and decrease in student achievement.

**Figure 4** outlines the workflow of this study using multiple datasets, Python, and Excel as tools for data cleaning, analysis and visualization.

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| **Figure 4**. Workflow and schema for study. |

**Data Management**

To ensure data loss does not occur, all datasets and data manipulations are documented and stored online at GitHub (<https://github.com/lesliempatton13/AEM_Project>). All datasets obtained are publicly open and anonymized data, so privacy concerns are a non-issue. In addition to storing data on GitHub, a copy of the project folder is also kept on a password protected external hard drive backed up on a weekly basis. All of our data should be retained for up to ten years, long beyond the scope of this project, in case this study is furthered to look at the long term effects of student achievement before and after Hurricane Harvey. We will share all original data, manipulated data, and the new dataset that was created with coordinates for 185 Texas school district central offices on GitHub.

**Results**

While the aggregate data limited the scope of the study, scored results from each district yielded a surprising amount of negative student performance level movement from 2017 to 2018 across the state (**Figure 5**). Due to the quantity of statistical data, the specific results for each t-test at each performance level are listed in Appendix A.

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| Figure 5.  \*This figure only includes public schools. Private schools are included in Figure 6. |

Expectedly, Houston exhibited a pronounced decrease in student achievement, in a spatial pattern consistent with rainfall quantity during Hurricane Harvey and with prior research reporting on the effects of missed schools days and experiencing a traumatic event. While other large urban areas such as Austin, San Antonio, and Dallas also display reduced student achievement, in all areas there were cases of improved student achievement and no spatial pattern of gradually decreasing achievement. Looking closely at Houston, Houston ISD (HISD) displayed the largest decrease in achievement, and the immediate suburbs of Houston subsequently were reduced by a unit of academic achievement, and areas further out from the city experienced no significant change.

To qualitatively asses the effect flooding (rainfall) has on overall student achievement, the rainfall amounts for Texas and scored districts were overlaid (**Figure 6**).

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| Figure 6. |

**Discussion**

This study may suggest, as is supported by prior research, a link exists between the severity of a natural disaster within a district and student achievement. As previously described, the argument is compelling when looking at the scoring results from the Houston area. The downtown Houston area was severely flood during the hurricane, and also resulting in a large, negative significance in student achievement as measured by the English STAAR test. The surrounding suburbs, which not-coincidentally lie on the bayou system of the greater Houston area, also exhibited a decrease in scores. While there are cases of *increased* achievement in Houston, two of these cases are private schools and may have had access to additional services or support to help their student bodies.

The TEA did attempt to capture students, faculty, and address decreases in student achievement for post-Harvey at the campus and district level though much of it was deemed unsuccessful. In Hurricane Harvey provisions were directly addressed in TEA’s 2018 Accountability Manual. For data collection on students at each campus, the Texas Student Data System was altered to include “Crisis Codes” measuring students enrolled at local education agencies (LEA’s) affected by Harvey, students left homeless due to Harvey, and students unaffected. However, this reporting is largely voluntary by the students to tell teachers or administration of their situation after Hurricane Harvey.

Similar provisions were implemented by TEA at the campus or district level where “school districts, open-enrollment charter schools, and campuses directly affected by Hurricane Harvey will be eligible for special evaluation” given they meet a set of criteria (2018 Accountability Manual). In December 2018, the TEA adjusted district evaluations according to whether districts met the criteria this Harvey Provision and were labeled *Not Rated*. These districts area listed in **Appendix A** and compared to the score we assigned based on STAAR results as a proxy for student achievement. The shaded rows show areas of disparity between our study and TEA’s assessment of school impacted by Harvey. Clear Creek ISD and Katy ISD, both high achieving school districts receiving an overall rating of ‘A’ for the 2017-2018 school year and thus not qualifying for the evaluation exemption, revealed drops in academic achievement before and after Harvey in different areas. For Clear Creek ISD, there were significant changes in the *approaching* and *met grade level categories*. Despite the overall campus academic achievement remaining high, it may convey an overlooked population adversely affected by Harvey. Likewise, Katy ISD had a significant negative change in the *masters grade level* category. Despite the district achievement not faltering during Harvey, again there is an overlooked population that is not captured by TEA’s implementation of the Harvey Provision.

Moreover, the Harvey Provision does not address student displacement and the effect that can have on campuses and districts. Multiple studies on Hurricane Katrina reported lower levels of academic achievement after displacement (Pane et al., 2008). Dallas ISD showed significant changes in our study, and was not given the Harvey Provision, despite Mayor Mike Rawlings releasing a statement in 2017 that at least 100 known families decided to make Dallas home after losing everything in the hurricane (Dallas News, 2017). Though the state attempted to gauge and address Hurricane Harvey’s student, campus, and district impact, there may have been areas unnoticed by TEA and not given the necessary support.

**Limitations**

A number of limitations exist in this study. Due to proper anonymization of students, STAAR data is heavily aggregated data making it difficult to study significant changes on at a campus level. And even with this aggregated data, several schools did not report across all performance levels, and consequently reduced the data set greatly. Because of the greatly reduced dataset after the data cleaning and analysis process, results are fragmented and does not give a concrete picture of results for the entire state of Texas.

The scoring process created also has limitations by not capturing all of the significant changes, as a score for one performance level of -1 and a score for a separate performance level would be canceled out and not accounted for a district. Further, to be able to test a true correlation between flooding and academic achievement there must be a compiled dataset of flooding in specific areas, as well as data reporting on damage done. From our own searches, a dataset with these qualities does not exist. While surveys of students and their families might be able to report on this, a state wide survey to all families wouldn’t likely receive adequate feedback.

**Further research**

This study only serves as a preliminary step in the scope of the problem to determine any significant changes in performance levels in hard hit areas by Hurricane Harvey. For instance, it is possible the changes are due not from students achieving lower in school, but instead teachers heavily impacted did not educate his/her students adequately—due to frequent absences, emotional distress, etc. A parallel study if we could gain access to this information is looking at teacher attendance and performance (from yearly evaluations) across districts showing significant changes after Hurricane Harvey.

Surveying students would also give more accurate results about the driving factors of lower achievement after a natural disaster. An implementation strategy could be to have all students in the state take this survey when they return to school after a natural disaster, and then take the same survey 6 months to a year from that time. A strategy such as this could gauge immediate post-disaster emotional distress, document time absent from school, and take a closer look at longer term effects.

Moreover, the same study we conducted could be further explored across a longer time span; for instance looking at the English based tests from 2015-2019 for the same group of kids. This would provide better validation that Hurricane Harvey explicitly depressed academic achievement. This research has vast research topics and policy implications, and is an under-researched area in comparison to the growing amount of natural disasters in the wake of climate change.

**Conclusion**

**Appendix A**

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| Districts Eligible for Harvey Provision | Districts Receiving Hurricane Harvey Provision | District Score from STAAR results |
| Houston ISD | X | 2 |
| Alvin ISD | X | 1 |
| Lamar CISD | X | 1 |
| Fort Bend ISD | X | 1 |
| Clear Creek ISD |  | 1 |
| Aldine ISD | X | 1 |
| Cy-Fair ISD | X | 1 |
| Goose Creek CISD | X | 1 |
| Humble ISD | X | 1 |
| Katy ISD |  | 1 |
| Pasadena ISD | X | 1 |
| Beaumont ISD | X | 1 |
| New Caney ISD |  | 1 |
| Dallas ISD |  | 1 |
| Columbus ISD |  | 0 |
| Rice CISD | X | 0 |
| Victoria ISD | X | 0 |
| Angleton ISD | X | 0 |
| Pearland ISD |  | 0 |
| Galveston ISD | X | 0 |
| Alief ISD | X | 0 |
| Channelview ISD | X | 0 |
| Crosby ISD |  | 0 |
| Klein ISD |  | 0 |
| Spring ISD | X | 0 |
| Spring Branch ISD | X | 0 |
| Sheldon ISD | X | 0 |
| Cleveland ISD | X | 0 |
| Brazosport ISD | X | -1 |
| Texas City ISD | X | -1 |
| Excel Academy |  | -1 |
| Galena Park ISD | X | -1 |
| Aransas County ISD | X | Not Scored |
| Port Aransas ISD | X | Not Scored |
| Gregory Portland ISD | X | Not Scored |
| Ingleside ISD | X | Not Scored |
| Taft ISD | X | Not Scored |
| Calhoun Count ISD | X | Not Scored |
| Weimar ISD |  | Not Rated |
| Runge ISD | X | Not Rated |
| Palacios ISD | X | Not Rated |
| Woodsboro ISD | X | Not Rated |
| Refugio ISD | X | Not Rated |
| Bloomington ISD | X | Not Rated |
| Boling ISD | X | Not Rated |
| El Campo ISD | X | Not Rated |
| Wharton ISD | X | Not Rated |
| Danbury ISD | X | Not Rated |
| Sweeny ISD | X | Not Rated |
| Columbia-Brazoria ISD |  | Not Rated |
| Anahuac ISD |  | Not Rated |
| Barbers Hill ISD |  | Not Rated |
| Needville ISD |  | Not Rated |
| Dickinson ISD |  | Not Rated |
| Hitchock ISD |  | Not Rated |
| Santa Fe ISD |  | Not Rated |
| Friendswood ISD |  | Not Rated |
| Deer Park ISD |  | Not Rated |
| Dayton ISD |  | Not Rated |
| Devers ISD |  | Not Rated |
| Tarkington ISD |  | Not Rated |
| Royal ISD |  | Not Rated |
| East Chambers ISD |  | Not Rated |
| Port Arthur ISD |  | Not Rated |
| Liberty ISD |  | Not Rated |
| Fort Worth ISD |  | Not Rated |
| La Grange ISD |  | Not Rated |

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