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THE EFFECTS OF SCHOOL SAFETY ON ACADEMIC ACHIEVEMENT

EVIDENCE FROM RWANDA, TANZANIA & ZAMBIA

Kibriya • Zhou • Zhang • Fatema

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Dr. EDWIN PRICE
Director, The Center on Conflict and Development at Texas A&M University

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ACRONYMS

AFR/SD/ED	Bureau for Africa, Office of Sustainable Development, Education Division
ATE	Average Treatment Effect
ATT	Average Effect of Treatment on the Treated
ConDev	Center on Conflict and Development at Texas A&M University
DRE	Doubly Robust Estimator
EGMA	Early Grade Mathematics Assessment
EGRA	Early Grade Reading Assessment
HESN	Higher Education Solutions Network
IPWRA	inverse probability weighting regression-adjustment
LGBT	Lesbian, Gay, Bisexual, Transgender
NNM	Nearest Neighbor Matching
OLS	Ordinary Least Squares
PIRLS	Progress in International Reading Literacy Study
PSM	Propensity Score Matching
READ	Reinforcing Education Accountability in Development Act
SRGBV	School-Related Gender-Based Violence
SSME	Snapshot of School Management Effectiveness
TIMSS	Trends in Mathematics and Science Study
USAID	United States Agency for International Development

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EXECUTIVE SUMMARY

Background

In recent years, school safety has gained increasing attention from policymakers and academics. A safe learning environment is a place where structured learning is free from environmental, internal, and external threats to learners and educators' well-being; where both the infrastructure of the organization and the people within that environment are deemed safe (USAID, 2016).

The United States 2017 Reinforcing Education Accountability in Development (READ) Act mandates the need for US Foreign Assistance to "expand access to safe learning environments, including by breaking down specific barriers to education for women and girls" (H.R. 601-4(B). United States Agency for International Development (USAID) programs emphasize the provision of safe learning opportunities for all children and youth, including formal and informal programs that focus on literacy, numeracy, and basic skills (USAID, 2011).

Safe learning environments can be threatened by internal threats, such as bullying, corporal punishment, and gang recruitment, external threats, such as attacks on schools, and environmental threats, such as natural disasters. All these threats have the potential to significantly decrease students' academic performance. While a growing body of research points to a connection between school environments and student outcomes, much remains unknown about the effect of perceived school safety on learning. Most evidence originates from middle and high-income countries and focuses on educational outputs, such as attendance and retention, rather than educational achievement. More quantitative analysis of the relationship between school safety and student performance in developing countries is needed.

The research objective of this study is to identify the causal direction and magnitudes of student and teacher perception of safety on learning outcomes in Rwanda, Tanzania, and Zambia through a quasi-experimental analysis.

Methodology

Data: Data for this study is tabulated from USAID's Global Reading Network: EdData Initiative. The EdData assessment collects primary surveys from developing country households, schools, and communities on issues of access to education, quality, and management. In this study, we gather information from three EdData assessments: Early Grade Reading Assessment (EGRA), the Early Grade Mathematics Assessment (EGMA), and the Snapshot of School Management

Effectiveness (SSME). Overall, we synthesize information on 3,711 primary school students in Rwanda, Tanzania, and Zambia, collected between 2011 and 2013.

Limitations: The dataset consists of student and head teacher reported perceptions of school safety. In Rwanda students responded if they felt safe in school; while in Zambia and Tanzania head teachers reported school safety on behalf of students. The dataset does not offer consistent and comparable variables across all countries, which does not accommodate comparisons across countries.

Variables: The key dependent variables in this study are standardized learning outcomes in English reading fluency and math addition problems. The key independent variables are the perception of school safety from students in Rwanda, and from head teachers in Tanzania and Zambia. The datasets also consist of control variables encompassing students, teacher, school, and family specific attributes. Table I summarizes the variables:

Table I: Associated Variables

Dependent Variables	Oral reading fluency in English Number of correct addition problems solved
Key Independent Variables	School safety reported by students School safety reported by head teachers
Control Variables	Student attributes Teacher attributes School attributes Family attributes

Methods: We initiate our estimation by conducting an Ordinary Least Square (OLS) analysis using alternate models encompassing student, teacher, school, and family specific characteristics. The OLS estimation provides an understanding of linkages between school safety and learning outcomes. Subsequently, we use a quasi-experimental design to estimate the effect of school safety on learning outcomes. Specifically, we apply Propensity Score Matching (PSM) and Doubly Robust Estimator (DRE) methods. In these matching mechanisms, we use the perception of school safety as "treatment" and match students based on their propensity to be selected into the treatment given background covariates, such as personal, family, and school-specific attributes. We match each participant in the treated group with similar participants in the control group and estimate the Average Effect of Treatment on the Treated (ATT) as the difference in mean outcomes between the two groups.

Findings

Student reported school safety: We find negative effects of an unsafe school environment on learning outcomes for reading and math in all aforementioned estimation procedures of Rwandan students, who self-reported their perception of school safety. Results show that for 6th grade math evaluations, a student who feels unsafe solves seven fewer addition problems correctly per minute (36% deviation from average performance), compared to peers who feel safe at school. For 4th grade math evaluations, the difference is about two problems per minute (20% deviation from average performance) when compared to students of similar characteristics, who only differ through the perception of school safety. Also, 6th grade English

reading fluency is significantly affected, with students who feel unsafe reading about five fewer words per minute than comparable peers (12% deviation from average performance).

Head teacher reported school safety: Negative effects are found both in regression and quasi-experimental estimation for Tanzania, where head teachers reported perceptions of school safety among students. Specifically, quasi-experimental estimation shows that Tanzanian students who reportedly had an unsafe learning environment solved 0.7 fewer problems correctly per minute in math addition (7% deviation from average performance). Also, English reading fluency is significantly affected, with students who had an unsafe environment reading about eight fewer words per minute than comparable peers (33% deviation from average performance). It is worth pointing out that an average Tanzanian student loses one-third of his/her reading efficiency (the mean being 24 words per minute) solely due to school safety issues. Particularly in the 2nd grade regression analysis for Tanzania, we find that female students perform worse than their male peers in English reading assessments, when both girls and boys are facing unsafe school environments. Also, the presence of security guards in unsafe school environments is found to reduce the negative consequence on 2nd grade math outcomes. For Zambia, where a head teacher reported safety, we do not find statistically significant effects of school safety, except for 3rd grade English reading. The quasi-experimental estimations show an 11% reduction from the average performance in English evaluations.

Table II: Summary of Quasi-Experimental Analysis Results

Student reported school safety		
Rwanda	4th grade	6th grade
Math	-1.9** (-20%)	-7*** (-36%)
Reading		-5.2* (-12%)
Head teacher reported school safety		
Tanzania	2nd grade	
Math	-0.7** (-7%)	
Reading	-8*** (-33%)	
Zambia	2nd grade	3rd grade
Math	-0.3 (-8%)	-0.07 (-1%)
Reading	-0.6 (-8%)	-3.6*** (-11%)

Note: The DRE estimates are presented for the matching methods (deviation from the average score in parentheses). To interpret, for example, the estimate -1.9 from 4th grade math means that a student who feels unsafe at school solves about two fewer addition problems correctly per minute compared to a similar student who feels safe at school. In parenthesis, the percentage deviation from the mean score indicates that an average student will lose 20% of his/her efficiency due to the unsafe environment in school.
Statistical significance level: *** p<0.01, ** p<0.05, * p<0.1

Conclusions and Recommendations

- Donors and implementers need to consider school safety concerns when designing education programs, as safety issues can be a barrier to students' academic achievement.
- Policymakers need to highlight school safety issues as a barrier to learning in policy design and implementation strategy.
- There is a need for more standardized measurement tools and more research to measure how threats to school safety affect performance and how these threats vary across sex, age, region, and other attributes.
- Alternative research approaches are needed to evaluate the impact of school safety on student achievement. A longitudinal or experimental approach will enable researchers and policymakers to understand the effect of specific policies and programs implemented to enhance students' academic performance.

CHAPTER ONE

INTRODUCTION: BACKGROUND AND PURPOSE

1.1. Objective

The Center on Conflict and Development at Texas A&M University (ConDev), a member of the United States Agency for International Development (USAID) Higher Education Solutions Network, in partnership with the Bureau for Africa, Office of Sustainable Development, Education Division (AFR/SD/ED) seeks to examine the effect of school safety on standardized learning outcomes in Rwanda, Tanzania, and Zambia. The primary objective of this study is to analyze available data and to generate evidence on the impact of safe learning environments on student achievement, in order to inform future policy and programming.

1.2. Background

The Nexus of School Safety and Academic Performance

A safe learning environment is defined as a place where structured learning is free from environmental, internal and external threats to learners and personnel's safety and wellbeing, where the infrastructure of a learning environment is deemed safe (USAID, 2016). In recent years, school safety has increasingly gained the attention of policymakers and academics. The United States 2017 Reinforcing Education Accountability in Development (READ) Act mandates the need for US Foreign Assistance to "expand access to safe learning environments, including by breaking down specific barriers to education for women and girls" (H.R. 601-4(B). Safety is also a key component of USAID's Education Strategy: "Education in conflict and crisis environments is a function of providing security, services, infrastructure, and stability where the absence of such fundamental requirements will prevent effective learning. It is, first and foremost, a question of assuring access to safe spaces, to physical infrastructure, and to basic education services, primarily to children and youth" (USAID, 2016).

A growing body of research indicates that a safe and healthy learning environment is essential for students to maximize academic performance and learning. Specifically, recent literature

demonstrates that unsafe schools will affect students' class attendance, engagement, and motivation. In some cases, students in unsafe schools may suffer from mental health problems, such as reduced self-esteem, inability to concentrate, and depression (Barrett et al., 2012; Dunne et al., 2013; Hazel, 2010; Hemphill et al., 2011; Kosciw et al., 2013; Ouellet-Morin et al., 2011; Ozer and Weinstein, 2004; Ripski and Gregory, 2009).

Threats to Safe Learning Environments

USAID has developed a conceptual mapping of the various threats to safety based on literature related to safe learning environments. Safety issues are broadly categorized as internal threats, external threats, and environmental threats (USAID, 2016). All these threats in a developing society have the potential to significantly decrease students' academic performance.

Internal threats can include but are not limited to, School-Related Gender-Based Violence (SRGBV), corporal punishment, bullying, verbal harassment, and gang activity/recruitment within a school (USAID, 2016). There is a small but growing body of research that highlights the association between internal threats to school safety and students' academic performance. The 2006 UN World Report on Violence Against Children notes that verbal abuse, bullying and sexual violence in schools are commonly reported as reasons for lack of motivation, absenteeism and dropout (Pinheiro, 2006). A 2015 research partnership between ConDev and USAID examined school violence, measured through bullying, and academic performance in Botswana, Ghana, and South Africa using the Trends in Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) datasets. The research concludes that school bullying and violence in developing countries is pervasive and have severe ramifications for student academic performance. The Longitudinal Young Lives study also provides evidence that corporal punishment is linked with poorer test scores across four countries (Portela & Pells, 2015). A recent meta-evaluation demonstrates that all forms of violence in childhood significantly affect a variety of educational outcomes, including school dropout/graduation, academic achievement, and grade retention (Fry et al., 2018). Lastly, forms of violence in childhood can affect school children differently because of their sex or gender identity.

Young people experience psychological, sexual, and physical violence differently, depending on their sex or gender identity, country and context (UNESCO, 2016). The psychosocial issues related to violence may be more concerning for female students (Majgaard and Mingat, 2012; Kibriya et al., 2016) as they also exacerbate school dropout levels along with performance (World Bank, 2015). In a survey of gender-based violence in Malawi, 61% of girls who experienced gender-based violence said it affected their school performance (Bisika, Ntata & Konyani, 2009). Additionally, the prevalence of violence experienced by lesbian, gay, bisexual and transgender (LGBT) students has been found to be three to five times higher than among their non-LGBT peers (UNESCO, 2017).

External threats to safety can include, but are not limited to, attacks on the way to/from school, ideological attacks on learning environments, armed/violent attacks on learning environments, and occupation of learning environment infrastructure by armed groups (USAID, 2016). Several studies have examined the connection between external threats to school safety and academic performance. O'Malley (2010) highlights the negative impact that attacks on schools have on

learning outcomes and school enrollment. These negative effects can be seen vividly in falling enrollment rates, high levels of student distraction in the classroom, and reduced attainment of learners. Concretely, in Gaza 30% of students in 4th to 9th grade failed their end of semester tests in Arabic and/or math in 2010 due to repeated attacks on schools. Likewise, Sheppard (2009) highlights how repeated attacks on schools and the occupation of classrooms in India's Jharkhand State has led to a significant drop in student enrollment. In 2008, many middle school teachers saw half of their students stop coming to school because occupied classrooms were not conducive environments for learning.

Environmental threats can include natural disasters and public health epidemics that damage school infrastructure and disrupt the supply of education services (USAID, 2016). Valuable instruction time is often lost when schools are damaged, destroyed, or used as evacuation sites during times of crisis. After the earthquakes in Nepal in 2015, schools and colleges in severely-affected districts were closed for more than a month, forcing more than two million children and youth to stay out of educational institutions (Ireland, 2016). Upon returning to school, children reported loss of motivation and high levels of anxiety in relation to exams. Almost a year after the attack, many students were still in makeshift or damaged schools, where their learning environment was unsafe and uncomfortable. Evidence shows that student achievement is impacted by building quality and modernization of infrastructure (Walberg 1982; Earthman and Lemasters 1997; Duran-Narucki 2008; Maphoso and Mahlo 2014). These studies have found evidence that primary school students in non-modernized buildings scored lower in basic skills assessments than students in modernized or new buildings.

Domestic research shows that perceptions of unsafe environments based on student self-reported measures of violence are consistently correlated with poorer academic performance (Milam et al. 2010; Jenkins and Bell 1994; Bowen and Bowen 1999). Yet similar studies have not been conducted in developing contexts. This study generates evidence to assist policymakers in designing school safety-sensitive programming and initiate a new pathway of research on the nexus between school safety and students' academic performance.

1.3. Data and Research Question

We extract information from USAID's Global Reading Network: EdData Initiative. The assessments contain English reading outcomes and evaluation of math addition for 2nd, 3rd, 4th and 6th grade students. The EdData initiative also collected information on student, family, teacher, and school-specific attributes through survey data. The main limitation of the datasets is that student-reported safety is available for Rwanda, but not Tanzania and Zambia.

Academic performance in school depends on a myriad of factors. Student performance depends not only on the children's efforts and characteristics but also school and family specific attributes. Hence, to investigate the causal effects of school safety and differences in male and female student learning outcomes, it is also important to include school and family-related variables. Standardizing student performance is challenging due to varied methods of academic evaluations in different societies. To overcome such issues, we use a) data from standardized evaluations; and b) information on school, family, and student-specific variables. Data for this study is collected from three of USAID's EdData projects: Early Grade Reading Assessment

(EGRA), the Early Grade Mathematics Assessment (EGMA), and the Snapshot of School Management Effectiveness (SSME). To offer consistency and confidence, we use data from three sub-Saharan countries: Rwanda, Tanzania, and Zambia. Our model specifications include controls for factors such as student demographics, geographic locations, teachers' attributes, family background, and school facilities. Since a simple regression analysis may not specify causation; we also opt for a quasi-experimental analysis to establish possible causality.

Research Question: In view of the current literature and available data, we further identify gaps in the realm of research on school safety that drives academic performance. The primary research question we seek to answer is: **What is the causal magnitude and direction of student and teacher perception of school safety on learning outcomes in Rwanda, Tanzania, and Zambia?**

Hypothesis: Based on our literature review of threats to school safety, we hypothesized school environments that are perceived as unsafe would reduce academic performance significantly. We summarize the key hypothesis as follows: **Students will underperform in school environments that are perceived as unsafe.**

CHAPTER TWO

DATA AND SUMMARY STATISTICS

2.1. Data Source

In this chapter we provide a comprehensive summary of the data source, collection procedure, list and a short description of variables, and summary statistics of the collected information. Data for this study are tabulated from USAID's Global Reading Network: EdData initiative. The EdData initiative collects primary surveys from developing country households, schools, and communities on issues pertaining to education access, quality, and management. Here we gather information from three EdData projects: Early Grade Reading Assessment (EGRA), the Early Grade Mathematics Assessment (EGMA), and the Snapshot of School Management Effectiveness (SSME). The EGRA dataset is collected through 15-minute oral assessments of reading skills of school children. The instrument is standard yet modified according to country and language. Thus, it establishes a benchmark of the countrywide reading performance of children and shows the state of child literacy development. The EGMA assessment is like the EGRA assessment and focuses on the fundamental math skills of children. This assessment tool tests skills of number identification, quantity discrimination (larger and smaller), missing-number identification, word problem solving, addition, shape recognition, and pattern extension. The SSME instrument collects information on school management practices such as pedagogical approaches; time on task; interactions among students, teachers, administrators, district officials, and parents; record keeping; discipline; availability and condition of school infrastructure; availability of pedagogical materials; and safety. The last element is of direct relevance to this study. This information is collected via direct classroom and school observation, student assessment and interviews with teachers, principals, and parents.[1] We synthesize all three data sources to create a comprehensive dataset to examine the identified research questions.

2.2. Geographic Scope and Participants

We considered multiple African countries for this analysis. Rwanda, Zambia, and Tanzania were selected due to the geographical scope and availability of key variables. However, Rwandan students reported their own school safety while for Zambia and Tanzania head teachers

[1] Description of the Data Source: https://globalreadingnetwork.net/eddata/eddata-overview

reported the perception of school safety on the students' behalf. Hence, the comparison between countries is not entirely feasible.

Table 2.1 shows the number of participants by country, grades, and assessment. The sample of Rwanda consists of 786 students, of which 382 are in the 4th grade and 404 in the 6th grade. The sample of Tanzania consists of only 2nd grade students, 2,125 in total. The sample of Zambia consists of 2nd and 3rd grade students, with 400 in each grade. Data collected for examination yields a variety of outcome and control indicators, which were used to examine the impact of school safety on students' academic performance.

Table 2.1: Number of Participants by Country and Grade Level

	2nd Grade	3rd Grade	4th Grade	6th Grade	Total
Rwanda			382	404	786
Tanzania	2,125				2125
Zambia	400	400			800

The key variable of interest is school safety. In Rwanda it is generated from the following question to student respondents: "do you feel safe at school?" In Tanzania and Zambia, the head teachers answered the question if their students are safe in school or if safety is a problem in their school.

2.3. Data Description – Rwanda

These data provide a broad collection of outcome and control indicators in examining the impact of school safety on students' academic performance in the case of Rwanda. Table A.2.1 in the Annex Section provides the general variable code (to be used in the regression analysis) for Rwanda, a brief description of variables and the values that each variable assumes. In Rwanda, English reading and math addition assessments were conducted. English reading assessments were conducted for 6th grade students, but not for 4th graders. For the math assessment, scores ranged between 0 and 29. School safety is a binary variable, with a value of 0 for safe and 1 for unsafe school environment. Also, the sex variable is binary, with a value of 0 for male and 1 for female. Covariates at the student level include demographic characteristics, homework, meals, and books owned. The dataset also provides information on teachers' sex, educational attainment, and teaching experiences. School-specific facilities such as internet and computers for student use were also collected for Rwanda. Family-specific attributes and facilities including television, mobile phone, toilet, and access to electricity were also collected. Such facilities at home may provide insights on students' socio-economic status and background which is likely to affect academic performance. Most of the family-specific attributes, student characteristics, and teachers' sex follow the same binary responses as student sex. However, variables such as teachers' education levels and homework follow discrete patterns albeit consisting of more than two types of responses. For example, teachers' education levels have at most five stages, while the number of homework assignments per week varied between 0 and 7. While such discrete responses may not be able to capture some intricate nuances for certain qualitative characteristics, they enable the statistical analysis to quantify drivers of academic performance.

Table A.2.2 (Annex) contains a summary of descriptive statistics for Rwanda. It shows that about one in five students (21%) in the 4th grade do not feel safe at school. We deem this to be a large enough sample portion to perform a statistical analysis. Approximately 54% of the students are female. The sample reveals that on average, 4th graders are 12.4 years old in Rwandan schools. Math homework is assigned a little more than twice per week, and most of the time (92%) it is checked by the teacher. About 16% of the schools have computers for student use, while only 3% have internet access. Only 10% of students have access to electricity, indicating that most students come from non-affluent families. The share of families that have flush toilets and television are even smaller (6% and 9% respectively). Notably, mobile phones are more widely used as about 54% of all students' families have access to these devices.

Table A.2.3 (Annex) shows the summary sample of 6th grade students in Rwanda. About 18% of the students feel unsafe in school. Approximately 53% are female students. The average age of an 6th grader is 14.6 years. Homework assignments are more than twice per week for math and reading, and close to 10% of them were not graded by the teacher.

Females only account for 19% of English teachers while one-third of math teachers are female. Family and school attributes are similar to 4th grade students. About 17% of schools have a computer, while only 3% have internet access. Only 8% of the students' families have a toilet at home, and 9% possess a television. The proportion of families that have electricity is 12%. About 57% of all families use a mobile phone.

2.4. Data Description – Tanzania

Table A.2.4 (Annex) provides the variable description and values for Tanzania. The dataset of Tanzania consists of test outcomes for English reading and math addition problems, school safety, student characteristics, and school and family attributes for 2nd grade students. This dataset includes some administrative variables associated with school safety, such as, the presence of a school security guard. Also, school location as urban or rural is recorded. In addition, the questionnaire documents the literacy status of the students' parents. The values of the variables are similar to data for Rwanda and are mostly comprised of discrete variables.

As shown in Table A.2.5 (Annex), reading assessment varies between 0 and 156 words per minute; while the math evaluation varies between 0 and 29 for addition. Among the sample of head teachers, 19% report that their students do not feel safe. About 51% of the students are female. The average age of the sample students is 8.6 years. Nearly half (48%) of the students had homework assignments the week prior to the survey. About one third (34%) were absent during that week. Forty-eight percent of the students surveyed attend urban schools. Further, 79% of the students are in schools with a security guard. Notably, 96% of students' mothers and 97% of their fathers are able to read. For household facilities, 18% of the students' families have computers, 48% of them have television, 53% have access to electricity, and 88% of them use mobile phones.

2.5. Data Description – Zambia

The dataset for Zambia consists of test outcomes for English reading and math addition problems, school safety, student and teacher characteristics, and family attributes for 2nd and 3rd grade students. The dataset contains information on 400 2nd grade and 400 3rd grade students. Table A.2.6 (Annex) provides the corresponding variable descriptions.

According to table A.2.7 (Annex), 12% of head teachers reporting on behalf of 2nd grade students reported an unsafe environment in school. About 48% of the students are female. Notably, over two-thirds (69%) of the teachers are female. Among parents, 77% of mothers and 88% of fathers were able to read. About 6% of the students' family has access to computers, 33% of them have televisions, and 21% have access to electricity. The average distance from home to school is 1.6 kilometers.

According to table A.2.8 (Annex), 12% of head teachers reporting on behalf of 3rd grade students reported an unsafe environment in school. About 49% of the students and approximately 62% of the teachers are female. About 79% of students' mothers and 90% of fathers can read. Meanwhile 6% of the students' family has access to computers, 36% of them have televisions, and 20% have access to electricity. The average distance from home to school is 1.5 kilometers. The reading assessment varies between 0 and 71 words per minute; while the mathematics addition evaluation varies between 0 and 26. The data structure is mostly discrete and follows the same pattern as Tanzania and Rwanda.

2.6. Limitations of Data

The EdData initiative is a unique resource that has enabled researchers and policymakers to analyze and understand standardized learning outcomes of students in African countries conditioned on school, family, and student-specific attributes. The survey methodology is also tailored to be consistent for all the countries. The survey is crafted carefully to encompass all the aforementioned categories to capture the drivers of students' socio-academic development. However, due to the contextualization of each survey, several data limitations emerge: a) school safety measures are weak and inconsistent; b) learning outcomes data vary by grade for each country; c) collected information on covariates is not consistent across countries; and d) there is a need for consistent time-variant data collection.

School safety measures are self-reported and are collected either through students or head teachers. Self-reported perceptions may cause students and teachers to under- or overstate an issue, such as school safety. In Tanzania and Zambia, head teachers were asked questions such as: "Are your students safe at school?" or "Is safety a problem in your school?". We identify several weaknesses with this approach. First, all countries should have a consistent measure of school safety. Second, a teacher is more likely to underreport an unsafe learning environment in school as it may reflect incompetency of the administration. Third, such reporting mechanism through head teachers aggregates the data of a safety variable into a higher level as opposed to a student level. Feelings of safety may vary among students in the same learning environment, due to family, teacher, and student-specific attributes.

The learning outcomes data vary by country and students' grade level. Hence, it is hard to generate a comparative analysis or aggregate the data for comprehensive statistical evaluation. Information for Rwanda consists of learning outcome evaluations for 4th grade math as well as a 6th grade English reading and math. While Zambia had the evaluation for 2nd and 3rd grade students for both math and English reading, data for Tanzania only consisted of 2nd grade students' math and English reading test outcomes.

CHAPTER THREE

RESEARCH METHODOLOGY

To investigate the research questions, we employ several parametric and non-parametric techniques. We initiate our analysis with an Ordinary Least Squares (OLS) estimation, that provides an understanding of the determinants of student achievements on standardized tests, including our key identified dependent variable of school safety. Due to endogeneity concerns we only use OLS specifications to establish correlation and directional linkage between school safety and learning outcomes. To understand causal direction and magnitude, we opted for a quasi-experimental design. As such, we employ a matching method that eliminates endogeneity bias to obtain magnitude and direction between the two variables. We perform sensitivity analysis through a Doubly Robust Estimator (DRE) to examine and correct for any misspecifications in the model. We also show the matching quality to identify if there are any unobserved differences between the treated and control population. As mentioned previously, since the structure of surveys and the sample population does not allow us to perform an aggregate analysis, we choose to conduct separate estimations for each country. However, we try to provide a comparative understanding of the results following the analysis.

3.1. OLS Models

Our statistical analysis commences with an Ordinary Least Square (OLS) model. The OLS estimates the unknown parameters in a linear regression model, with the goal of minimizing the sum of the squares of the differences between the observed outcome variable (student score in our analysis) in the given dataset and those predicted by a linear function of a set of explanatory variables (school, student and family specific characteristics in our analysis). We use a multiple regression model to accommodate all the explanatory variables in our estimation. The trivial mathematical equation for the regression analysis is:

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots + \ldots \beta_n X_{ni} + u_i \qquad (1)$$

In equation (1), the dependent variable Y_i is the assessment score for a student (denoted by i). The regression coefficients (denoted by β) represent the *independent* contributions of each independent variable to the prediction of the dependent variable. For example, variable X_1 (school safety) is correlated with the Y (student score) variable, after controlling for all other independent variables. However, if such result is caused by other (control) variables such as students age (X_2), then the statistical significance and magnitude would reduce/disappear if X_2 is included in the model. This estimation will provide an understanding of prime

determinants of student performances especially controlled for school-specific and family-specific characteristics.

However, OLS estimation may suffer from several econometric shortcomings that arise when using cross-sectional data. Of particular concern is endogeneity, which is the correlation between academic performance and the error term of the estimate. Endogeneity may occur because of omitted variable bias, selection bias, simultaneity, and autoregressive characteristics of the data. For example, due to simultaneity, a student exposed to an unsafe learning environment may also perform poorly in academics because feeling unsafe can reduce academic performance or reduced academic performance can enhance the lack of a safe learning environment. Alternatively, endogeneity arises because of omitted variable bias. Omitted variable bias occurs when variables that should be included in the model are not, a situation that is typically the result of data limitations. Other models need to be used to overcome the endogeneity problem and to check the robustness of the estimations.

3.2. Quasi-Experimental Method

Subsequently, to verify the results of the OLS estimation for school safety, we apply a quasi-experimental approach. The complex relationship between students' academic performance and school safety immediately points to the aforementioned endogeneity bias in estimation. Additionally, the coefficients of the OLS estimations may over or understate the effects of an unsafe environment, since such feelings can be highly correlated with school, family, and student-specific attributes. Therefore, to verify causal impacts and determine magnitudes, we use school safety as a 'treatment' and test whether this treatment can affect students' academic performance. Henceforth in this analysis, we will use "treated" as students who felt unsafe in school, and "untreated" as a control group in a quasi-experimental analytical perspective.

Let T denote our binary treatment variable (T=1 if a student feels unsafe and T=0 otherwise). Let Y_1 denote the outcome (students' score); let X be a vector of observable covariates (background characteristics or 'pretreatment' variables). If T could be randomly assigned to school children, estimating the Average Treatment Effect (ATE) provides the causal magnitude and direction of feeling safe at school on academic performance. However, creating such a controlled environment (i.e., creating an unsafe school environment) is neither possible nor ethical. Since we cannot randomize an intervention to avoid selection bias, it is more appropriate to revert to quasi-experimental techniques (see Cook, Shadish, and Wong, 2008) to improve (if not isolate) the effect of school safety on students' academic performance. Instrumental variables and regression discontinuity may both be useful but will be very difficult to apply in this scenario. Valid instruments are difficult to identify (Imbens and Woolridge, 2009) especially for a subjective variable such as perception of school safety. The option of regression discontinuity requires consistent decision-making around some arbitrary cutoff. In this particular survey, school safety was not measured to accommodate such cutoff points. Therefore, we employ a quasi-experimental approach, propensity score matching, in which all observable confounding factors are statistically balanced to neutralize any potential selection bias, thus allowing us to isolate the causal effect and magnitude of school safety on academic performance.

An unbiased Average Effect of Treatment on the Treated (ATT) could be calculated as the difference in mean outcome for the treated given that they received treatment and the mean outcome for the treated had they not received treatment. However, this outcome of the treated had they not received treatment is the counterfactual that cannot be observed in reality. Matching aims to solve this problem by constructing the correct sample counterpart for the missing information on the outcomes of the treated group had they not been treated. In other words, it addresses the 'counterfactual' by pairing each participant in the treated group with similar participants in the control group and then estimating the ATT as the difference in mean outcomes between the two groups. This can be expressed as follows:

$$ATT = E(X, T = 1)$$
$$ATT = E[E(X, T = 1) - E(X, T = 1)]$$
$$ATT = [(E(T = 1) - E(T = 0)) - (E(T = 1) - E(T = 0))] \quad (2)$$

Equation (2) shows how the ATT can provide correct estimates by adjusting for selection bias.

3.3. Propensity Score Matching (PSM)

One way to implement matching could be to match treated and control students on every covariate. However, as more variables are added to the analysis, it becomes harder to find exact matches for observations. The Propensity Score Matching (PSM) technique, proposed by Rosenbaum and Rubin (1983), solves this 'curse of dimensions' by combining all confounders into a single score and matching observations based on such (propensity) score. In this study, the propensity score is the conditional probability that a student feels safe at school, given its vector of observed covariates. PSM technique simulates the conditions of a randomized experiment by relying on two assumptions. The first is the assumption of conditional independence (or unconfoundedness), which requires potential outcomes to be independent of treatment, conditional on background variables. Under the conditional independence assumption, the propensity score is defined as the conditional probability of receiving treatment, given pre-treatment characteristics:

$$p(X) = pr\ (T = 1|X) \quad (3)$$

For our purposes, the conditional assumption implies that by adjusting for all observable covariates (or 'pretreatment' differences) between safe and unsafe students, we can regard the treatment assignment, school safety, as random and uncorrelated with exam score outcomes. The second assumption of PSM is the common support assumption that states for each value of X, there is a positive probability of being both treated and untreated, i.e.

$$0 < pr\ (T = 1|X) < 1 \quad (4)$$

In other words, it assumes that the support of the conditional distribution of the covariates for students who feel safe at school sufficiently overlaps with the conditional distribution of the covariates for students who feel unsafe at school. If these two assumptions hold, then the PSM

estimator for ATT is the mean difference in conflict status between safe students matched with unsafe students, based on their propensity scores. This can be expressed as:

$$ATT = E(T = 1, p(X)) - E(T = 1, p(X)) \quad (5)$$

Once the propensity scores are generated, households must be matched based on their scores. Since PSM methods are sensitive to the exact specification and matching method (Imbens 2004; Caliendo and Kopeinig, 2008), we employ three commonly used algorithms to ensure the robustness of PSM estimates. These include Nearest Neighbor Matching (NNM), Kernel-based matching and radius matching. NNM matches safe students to unsafe students that are closest to its propensity score. For NNM, we use three nearest neighbors with replacement. This is because replacement increases the quality of matching, especially when there are fewer close matches. Kernel matching uses a weighted average of all unsafe students to match it with safe students, placing higher weights on households with similar propensity scores. Following Heckman, Ichimura and Todd (1997), we use the Epanechnikov Kernel function with a bandwidth of 0.05. Radius matching algorithm matches each safe student with all unsafe students whose propensity scores fall within the predefined neighborhood of the propensity score of safe students (known as the caliper). We choose a caliper of 0.001, which is commonly used in the literature.

The choice of variables included in the estimation is guided both by data availability and previous research, as well as the literature on matching (see Dehejia and Wahba, 2002; Heckman, Ichimura and Todd, 1997, 1998; Abadie and Imbens, 2006; and Caliendo and Kopeinig, 2008). In summary, variable selection for matching methods is an iterative process involving a tradeoff between efficiency and bias. Therefore, it is recommended to start with a rich set of explanatory variables that simultaneously affect treatment and outcome through a process of iteration, selecting the set of covariates that gives the best balance in terms of distribution of propensity scores, as well as distribution in covariates across the treated and control groups.

3.4. Doubly Robust Estimator (DRE)

To ensure the robustness of our estimates, we also use a Doubly Robust Estimator (DRE). The DRE requires us to specify regression models for the outcome and the exposure as a function of covariates. In the case of this particular DRE we model the relations between confounders and the outcome within each exposure group. As such, DRE requires specifying two separate models – one for treatment (students in an unsafe school environment) and one for the outcome (scores). The advantage of using DRE is that it allows for misspecification in either the treatment model or outcome model. That is, as long as either one of the specifications is correct, DRE will provide unbiased estimates. Following Wooldridge (2010), we use the inverse probability weighting regression-adjustment (IPWRA) combination as the DRE. IPWRA estimators use weighted regression coefficients to compute averages of treatment-level predicted outcomes, where the weights are the estimated inverse probabilities of treatment. The contrasts of these averages estimate the treatment effects. Mathematically, the DRE is:

$$\widehat{\Delta}_{\mathrm{DR}} = \mathrm{n}^{-1} \sum_{\mathrm{i}=1}^{\mathrm{n}} \left[\frac{\mathrm{T_i Y_i}}{\mathrm{e}(\mathrm{X_i}\hat{\beta})} - \frac{\{\mathrm{T_i} - \mathrm{e}(\mathrm{X_i}\hat{\beta})\}}{\mathrm{e}(\mathrm{X_i}\hat{\beta})} \mathrm{m}_1(\mathrm{X_i}\hat{\alpha}_1) \right] - \mathrm{n}^{-1} \sum_{\mathrm{i}=1}^{\mathrm{n}} \left[\frac{(1-\mathrm{T_i})\mathrm{Y_i}}{1-\mathrm{e}(\mathrm{X_i}\hat{\beta})} - \frac{\{\mathrm{T_i} - \mathrm{e}(\mathrm{X_i}\hat{\beta})\}}{1-\mathrm{e}(\mathrm{X_i}\hat{\beta})} \mathrm{m}_0(\mathrm{X_i}\hat{\alpha}_0) \right] \quad (6)$$

where $e(X_i\hat{\beta})$ is the postulated model for the true propensity score, $m_1(X_i\hat{\alpha}_1)\ and\ m_0(X_i\hat{\alpha}_0)$ are postulated models for the true regressions $E[Y|T=1,X]$ and $E[Y|T=0,X]$. The covariates of the two models are the same as discussed above.

Finally, we address the concern of matching quality, e.g., whether the distributions of the covariates in the control and treatment groups are balanced. If the matching is successfully balanced, then the differences between covariate means of the treatment and control groups should be significantly lower after matching. Following Diamond and Sekhon (2013), we measure each covariate balance by the mean standardized difference. Smaller mean standardized differences indicate that the covariates are well balanced.

CHAPTER FOUR

EMPIRICAL RESULTS

In this chapter, we detail the main empirical results from Ordinary Least Squares (OLS), Propensity Score Matching (PSM), and Doubly Robust Estimator (DRE) methods for Rwanda, Tanzania, and Zambia. The outcome variables of interest are reading, defined as English reading fluency and math, defined as the number of addition problems solved correctly per minute. In all OLS specifications, standard errors are adjusted for school-level clustering and heteroskedasticity, that is, for the grouping of observations at the school level and the different variances in the variables included in the model. In all matching specifications, we use a bootstrapping procedure to construct the standard errors for the ATT.

4.1. Rwanda

The dataset for Rwanda consists of math and reading for 4th and 6thgrade students (4th graders have math outcomes but not English). Table 4.1 shows the results of OLS estimation.

Table 4.1: Impact of Student Perception of School Safety on 4th Grade Math in Rwanda

	(1)	(2)	(3)	(4)	(5)
Unsafe School	-1.921***	-1.778***	-1.798**	-1.775**	-1.846**
	(0.594)	(0.675)	(0.751)	(0.767)	(0.794)
Homework last week (number of times)		-0.390*	-0.666***	-0.657**	-0.623**
		(0.212)	(0.245)	(0.254)	(0.258)
Teacher checked home work last week		1.787*	2.800*	2.735	2.702
		(0.954)	(1.601)	(1.739)	(1.799)
Controls	No	Student	Student Teacher	Student Teacher School	Student Teacher School Family
Observations	382	341	253	248	244
R-squared	0.025	0.047	0.094	0.093	0.099

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression specification varies from (1) to (5) by adding covariates of the student, teacher, school, and family attributes and characteristics. For conciseness, we only show the coefficients of the variables of interest, major control variables and mention the important attribute in clusters. For example, in Table 4.1 we use every available control variable from survey respondents such as student (e.g., age, sex); teacher (e.g., sex, education level); school characteristics (e.g., location, facility, etc.); and facilities available through family (e.g., mobile phone, electricity). Column (1) shows results from the barebones model while column (5) shows the full model encompassing all the controls and school safety.

Table 4.2: Impact of Student Perception of School Safety on 6th Grade Math in Rwanda

	(1)	(2)	(3)	(4)	(5)
Unsafe School	-2.485***	-2.707***	-3.015***	-3.963***	-4.622***
	(0.846)	(0.833)	(1.153)	(1.211)	(1.247)
Student's sex (female)		-3.022***	-2.891***	-2.821***	-2.641***
		(0.739)	(0.983)	(0.983)	(0.966)
Homework last week (number of times)			1.240***	1.201***	1.255***
			(0.436)	(0.433)	(0.443)
Teacher's highest level of education			2.146***	1.746***	1.554***
			(0.482)	(0.540)	(0.542)
Computer in School for student use				2.610*	0.885
				(1.464)	(1.577)
Student's family have a television					7.289**
					(3.064)
Controls	No	Student	Student Teacher	Student Teacher School	Student Teacher School Family
Observations	404	404	222	222	222
R-squared	0.017	0.057	0.184	0.193	0.226

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We consistently find significant results for the negative impact of unsafe school environments on 4th grade math performance. The economic magnitude implies that controlling for all covariates, respondents who felt unsafe in school solve 1.8 fewer addition problems correctly than students who reported that they felt safe in school. Considering the mean scores are only 10 points, this difference in performance is quite large. The analogous model for math outcomes of 6th grade students in Rwanda (Table 4.2) shows similar but larger negative impacts from unsafe school environments. Students who reported an unsafe school environment

perform on average 4.6 points fewer additions correctly than their peers who felt safer at school.

Table 4.3: Impact of Student Perception of School Safety on 6th Grade English in Rwanda

	(1)	(2)	(3)	(4)	(5)
Unsafe School	-2.106	-5.659*	-13.87***	-15.16***	-12.03***
	(2.407)	(3.166)	(4.667)	(4.663)	(4.349)
Student's sex (female)		-4.633**	-6.665***	-7.086***	-5.538**
		(2.003)	(2.451)	(2.508)	(2.286)
Student's age		-3.853***	-3.553***	-4.054***	-2.936***
		(0.522)	(0.650)	(0.704)	(0.641)
Teacher's sex (female)			2.796	6.103*	6.446**
			(3.119)	(3.370)	(3.211)
Teacher's years of teaching experience			0.719***	0.758***	0.411**
			(0.192)	(0.202)	(0.192)
Computer in School for student use				11.75***	6.890**
				(2.927)	(2.945)
Student's family have a television					31.99***
					(6.202)
Controls	No	Student	Student Teacher	Student Teacher School	Student Teacher School Family
Observations	404	400	235	225	223
R-squared	0.002	0.150	0.267	0.319	0.462

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.3 displays the results from reading scores of 6th grade students. Regressions with different covariates (columns 2 through 5) indicate that school safety has a significantly negative impact on reading test outcome. Once again, we find that female students perform worse than male students in all regressions. Female teachers seem to be associated with better reading outcomes of students.

To summarize the regression analysis for Rwanda, we find that an unsafe school environment significantly reduces performance in these standardized evaluations. However, the magnitude of this impact is greater for 6th graders.

Table 4.4 shows the results of school safety using PSM. We use three matching methods in PSM analysis, namely, nearest-neighbor matching, radius matching, and kernel matching.

Table 4.4: Impact of Student Perception of School Safety on Academic Performance in Rwanda, PSM

	Outcomes		
	4th grade math	6th grade English	6th grade math
Matching methods	(1)	(2)	(3)
Nearest neighbor	-2.118*	-5.797*	-4.235*
	(1.206)	(5.709)	(2.912)
Obs	242	199	207
Radius/caliper	-2.511	-8.361*	-3.225*
	(1.779)	(9.477)	(3.959)
Obs	242	199	207
Kernel (Epanechnikov)	-1.785*	-3.172	-3.902**
	(1.050)	(5.181)	(1.985)
Obs	242	199	207

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results are largely consistent with the findings from OLS estimation, except for the reading outcome of 6th grade students. While in OLS regressions reading performance reduced by approximately 12 words for the unsafe school environment, using PSM, the effects reduce to around 6 words on average. We lean towards PSM to derive the magnitude of such effects. The PSM results help cross-validate our OLS finding that school safety indeed has a negative and statistically significant impact on students' learning outcomes.

Table 4.5 shows the DRE of the impact of school safety on performance. The estimates are similar to the average propensity score estimates in Table 5.4. This result further substantiates our hypothesis that students who feel unsafe at school perform worse than students reporting otherwise.

Table 4.5: Impact of Student Perception of School Safety on Academic Performance in Rwanda, DRE

	(1)	(2)	(3)
	4th grade math	6th grade English	6th grade math
Unsafe School	-1.927**	-5.236*	-7.044***
	(0.798)	(3.820)	(1.880)
Observations	242	224	222

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Next, we present the results of matching quality tests. Figures below show the standardized differences in means between treated and control groups for each covariate before and after matching. Figures B.4.1, B.4.2, and B.4.3 (See Annex B) show results for students in 4th grade math, 6th grade math, and 6th grade English exams respectively. They show that standardized differences in means are close to zero for each covariate post-matching. This implies that the mean value of each covariate is similar in the treated and control groups after they have been matched. In contrast, the standardized differences in means in the unmatched sample can be seen to be dissimilar for most covariates in all three figures. This assures us that the balancing property is satisfied for all covariates of interest and indicates good quality matching.

4.2. Tanzania

The dataset for Tanzania consists of 2nd grade math and English exams. The perception of school safety in Tanzania is reported by head teachers. While we have only two test scores for Tanzania, the sample size of 2,125 observations provides a large enough dataset to enable robust statistical analysis. From Table 4.6, we can see a consistently negative impact of an unsafe school environment on math outcomes. In all regressions, the school safety variable is statistically significant at the 5% level. Controlling for student, school, and family-specific characteristics, feeling unsafe in school leads to about 1.2 fewer correct problems in math scores. The economic magnitude of this decline is quite large considering the average math score is 9.50 correct problems. We also find that students in unsafe school environments that are equipped with a security guard solve two more problems than their counterparts in unsafe school environments that do not have a security guard.

Table 4.6: Impact of Head Teacher Perception of Students' School Safety on 2nd Grade Math in Tanzania

	(1)	(2)	(3)	(4)	(5)
Unsafe school	-0.803***	-0.628**	-1.096**	-1.168**	-1.171**
	(0.277)	(0.284)	(0.523)	(0.525)	(0.510)
Homework last week		1.076***	0.627***	0.599***	0.252
		(0.205)	(0.203)	(0.202)	(0.206)
School in urban area			2.190***	2.173***	1.583***
			(0.220)	(0.220)	(0.228)
Security guard in school			0.625*	0.579*	0.189
			(0.327)	(0.327)	(0.327)
School safety*School security			1.860**	1.895***	2.044***
			(0.723)	(0.726)	(0.705)
Student's family have a television					1.352***
					(0.290)
Student's family have a computer					0.684**
					(0.270)
Controls	No	Student	Student School	Student School Family	Student School Family
Observations	2,125	2,069	2,069	2,069	2,069
R-squared	0.004	0.023	0.088	0.090	0.120

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.7 presents the results of English reading outcomes in Tanzania for 2nd grade students. The school safety variable is statistically significant in most of the columns although its relative magnitude declines as control variables are added. To formally interpret this finding, students in schools perceived as unsafe identify 1.6 fewer words correctly in English exams, controlling for all other school, student, and family-specific effects. Considering the mean score in English reading evaluation is 24 words, the magnitude of this decline is lower than math exams.

However, some other identified key variables reveal higher magnitude and significance levels in our models. We find that on average female students score more than their male counterparts, controlling for all the covariates. In the most comprehensive model (Row 2, Column 5) we find that female students are able to read three more words correctly in the English reading evaluation. School location and security appears to matter in driving English exam scores. Students who attend school in urban areas score over 8.5 words more than their rural counterparts (Row 7, Column 5). However, if the school located in an urban area is unsafe, then students perform worse than those from an unsafe rural school. We also find that school security guards increase reading efficiency by about eight words in the full specification model. (Row 9, Column 5).

Table 4.7: Impact of Head Teacher Perception of Students' School Safety on 2nd Grade English in Tanzania

	(1)	(2)	(3)	(4)	(5)
Unsafe school	-14.40***	-9.770***	-1.790	-1.503*	-1.637*
	(1.134)	(1.627)	(1.933)	(1.933)	(1.858)
Student's sex (female)		1.817	2.581**	2.712**	3.111***
		(1.287)	(1.205)	(1.206)	(1.105)
		(2.356)	(2.199)	(2.199)	(2.094)
Student's age		-5.390***	-4.064***	-3.939***	-2.260***
		(0.450)	(0.440)	(0.442)	(0.422)
Homework last week		17.56***	13.77***	13.57***	9.230***
		(1.108)	(1.085)	(1.083)	(1.019)
Student absent from school last week		-2.728**	-3.015***	-3.022***	-2.394**
		(1.154)	(1.078)	(1.077)	(0.989)
School in urban area			15.39***	15.28***	8.536***
			(1.300)	(1.298)	(1.265)
School Safety*School urban			-19.34***	-18.88***	-13.73***
			(2.283)	(2.279)	(2.188)
Security guard in school			12.34***	12.08***	8.129***
			(1.022)	(1.019)	(0.942)
Student's father literacy				5.674***	1.095
				(1.895)	(1.768)
Student's mother literacy				4.460**	2.796
				(1.952)	(1.788)
Student's family have electricity					5.418***
					(1.236)
Student's family have a phone					3.085***
					(1.116)
Student's family have a television					11.72***
					(1.399)
Student's family have a computer					11.24***
					(1.698)
Controls	No	Student	Student School	Student School Family	Student School Family
Observations	2,125	2,069	2,069	2,069	2,069
R-squared	0.041	0.206	0.305	0.307	0.417

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.8 presents the results of school safety using PSM. Once again, we use the three matching methods applied to Rwanda. The math results are largely consistent with the findings from OLS estimation. We verify that students who feel unsafe at school, as reported by the head teacher, answer 0.7 fewer problems correctly than their peers who feel safe at school. This result is statistically significant across all three matching methods. However, for the English exams, we find stronger evidence of unsafe school environment on performance using matching. Since PSM allows for a more sophisticated comparison by matching students, based on similar background characteristics such as location, family attributes, and security facilities, we suspect that the OLS specification may have biased our estimates downwards.

Table 4.8: Impact of Head Teacher Perception of Students' School Safety on Academic Performance in Tanzania, PSM

	Outcomes	
	(1)	(2)
Matching methods	2nd grade math	2nd grade English
Nearest neighbor	-0.711*	-7.685***
	(0.469)	(2.599)
Obs	2069	2069
Radius/caliper	-0.649**	-7.703***
	(0.296)	(1.449)
Obs	2069	2069
Kernel (Epanechnikov)	-0.673**	-8.177***
	(0.327)	(1.291)
Obs	2069	2069

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.9 presents DRE estimates, which validate our PSM results. English fluency appears to decrease by about eight words for students with an unsafe school environment; while math scores decrease by about 0.7 correct addition problems on average. The DRE estimation further validates the proposition of OLS results underestimating the effect of school safety response.

Table 4.9: Impact of Head Teacher Perception of Students' School Safety on Academic Performance in Tanzania, DRE

	(1)	(2)
	2nd grade math	2nd grade English
Unsafe school	-0.742**	-8.039***
	(0.291)	(1.108)
Obs	2,069	2,069

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Finally, Figures B.4.4 and B.4.5 (Annex) show the standardized difference in means for each covariate before and after matching in the English and math exams respectively. As before, the standardized differences in means are close to zero for each covariate post-matching. It may be noted that in particular for school security (security) and location (urban) variables, the difference in mean is much higher in the unmatched sample between students who feel unsafe and those who do not, as reported by the teacher. This implies that these two groups of students may be systematically different from each other and hence a direct comparison of their mean scores leads to biased estimates. This difference in means becomes much closer to zero after matching. Since most of the covariates in the treated and control groups show similar means, post-matching, we can be assured that matching enhanced the quality of the comparison between students who feel safe and those who do not.

4.3. Zambia

Our sample for Zambia consists of 800 students, which were equally split between 2nd graders and 3rd graders. Similar to Tanzania, head teachers were the ones reporting perceptions of school safety in Zambia. About 12% of students are in the administration of head teachers who reported their students are not safe in school. Table 4.10 portrays the OLS regression results for 2nd grade math exams. We do not find any significant relationship between school safety and scores in any of our models. However, for all models tested, we find a statistically significant relationship at 1% level for students' sex, which is negative for female students. The full model reveals (row 2 column 5) that female students solve fewer problems correctly than their male counterpart controlling for the student, school, and family specific characteristics. Additionally, female teacher participation increases math exam performance by 0.9 problems on average. Given that the mean score was 3.6 correct problems the results suggest a strong sex-specific effect in determining learning outcomes.

Table 4.10: Impact of Head Teacher Perception of Students' School Safety on 2nd Grade Math in Zambia

	(1)	(2)	(3)	(4)	(5)
Unsafe school	-0.457	-0.306	-0.493	-0.505	-0.713
	(0.415)	(0.405)	(0.437)	(0.434)	(0.519)
Student's sex (female)		-0.951***	-0.977***	-0.955***	-0.960**
		(0.325)	(0.328)	(0.338)	(0.392)
Student's age		0.210*	0.257*	0.274**	0.498***
		(0.124)	(0.135)	(0.139)	(0.161)
Teacher's sex (female)			0.496	0.527	0.884*
			(0.377)	(0.373)	(0.523)
Student's father literacy					1.083*
					(0.559)
Controls	No	Student	Student Teacher	Student Teacher School	Student Teacher School Family
Observations	400	400	390	390	300
R-squared	0.002	0.035	0.044	0.045	0.108

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.11: Impact of Head Teacher Perception of Students' School Safety on 2nd Grade English in Zambia

	(1)	(2)	(3)	(4)	(5)
Unsafe school	-0.624	-0.587	-0.300	-0.286	-0.477
	(0.702)	(0.727)	(0.710)	(0.747)	(0.779)
Student's mother literacy				0.903*	0.551
				(0.534)	(0.647)
Distance from home to school					-0.244***
					(0.0890)
Controls	No	Student	Student Teacher School	Student Teacher School Family	Student Teacher School Family
Observations	400	400	390	375	300
R-squared	0.001	0.002	0.011	0.017	0.032

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.11 presents the full results of the regression analysis of English reading outcomes. Similar to math outcomes, English reading outcomes of 2nd grade students in Zambia show that there is no statistically significant relationship between school safety and student performance.

Table 4.12: Impact of Head Teacher Perception of Students' School Safety on 3rd Grade Math in Zambia

	(1)	(2)	(3)	(4)	(5)
Unsafe school	0.244	0.188	0.155	-0.0658	-0.228
	(0.759)	(0.771)	(0.837)	(0.840)	(0.860)
Student's sex (female)		-1.032**	-1.248**	-1.164**	-1.365**
		(0.475)	(0.493)	(0.510)	(0.543)
Student's age		0.222	0.365*	0.416**	0.369*
		(0.177)	(0.189)	(0.198)	(0.202)
Student's father literacy				0.652	1.089*
				(0.694)	(0.642)
Distance from home to school (in kilometers)					-0.200**
					(0.0878)
Controls	No	Student	Student Teacher School	Student Teacher School Family	Student Teacher School Family
Observations	400	399	370	356	297
R-squared	0.000	0.018	0.049	0.057	0.076

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.12 shows that head teacher perception of school safety is not a significant determinant of math outcomes among 3rd grade students in Zambia. However, once again we find strong sex discrepancy in performance across almost all models. Female students answer 1.3 fewer correct problems than their male counterparts in math exams. While Table 4.13 shows that an unsafe environment in school has a statistically significant and negative effect on English reading outcomes in all specifications. In the model with all controls included, we find that unsafe environments in schools reduce scores by 4.6 words.

Table 4.13: Impact of Head Teacher Perception of Students' School Safety on 3rd Grade English in Zambia

	(1)	(2)	(3)	(4)	(5)
Unsafe school	-3.471***	-3.542***	-4.485***	-4.565***	-4.648***
	(1.025)	(1.047)	(0.883)	(0.966)	(1.076)
Teacher's sex (female)			-2.924**	-2.736*	-1.748
			(1.372)	(1.420)	(1.461)
Student's father literacy				2.866*	4.025***
				(1.672)	(1.276)
Distance from home to school					-0.458***
					(0.157)
Controls	No	Student	Student Teacher School	Student Teacher School Family	Student Teacher School Family
Observations	399	398	369	355	296
R-squared	0.009	0.018	0.044	0.048	0.059

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Similar to OLS results, PSM and DRE results shown in Table 4.14, and 4.15 provide evidence of the negative impact of school safety problems on English reading and math outcomes for 3rd grade students. However, we only find statistical significance for 3rd grade English reading outcomes in Kernel matching and DRE results.

Table 4.14: Impact of Head Teacher Perception of Students' School Safety on Academic Performance in Zambia, PSM

	Outcomes			
	2nd grade English	2nd grade math	3rd grade English	3rd grade math
Matching methods	(1)	(2)	(3)	(4)
Nearest neighbor	-0.804	-1.186	-0.513	-0.403
	(1.288)	(1.004)	(2.865)	(1.435)
Obs	194	194	296	297
Radius/caliper	-0.347	-0.294	-3.476	0.499
	(1.247)	(0.828)	(2.372)	(1.321)
Obs	194	194	296	297
Kernel (Epanechnikov)	-0.311	-0.551	-4.527***	0.506
	(0.982)	(0.640)	(1.451)	(0.981)
Obs	194	194	296	297

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.15: Impact of Head Teacher Perception of Students' School Safety on Academic Performance in Zambia, DRE

	(1)	(2)	(3)	(4)
	2nd grade English	2nd grade math	3rd grade English	3rd grade math
Unsafe school	-0.646	-0.330	-3.602***	0.0660
	(0.752)	(0.435)	(1.149)	(0.809)
Obs	385	385	384	385

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As before, using Figure B.4.6 through B.4.9 in Annex B we show that the matching quality is generally satisfactory for students with and without school safety issues on reading and math outcomes for 2nd and 3rd grade students in Zambia. This finding validates the quality of the matching and reaffirms that unsafe school environments may not be a significant driver of academic performance for Zambian students.

4.4. Summary of Findings

The analysis reveals that 6th grade Rwandan students who reported unsafe school environments perform worse on standardized tests, in both math and English; while similar environments caused a decline in performance for 4th graders in math evaluations. In Tanzania, the teacher-reported school safety measures for students show that unsafe learning environments negatively impact 2nd grade students' performance in both math and English evaluations. In Zambia, we only find a significant effect of unsafe school environments reported by teachers for 3rd grade English learning outcomes; however, we do not find such evidence for their math evaluations. Also, we do not find any evidence of teacher-reported unsafe environment affecting the outcomes of 2nd grade English and math evaluations.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

The goal of this report is to identify the effect of school safety on learning outcomes for Rwanda, Tanzania, and Zambia. Academic performance depends on a myriad of student, school, and family-specific characteristics; we encompass all those facets in our statistical analysis. As noted in the introduction, school safety in Africa is often suggested by international organizations and policymakers as one main driver of children's academic achievement. However, quantitative evidence of such phenomena for developing countries is largely absent. This study provides evidence to assist policymakers in adopting school safety-sensitive programming and initiate a new pathway of research on the nexus between school safety and students' academic performance.

5.1. Conclusions

We draw three major and consistent conclusions from our analysis:

1) The effect of student-perceived school safety on academic performance in Rwanda is significantly negative. In particular, the magnitude of this negative impact is greater for 6th grade students.
2) Similar with the findings in Rwanda, the effect of head teacher-perceived students' school safety on academic performance in Tanzania is significantly negative. However, in Zambia, where head teachers report the perceived school safety for students, we do not find a statistically significant effect of school safety on most learning outcomes.
3) Due to the limitations of the data, there is a need for consistent data collection. While the EdData initiative collects data on several important variables pertaining to school safety and learning outcomes, it does not offer consistent and comparable variables across all countries. For example, school security guard information was only collected in Tanzania, while the distance from school to home information was only recorded in Zambia. Due to these discrepancies in the collected data, an aggregate study could not be performed, and we were not able to draw universal conclusions for all three countries or compare across them. Also, there is a need for more granular tools to measure safety. School safety measures should be consistent across all countries and can be improved. The dataset consists of self-reported measures of school safety, which has the potential of biased reporting. In Rwanda, we have student self-reported school safety, while in Zambia and Tanzania head teachers reported school safety on behalf of students, which made statistical analyses and conclusive inferences challenging.

5.2. Way Forward

On the basis of these conclusions we offer the following recommendations to USAID and the broader development community:

1) Donors and implementers need to consider school safety concerns when designing education programs, as safety issues can be a barrier to students' academic achievement.
2) Policymakers need to highlight school safety as a barrier to learning in policy design and implementation strategy.
3) Future research needs more standardized measurement tools, as well as examining what types of threats to school safety affect performance and how these threats vary across sex, age, region, and other attributes. The standardized measurement tools and assessments provide researchers a unique opportunity to pursue an understanding in a comparative cross-country perspective.
4) Alternative research approaches are needed to evaluate the impact of education programs conducted in African countries. A longitudinal or experimental approach will enable researchers and policymakers to understand the effect of specific policies and programs implemented to enhance student performance. We suggest conducting a longitudinal survey designed to examine the nexus of school safety and learning outcomes, specifically focusing on discrepancies in teacher, school, and education-system characteristics. Tracking cohorts of students will enhance our understanding of internal, external, as well as environmental threats to safe learning environments. Also, it will provide further insight into causal effects of policy intervention.

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ANNEXES

Table A.2.1: Variable Description - Rwanda

Variable	Description	Value Definition
Test Outcome		
English	Oral reading fluency in English	
Math	Correct addition problems per minute	
School Safety		
Safety	Student: do you feel safe at school?	0 "safe", 1 "unsafe"
Student		
Grade	What is the student's grade level?	
Female	Student's sex: 0 "Male" 1 "Female"	
Age	Student: How old are you	
HwkE	Last week, how many times did you get English homework?	
HwkEcheck	Did your teacher check your English homework last week?	0 " No" 1 " Yes"
HwkM	Last week, how many times did you get mathematics homework?	
HwkMcheck	Did your teacher check your mathematics homework last week?	0 " No" 1 " Yes"
Book	Student: do you have any exercise books? how many	0, 1, 2, 3, 4, 5 and more
Meal	Student: did you have a meal before you arrived at school	0 " No" 1 " Yes"
MealS	Student: meal at school	0 " No" 1 " Yes"
Teacher		
FemaleTE	English teacher: Is the teacher female	0 "Male", 1 "Female"
EduTE	English teacher: highest level of academic education	
ExpTE	English teacher: How many years have you been a teacher	
FemaleTM	Mathematics teacher: Is the teacher female	0 "Male", 1 "Female"
EduTM	Mathematics teacher: highest level of academic education	
ExpTM	Mathematics teacher: How many years have you been a teacher	
School		
Internet	School: is there internet access	
Computer	School: are there any computers for student use	
Family		
TV	Student: Television at home?	0 " No" 1 " Yes"
Electricity	Student: Electricity at home?	0 " No" 1 " Yes"
Toilet	Student: Flush toilet? at home?	0 " No" 1 " Yes"
Phone	Student: Mobile phone at home	0 " No" 1 " Yes"

Table A.2.2: Summary of Descriptive Statistics – 4th Grade Rwanda

Variable	Obs	Mean	Std.Dev.	Min	Max
Test Outcome					
Math	384	10.17	4.89	0	29
School Safety					
Safety	382	0.21	0.41	0	1
Student					
Grade	384	4	0	4	4
Female	384	0.54	0.50	0	1
Age	384	12.47	2.09	6	20
HwkM	375	2.38	1.38	0	5
HwkMcheck	348	0.92	0.27	0	1
Book	380	1.67	1.20	0	5
Meal	383	0.53	0.50	0	1
MealS	382	0.14	0.35	0	1
Teacher					
FemaleTM	286	0.36	0.48	0	1
EduTM	286	5.58	0.72	3	7
ExpTM	286	10.30	8.74	0	31
School					
Internet	376	0.03	0.16	0	1
Computer	376	0.16	0.37	0	1
Family					
TV	383	0.09	0.28	0	1
Toilet	378	0.06	0.23	0	1
Electricity	383	0.10	0.30	0	1
Phone	383	0.54	0.50	0	1

Table A.2.3: Summary of Descriptive Statistics – 6th Grade Rwanda

Variable	Obs	Mean	Std.Dev.	Min	Max
Test Outcome					
English	408	40.26	19.08	0	103
Math	408	19.23	7.47	4	53
School Safety					
Safety	404	0.18	0.39	0	1
Student					
Grade	408	6	0	6	6
Female	408	0.53	0.50	0	1
Age	408	14.60	1.80	10	19
HwkE	407	2.51	1.21	0	5
HwkEcheck	405	0.89	0.31	0	1
HwkM	404	2.87	1.41	0	5
HwkMcheck	389	0.94	0.24	0	1
Book	405	1.58	1.22	0	5
Meal	405	0.59	0.49	0	1
MealS	405	0.15	0.36	0	1
Teacher					
FemaleTE	250	0.19	0.39	0	1
EduTE	250	5.80	0.40	5	6
ExpTE	240	7.70	6.85	0	29
FemaleTM	243	0.33	0.47	0	1
EduTM	234	5.44	0.87	3	7
ExpTM	243	6.58	5.17	0	23
School					
Internet	398	0.03	0.16	0	1
Computer	398	0.17	0.38	0	1
Family					
TV	405	0.09	0.29	0	1
Toilet	404	0.08	0.27	0	1
Electricity	404	0.12	0.33	0	1
Phone	405	0.57	0.50	0	1

Table A.2.4: Variable Description – Tanzania

Variable	Description	Value Definition
Test Outcome		
English	Oral reading fluency in English	
Math	Correct addition problems per minute	
School Safety		
Safety	Head teacher: Is safety a problem in your school?	0 "No" 1 "Yes"
Student		
Female	Is the student female?	0 "Male" 1 "Female"
Age	How old is the student?	
Hwk	Student: Did you have any homework last week?	0 " No" 1 " Yes"
Absent	Student: Were you absent from school any day last week?	0 " No" 1 " Yes"
School		
Urban	Urban/Rural	0 "Rural" 1 "Urban"
Security	Is there a security guard?	0 "No" 1 "Yes"
Family		
LiteracyM	Does your mother/guardian know how to read?	0 " No" 1 " Yes"
LiteracyF	Does your father/guardian know how to read?	0 " No" 1 " Yes"
Electricity	Does your family have electricity at home?	0 " No" 1 " Yes"
Phone	Mobile phone at home	0 " No" 1 " Yes"
TV	Television at home	0 " No" 1 " Yes"
Computer	Computer at home	0 " No" 1 " Yes"

Table A.2.5: Summary of Descriptive Statistics – 2nd Grade Tanzania

Variable	Obs	Mean	Std.Dev.	Min	Max
Test Outcome					
English	2,125	24.01	27.87	0	156
Math	2,125	9.50	4.76	0	29
School Safety					
Safety	2,125	0.19	0.39	0	1
Student					
Female	2,125	0.51	0.50	0	1
Grade	2,125	2	0	2	2
Age	2,069	8.61	1.19	5	12
Hwk	2,125	0.48	0.50	0	1
Absent	2,125	0.34	0.47	0	1
School					
Urban	2,125	0.48	0.50	0	1
Security	2,125	0.79	0.41	0	1
Family					
LiteracyM	2,125	0.96	0.19	0	1
LiteracyF	2,125	0.97	0.17	0	1
Electricity	2,125	0.53	0.50	0	1
Phone	2,125	0.88	0.32	0	1
TV	2,125	0.48	0.50	0	1
Computer	2,125	0.18	0.39	0	1

Table A.2.6: Variable Description – Zambia

Variable	Label	Value Definition
Test Outcome		
English	Oral reading fluency in English	
Math	Correct addition problems per minute	
School Safety		
Safety	Head teacher: Are your students safe in school?	0 "No" I "Yes"
Student		
Female	Is the student female?	0 "Male" I "Female"
Age	Student: How old are you	
Teacher		
FemaleT	Is the teacher female	0 "Male" I "Female"
Family		
Distance	How far away, in kilometers, is this school from your home	
LiteracyF	Can your father read?	0 "No" I "Yes"
LiteracyM	Can your mother read?	0 "No" I "Yes"
TV	Television at home?	0 "No" I "Yes"
Electricity	Electricity at home?	0 "No" I "Yes"
Computer	Computer at home?	0 "No" I "Yes"

Table A.2.7: Summary of Descriptive Statistics – 2nd Grade Zambia

Variable	Obs	Mean	Std.Dev.	Min	Max
Test Outcome					
English	400	1.37	5.40	0	40
Math	400	3.63	3.39	0	30
School Safety					
Safety	400	0.12	0.33	0	1
Student					
Female	400	0.48	0.50	0	1
Age	400	9.19	1.65	4	16
Teacher					
FemaleT	390	0.69	0.46	0	1
Family					
LiteracyF	388	0.88	0.33	0	1
LiteracyM	392	0.77	0.42	0	1
TV	400	0.33	0.47	0	1
Electricity	400	0.21	0.41	0	1
Computer	400	0.06	0.24	0	1
Distance	320	1.59	3.31	0	15

Table A.2.8: Summary of Descriptive Statistics – 3rd Grade Zambia

Variable	Obs	Mean	Std.Dev.	Min	Max
Test Outcome					
English	399	5.15	11.85	0	71
Math	400	6.49	4.81	0	26
School Safety					
Safety	400	0.12	0.33	0	1
Student					
Age	399	10.31	1.46	7	17
Female	400	0.49	0.50	0	1
Teacher					
FemaleT	370	0.62	0.49	0	1
Family					
LiteracyF	391	0.90	0.31	0	1
LiteracyM	394	0.79	0.41	0	1
TV	400	0.36	0.48	0	1
Electricity	400	0.20	0.40	0	1
Computer	400	0.06	0.23	0	1
Distance	340	1.52	2.66	0	12

Figure B.4.1: Matching Quality for Rwanda 4th Grade Math

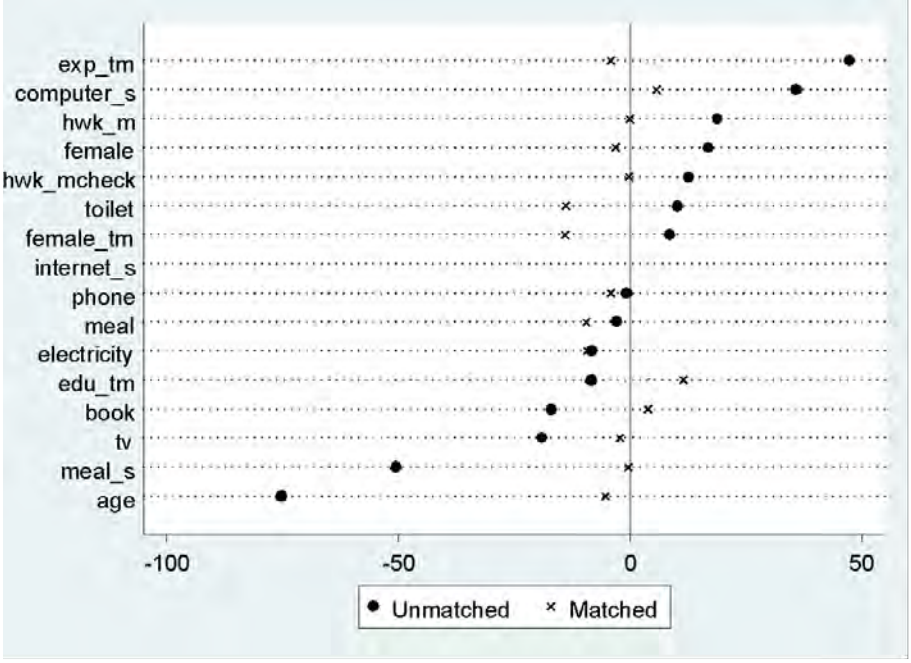


Figure B.4.2: Matching Quality for Rwanda 6th Grade English

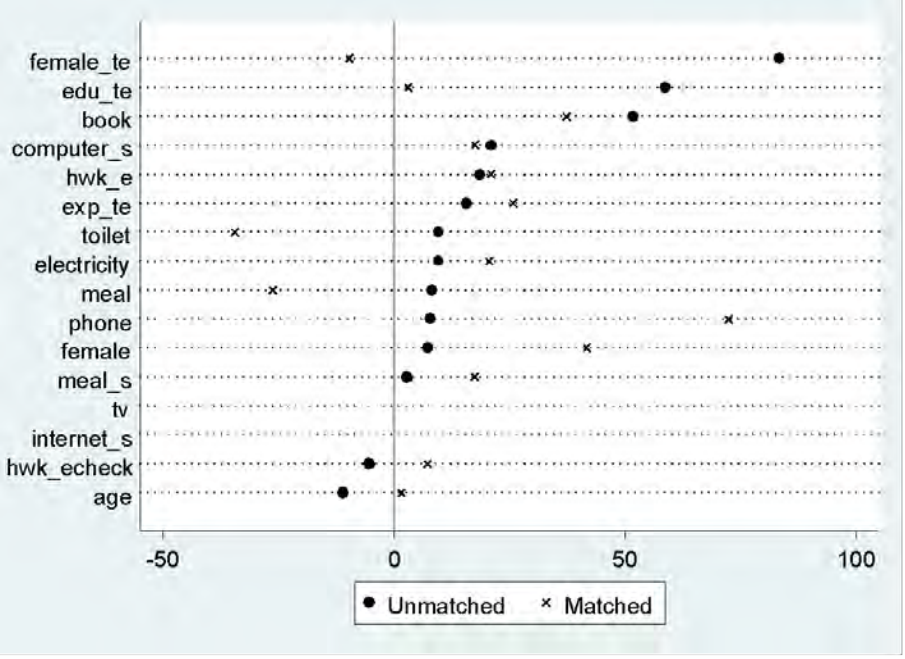


Figure B.4.3: Matching Quality for Rwanda 6th Grade Math

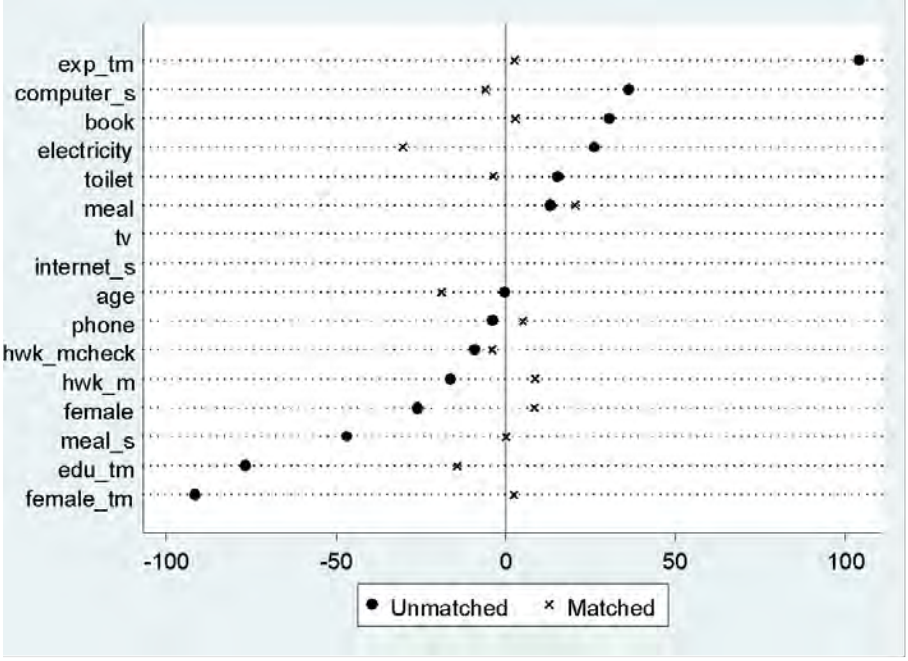


Figure B.4.4: Matching Quality for Tanzania 2nd Grade English

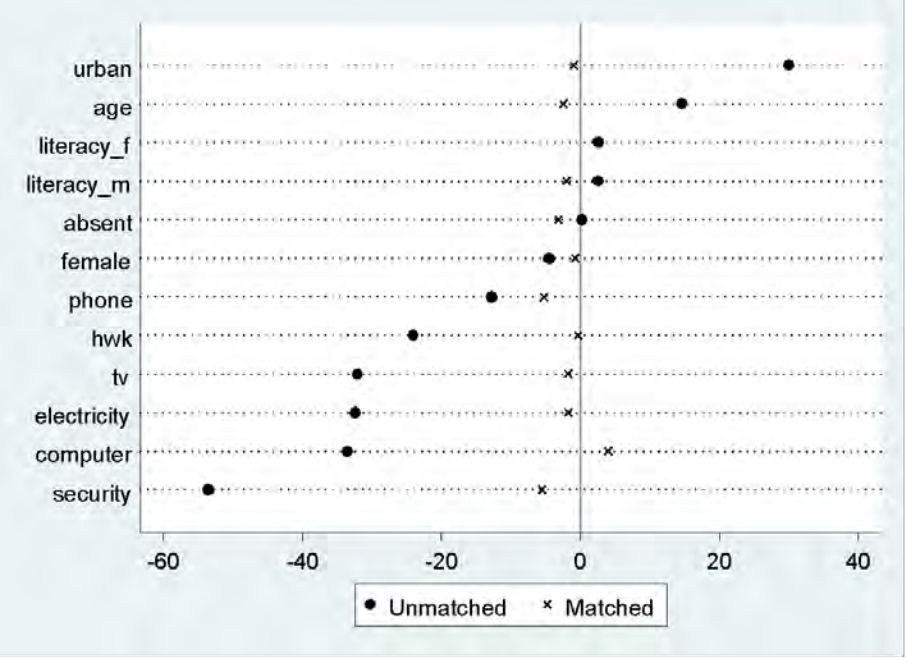


Figure B.4.5: Matching Quality for Tanzania 2nd Grade Math

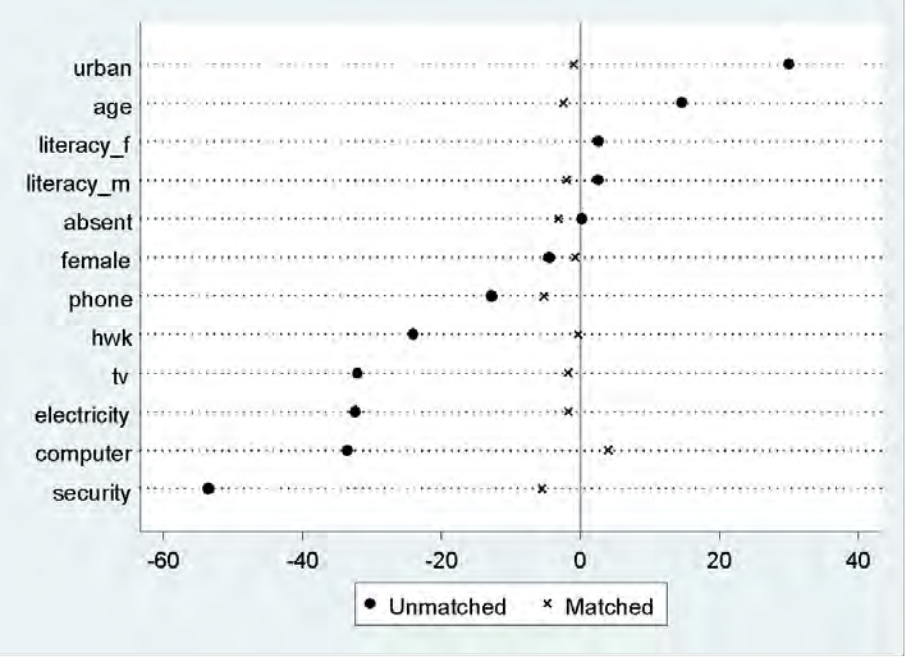


Figure B.4.6: Matching Quality for Zambia 2nd Grade English

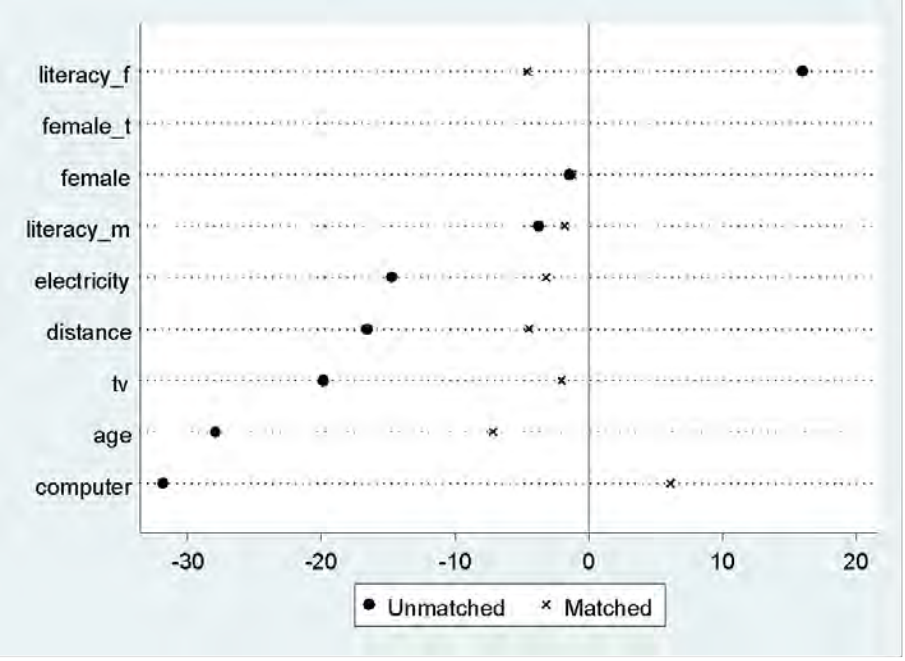


Figure B.4.7: Matching Quality for Zambia 2nd Grade Math

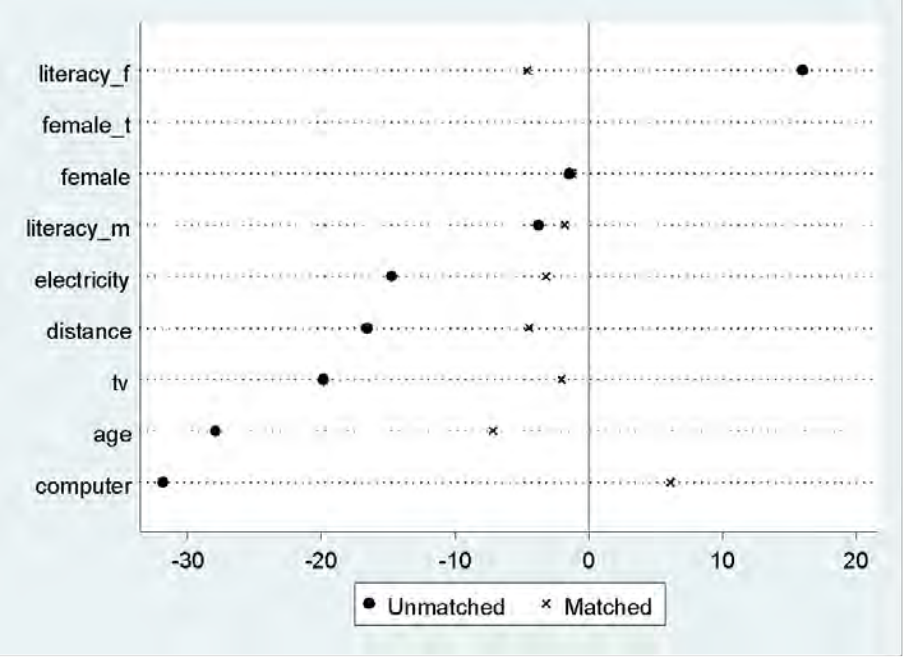


Figure B.4.8: Matching Quality for Zambia 3rd Grade English

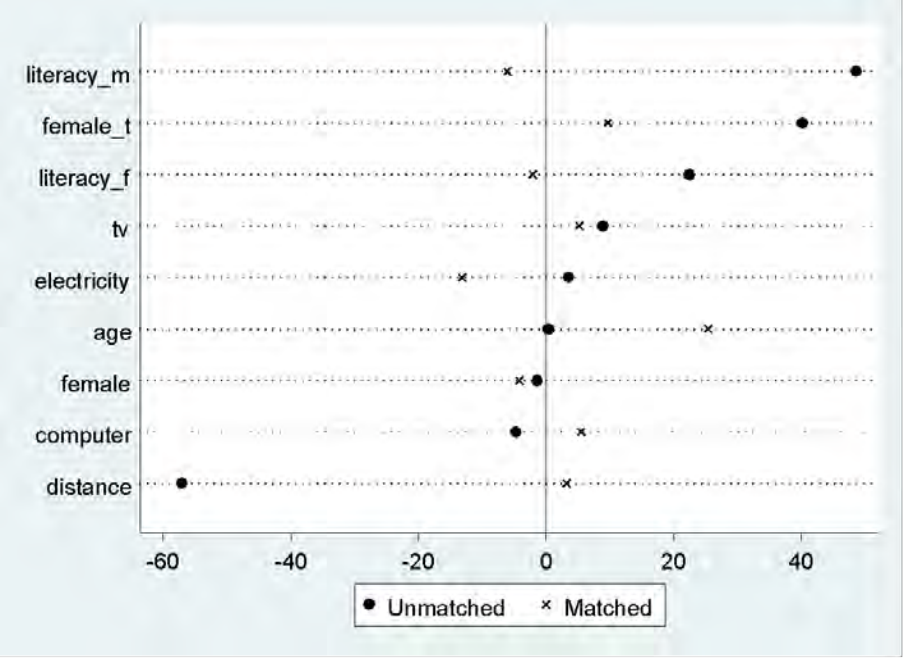
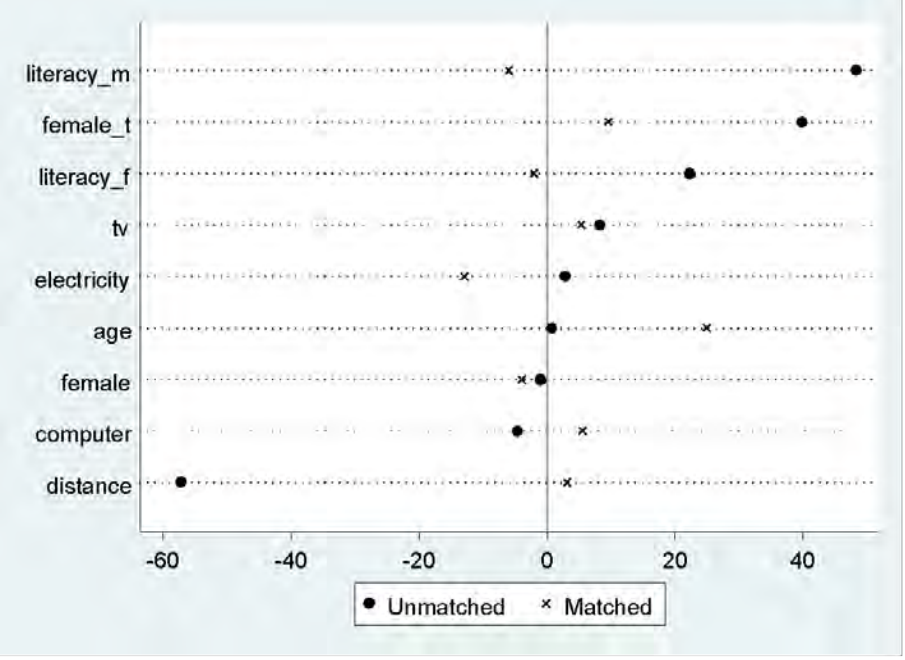


Figure B.4.9: Matching Quality for Zambia 3rd Grade Math



Addendum I: Control Variables Description

To isolate the effect of school safety on learning outcomes we need to acknowledge and account for other drivers of learning outcomes. We divide these attributes into three categories: school, teacher, and family attributes.

School-specific attributes can influence students' learning outcomes (Astor et al., 2010; Brand et al., 2003; Bucher and Manning, 2005; Majgaard and Mingat, 2012). School management strategies can also be a driver of students' academic performance (Patrinos and Fasih, 2007). Better facilities and infrastructure (Hanushek, 1995) have been documented to increase students' academic performance significantly. Among such amenities, we specify computer and internet facilities along with school security measures. School location and distance can impact students' learning outcomes as well. Data from United Nations (2005) implies that the dropout rate from school is significantly higher in rural schools. According to Majgaard and Mingat (2012), the estimated rural dropout rate is more than 4.5 folds higher than the urban dropout rate. Schools located in rural areas may also lack adequate facilities and teachers and are likely to invest less on a per-student basis. Such lack of investment (Hanushek, 2003) may hinder achievement and performance of students.

Teacher attributes also play an important role in students' learning outcomes. Wayne and Youngs (2003) provide an in-depth review of teacher quality, training and achievements and their impact on students' performance, showing these variables have a positive correlation with student achievements. Teacher quality and training are expected to impact academic achievement significantly and positively (Harris and Sass, 2011). To assess such qualities and training, we include several variables in our analysis such as teachers' experience and education. The influence of teachers' sex on academic performance shows mixed results and varies by disciplines in the current literature (Chudgar et al., 2008; Krieg, 2005; Warwick and Jatoi, 1994; Dee, 2007). There are few types of research specific to African schools that address teachers' sex and performance in standardized tests, (Kibriya et al., 2017) shows some evidence. Data shows that there is a lack of female teachers in the region (Majgaard and Mingat, 2012). In African schools, lack of training and adverse selection procedures experienced by female teachers may hinder students' performance.

For family attributes, parents' education and socioeconomic status have been shown to have a positive effect on students' performance (Davis-Kean, 2005). Literate parents can assist their children in academic grooming. Furthermore, parents with advanced education are more likely to have higher income levels to provide their children with better facilities. The EdData initiative provides information on parents' literacy. The database also provides extensive information on facilities available at home and in some cases distance from home to school. We have data on flush toilets, television, mobile phone and internet facilities available at students' households. These variables also portray socio-economic status of a family, availability of information and investments towards a student's academic growth. The above literature review reveals that for such research to be conclusive, it is imperative to encompass specific aspects of the school, teacher, student and family-specific attributes. Accordingly, we design a methodology that encompasses all facets of school, student and family attribute to understand the impact of school safety on learning outcomes.

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“Let us remember: One book, one pen, one child, and one teacher can change the world.”

Malala Yousafzai
2014 Nobel Peace Prize Recipient

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