THE RELATIONSHIP BETWEEN SCHOOL BUILT ENVIRONMENT AND STUDENT ACHIEVEMENT IN PAKISTAN

by

Nahida Begum Khudadad

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Approved by:

_____
Dr. Roslyn Arlin Mickelson

_____
Dr. Greg Wiggan

_____
Dr. Michael Lizotte

_____
Dr. Jason Giersch

_____
Dr. Beth Elise Whitaker

ABSTRACT

NAHIDA BEGUM KHUDADAD. The Relationship between School Built Environment and Student Achievement in Pakistan. (Under the direction of DR. ROSLYN ARLIN MICKELSON)

Schools in Pakistan face many challenges, ranging from lack of qualified teachers to insufficient teaching resources. Another obstacle is the low quality of school built environment. Some important built environment factors include an available water supply, sanitation facility, electricity access, proper seating arrangement and space, and school age. The quality of most schools' built environment in Pakistan is poor because schools are either built poorly or not well-maintained. Scholars have rarely studied the effects of school built environment on educational outcomes in Pakistan.

Therefore, this study investigates the effects of school built environment on achievements of 72,843 students in grades 1 to 10. The study uses secondary data collected in 2015 by the Annual Status of Education Report (ASER), a Pakistani nongovernment organization. The data come from a nationwide random sample of 5,296 Pakistani schools. Indicators of the built environment in multi-level regression models are the facility's age and if school has electricity, water supply, toilet facilities, a boundary wall, multi-grade classrooms, and seating arrangement. The models control for student and family background characteristics, urban or rural school location and public or private sector affiliation.

Findings indicate that variations in school built environment are significantly related to variations in academic achievement. The better the built environment, the higher the students' achievement in all grades. The study also finds the impact of school built environment on academic achievement is conditioned by gender, such that female

students are more vulnerable than male students to the effects of variations in school built environments, particularly due to the absence of sanitation and water. Findings highlight the importance of school built environment for student performance. Given the paucity of research on the issue, this study contributes to the existing literature on the topic. Policy implications of the findings are considered.

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DEDICATION

To my husband, Khudadad and my children, Pari and Izaan, with love.

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LIST OF ABBREVIATIONS

AEPAM	Academy of Educational Planning and Management
ASER	Annual Status of Education Report
BCI	Building Condition Index
BE	Built Environment
CDC	Center for Diseases Control and Prevention
EHP	Environment- Human-Performance
GDP	Gross Domestic Product
GEPEA	Global Coalition to Protect Education from Attack
HSSC	Higher Secondary School Certificate
ICC	Intraclass Correlation
IMF	International Monetary Fund
KPK	Khyber Pakhtunkhwa
MoF	Ministry of Finance
NMAR	missing at Random
MAR	Missing at Random
MCAR	Missing Completely at Random
SEM	Statistics, Economics and Mathematic
SSC	Secondary School Certificate
UNICEF	United Nations Children's Fund
UNESCO	United Nations Educational. Scientific and Cultural Organization

CHAPTER 1: INTRODUCTION

Pakistan's education attainment indicators are lower than most developing countries in Asia. UNESCO (2012) data show Pakistan has the second highest number (5.1 million) of children not attending school. Two-thirds of the 5.1 million children not attending school are girls. Pakistan has the third largest illiteracy rate globally. About 49.5 million adults are illiterate. Of these illiterate adults, two-thirds are women. All the disparities in educational attainment have resulted in Pakistan being ranked at 113 of 120 countries on UNESCO's Education Development Index (UNESCO, 2014).

Many potential reasons exist for the disparities in educational attainment in Pakistan. One is the lack of political support. Pakistan spends just 2.3 percent of its gross national product on education (UNESCO, 2012). Second is poverty among citizens. According to the Ministry of Finance Pakistan (2014), more than half of the country lives below the poverty line ($2 a day). For poor families, the cost of sending children to schools is very high (Baschieri & Falkingham, 2009). A third reason is religious fundamentalism, which opposes secular education, especially for girls. Religious fundamentalism also creates a security dilemma for schools due to terrorists bombing schools (Qasim, Safdar & Stancati, 2015). A fourth reason is lack of access to schools. Schools are either very far from homes or there are no schools at all (Fennel, 2008).

Lastly, schools are either built poorly or poorly maintained, resulting in poor built environment of schools (Lall, 2012). Twenty-five percent of schools in Pakistan are without water supply systems (ASER, 2015). The quality of water available in the other 75 percent of schools is unknown. Classrooms are very hot in the summer and very cold in the winter. Ceiling fans are the only option to keep the heat out of classrooms during

hot summers. However, 27 percent of schools do not have access to electricity (ASER, 2015). The 73 percent of schools with access to electricity face many hours of power outages.

Not having proper sanitation facilities is another issue. Schools either do not have toilet facilities (29 percent) for students or the toilet facilities are not operational. Striking differences exist between female students' access to these important amenities, compared to male students' access. For example, 38 percent of schools for girls do not have toilets, compared to 26 percent of schools for boys. Similarly, 23 percent of schools for boys, compared to 30 percent of schools for female students, do not have access to a water supply. Pakistani researchers have rarely explored the effects of built environment of schools on student achievement.

However, a plethora of research is available about issues, such as lack of government spending on education, the relationship between socio-economic status, demographics, religious fundamentalism, and access to schools, and their effects on educational outcomes in Pakistan. To fill the research gap, this study describes the distribution of built environment elements and investigates several critical aspects of Pakistani schools' built environment. Based on prior research, this study examines key elements of the built environment, including running water, toilet facilities, electricity access, and proper seating arrangements at the school. To demonstrate if built environment variations across Pakistani schools are related to differences in student achievements, this study includes individual, family, and other school-level characteristics in models predicting students' test scores.

The first research question that motivates the study is: Does built environment of schools affect academic achievement among Pakistani students in grades 1 to 10? The second motivating question is: Do variations in school built environment affect male and female students differently? The third question is: Do the effects of school built environment change as student age change. In response to these research questions, the key expectation is that students studying in schools with better quality built environments have greater academic achievement.

The research tests five specific hypotheses. The first hypothesis holds that school built environment affects student achievement among Pakistani students in grades 1 to 10 students. A second hypothesis is the effects of school built environment on academic achievement vary, depending upon student gender, student age, number of siblings, students getting paid tutoring, student-family socio-economic status (SES), school type and school location. The third hypothesis is the impact of school built environment on academic achievement is conditioned by gender, such that female students are more vulnerable than male students to the effects of variations in school built environments. A fourth hypothesis to test is if the impact of built environment on achievement is conditioned by student age, resulting in older students being more susceptible to the effects of variations in school built environments. An analysis of the relationship between built environment of schools and academic achievement provides empirical evidence regarding whether or not schools' built environment is a critical policy issue for Pakistan.

1.1 CONTEXT OF THE STUDY

This section discusses the different factors that might have contributed to poor school building infrastructure, but first it explores existing education system in the

country. Pakistan has many types of public and private school systems. The types include government-run secular schools, expensive private schools, private schools for children from low-income families, schools administered by communities, and schools managed by religious organizations: Madrasas[1] (Ali, 2012; Ali & Tahir, 2009).

Public schools are the predominant providers of education, but private school systems have flourished in Pakistan (Nguyen & Raju, 2014). About 58 percent of students attend public schools and 42 percent attend private schools (Norric, 2006). According to the Pakistan Bureau of Statistics (2015), a total of 5,689,569 students were enrolled in private schools as of March 2000. The number of private schools in Pakistan doubled to 70,000 from 1990 to 2010 (Nguyen & Raju, 2014, p.2).

The current public or government administered secular[2] schools with a *Kuchi* (pre-school, nursery or play group) program enroll children beginning at age three. Kuchi is followed by *Paki* (prep, kindergarten) and five years of primary (elementary) school. The middle school is a three-year program and matric (secondary school certificate - SSC) is a two-year program. The sorting and allocating of youth into disparate pathways for advanced studies starts at the secondary school certificate (SSC) level with two tracks: arts/humanities and science.

Higher Secondary School Certificate (HSSC) is the next level of schooling after SSC. HSSC is a two-year program with science tracking further divided into tracks for pre-engineering, pre-medical, intermediate of commerce, and intermediate of statistics,

[1] Madrasas are "Islamic institutions offering instructions in Islamic subjects including, but not limited to Quran, the sayings of the Prophet, jurisprudence (fiqh) and law" (Blanchard 2007, p. 2).

[2] Madrasas schools have a different curriculum and grade levels than the secular schools. Madrasas are private schools.

economics and mathematics (SEM). At the bachelor's level, pre-medical and pre-engineering students complete a four-year study, while students in other tracks complete two-year bachelor's programs. Currently, some public and private higher education institutions provide four-year honors degrees at the bachelor level followed by a one-year master's degree. However, master's level programs are usually two years.

Students can earn master's degrees in philosophy before entering a Ph.D. program or can be directly admitted to a Ph.D. program after completing their master's degrees. For students, choosing a track depends on scores in previous grades, family socio-economic status and access to schools with different tracks. Science tracks, such as pre-engineering and pre-medical, especially require higher scores in previous grades and passing of entry tests.

The law allows children up to age 15 to get free schooling. But not all children within the age bracket go to school. A total of 83 percent (70 percent, according to UNICEF) of children get enrolled in primary school. Of those, 65 to 70 percent can complete grade 5, while 62 percent of children are able to attend middle schools (73 percent in urban areas and 50 percent in rural areas) (AEPAM, 2013). In real terms, 6.7 million children of primary school age are out of schools. Of these youth, some have never attended school and some drop out of school before completing primary education (AEPAM, 2013). Of those enrolled, 58 percent attend public schools and 42 percent attend private schools (Norric, 2006). Moreover, compared to the South Asian[3] averages, primary school enrollment rates in Pakistan are very low. In South Asia, the average enrollment rate is 90 percent, while it is 70 percent in Pakistan (UNESCO 2012).

[3]South Asian countries include Pakistan, India, Bangladesh, Sri Lanka, Nepal, Bhutan, Maldives and Afghanistan.

There is great disparity in educational attainment for rural and urban areas in Pakistan. The majority (63 percent)[4] of the population lives in rural areas (UNESCO, 2012). UNICEF (2012) shows that in urban areas, the net attendance ratio for primary (elementary) schools is 77.6 percent, while it is 61.7 percent in rural areas. So, the primary school net attendance ratio of urban to rural is 1.3. In addition, the adult literacy rate is 36 percent in rural areas, while it is 65 percent in urban areas. Additionally, the primary school dropout rates are higher (18 percent) for rural areas and lower (11 percent) for urban areas (Siddique, 2012, p.115).

The current condition of schools and education in Pakistan is a product of existing policies resulting from contemporary complicated geo/political, economic and social realities. These realities include poverty among citizens, lack of spending on education, high-level corruption and lack of security. Pakistan is a country of 200 million people (World Bank, 2017). As mentioned before, the majority (63 percent) lives in rural areas (UNESCO, 2012). Rural communities mostly depend on agrarian economy. Seventy-nine percent of rural women are engaged in agriculture, as compared to 61 percent of their male counterparts (Zaheer, Zeb and Khattak, 2014). The likely reasons are that women and children provide unpaid or cheap labor for agriculture, whether it is working on family farms or working on the farms of landlords. Girls are especially at risk of not attending school because they work on farms, fetch water and wood or provide care for siblings (Herz & Sperling, 2004; Papanek, 1985).

Similarly, Papanek (1985) finds that most family members have to work to contribute to the family income. Within the family, elder siblings (especially boys) drop

[4] Siddique (2012) reports as 67% of the population living in rural areas.

out of school to support younger siblings. In the case of girls, parents often do not send them to school because of the high opportunity costs of a girl's education. Therefore, decisions to send children to school also depend on the future return of sons' and daughters' educations for the family (Papanek, 1985).

Although the majority of the poor live in rural areas, the urban poor also have limited access to quality education. Using relative poverty measurement methods such as a poverty gap index, Anwer and Siddique (2005) show that 46.7 percent of the population in rural areas and 31.1 percent of people in urban areas are poor.[5] About 60 million people are poor in Pakistan (Anwer & Siddique, 2005, p.1118). Therefore, poverty is a general phenomenon all over Pakistan. Twenty-one percent of Pakistan's population lives below the poverty line and human development index values at 0.515 (World Bank, 2009). The per capita income per annum is $1,290 (World Bank, 2014). Therefore, parents cannot afford to send their children to school since they cannot afford education-related costs, such as school fees, cost of books, notebooks and the incurred opportunity costs.

With a significant number of people living in poverty, Pakistan spends just 2 percent of its GDP on education (Majid, 2011). Of this, 34 percent is spent on higher education and the rest is spent on primary, middle, technical and vocational teaching and training (UNESCO 2012). Furthermore, the annual average per student spending on primary level education is Rs. 14,954 ($140)[6], while middle and secondary level per-student expenditure is 50 percent or less of $140 (AEPAM, 2013). This shows the grim

[5] Data were collected in 2001 – 2002.
[6] In the United states, per pupil spending is $10,700 as of 2013 (see http://www.census.gov/newsroom/press-releases/2015/cb15-98.html)

situation of resource allocation for education in Pakistan. Educational polices regarding the level of government spending on education impact how schools are built.[7]

In education plans and policies, the government promises to increase budget allocations for education, but spending remains low. For example, in its ninth five-year plan, the government pledged to increase spending on education to 4 percent from the current 2.2 percent, but the actual spending remains lower than 2 percent. The same trend holds for most education plans. As is illustrated in figure 1, Pakistan's education expenditure as a percentage of GDP has constantly been under 3 percent from 1971 to 2014 (available data), with an exception in 1997 when education expenditure reached 3 percent.

The actual utilization of budget allocations on education also is questionable. According to the Academy of Educational Planning and Management (AEPAM, 2013) and World Bank (2015), just 90 percent of budget allocations is eventually spent on education. In addition, budget allocations for girls' education is lower, compared to boys' education expenditures (Sabir, 2002). This disparity is evident from the lower number of educational institutions that are yearly planned and implemented. For example, in the eighth five-year plan (1993-98), the issue of the lower number of schools for girls is recognized. The plan pledges to construct 65 percent of newly built schools for girls (GoP, 1993). However, the number of schools remains low. Women and girls living in dire poverty are especially impacted due to inequalities in education spending (Sabir, 2002).

[7] Education is a provincial (state) subject, however the federal government through the University Grant Commission (currently as Higher Education Commission) finances higher education in Pakistan (Sabir, 2002, p.479-480).

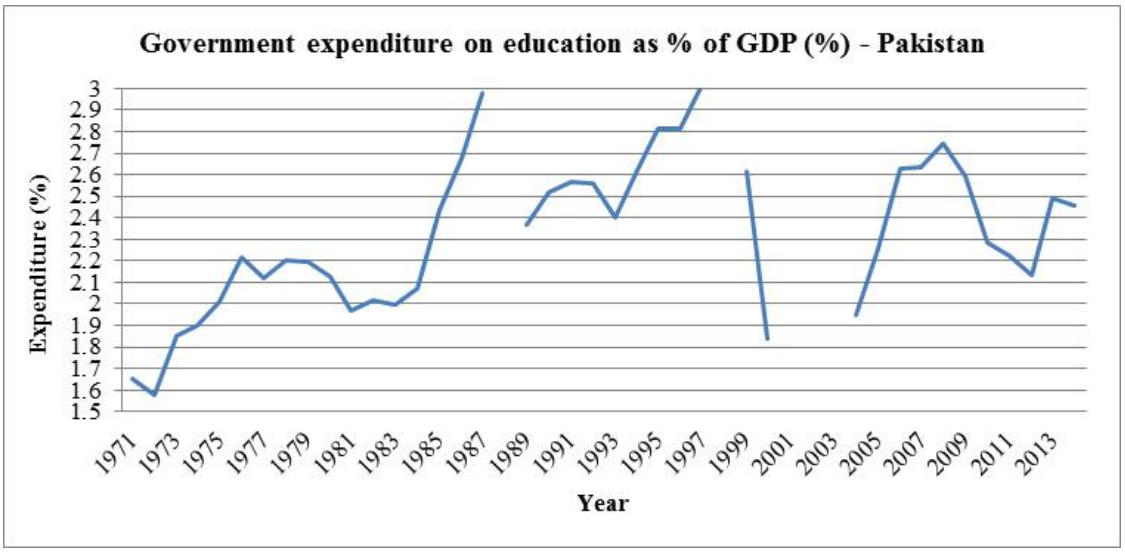

Figure 1: Government expenditure on education as a percent of GDP with gaps showing missing data. Source World Bank (2016)

The level of government spending on education also dictates the size of school buildings, hence the quality of the space available for each student in the schools. Primary schools consist of seven grades (pre-k to grade five). However, primary school buildings consist of one or two classrooms. Therefore, classrooms are usually multi-grade or classes are conducted in veranda (corridors) of the school or sometimes outdoors. Recently, the provincial government in Khyber Pakhtunkhwa (KPK) province (state) revised its primary school construction protocols. For primary schools, it increased the number of classrooms from two to six (Asfaq, 2014). Allocating the total number of teachers depends on the number of classrooms in the school. For example, if there are two classrooms, two teachers are budgeted (Asfaq, 2014)[8]. Therefore, the size of school buildings affects the quantity of teachers.

[8] I tried to find out about the school construction protocols for the other four provinces (Baluchistan, Gilgit-Baltistan, Punjab, Sindh) and federal and tribal areas but could not find the information on the web.

So, why is education not a priority for the government? Why does the government not allocate the required finances to education? The likely reason is most of the country's budget is either spent on internal and external security challenge due to the war on terror and religious extremism or used for repaying foreign debt. The country is highly dependent on foreign loans. Pakistan's net government debt as a percentage of GDP is 64.21[9] (IMF, 2015). Pakistan owes around $72.6 billion in foreign debt (Malkham, 2016)[9] to international financial organizations, such as the International Monetary Fund (IMF), the World Bank and the Asian Development Bank. As a result, a major chunk of the annual budget goes to repaying loans. For example, in the 2016-2017 budget, about 27.77 percent is allocated for debt repayments (Saleem, 2016). Hence, more than a quarter of the budget goes to loan repayments to national and international organizations[10].

Defense and security are other priorities. Pakistan faces internal and external security threats. Pakistan has fought three wars with India since its freedom from British colonialism in 1947, parting the Indian subcontinent into two sovereign states – India and Pakistan. In 1971 Pakistan was divided into Pakistan and Bangladesh. Parts of the region, such as Jammu and Kashmir, are still disputed territories between the two countries. This results in frequent wars and war-like situations. This leads to an on-going arms race between the countries.

[9] Bloomberg reports a foreign debt of $124 billion for Pakistan. See http://www.bloomberg.com/news/articles/2016-02-14/pakistan-default-risk-surges-as-50-billion-debt-bill-coming-due for details.
[10] Down News (2016) reports that 77% of the 2016-2017 annual budget is allocated for debt repayments. See details in http://www.dawn.com/news/1239706

Additionally, the war on terrorism is ongoing with *Zerb-e-Azb* and *Rudul Fasad*, the on-going military operations against militant groups, such as the Taliban. Terrorism is a phenomenon faced by Pakistan since South Union invaded Afghanistan in 1979. Therefore, Pakistan allocates about 17.56 percent of its 2016-2017 budget to defense and security services (MoF[11], 2016; The News, 2016). This year (2017-2018), the security budget has increased 9 percent.

The security situation not only takes its toll on education indirectly through skewed finances, but it also affects schools and students directly (Qasim, Safdar & Stancati, 2015). Schools are bombed or closed due to security threats. According to The New York Times, the Taliban burned or bombed 10,000 schools in Pakistan (Walsh, 2014). The December 2014 attack on Army Public School Peshawar is an example of this terrible situation, when the Taliban opened fire on school staff and children and killed 141 people, including 132 children.

Data from Global Coalition to Protect Education from Attack (GEPEA, 2014, p.16) show that from 2009 to 2012 armed groups attacked at least 838 schools in Pakistan and left many students out of school. During the same period, Pakistan stands among countries in which military-purpose[12] use of schools and educational institutions is high. The status of efforts to restore and rehabilitate bombed and burned school buildings is unknown. The army public school attacked by the Taliban in December 2014 was restored by the army, its administrator.

[11] Ministry of Finance (MoF)
[12] During wars, the military or other militia groups use school as a base camp, a detention center, as a weapon storage facility, or as a barricade etc (GEPEA, 2014).

All the above policy issues affect children's access to school and quality school buildings. Not having quality school buildings then affects student learning and consequently their academic achievement. This dissertation reviews existing literature on the research topic, the encompassing theoretical approaches that help explain the relationship mechanisms and the research significance. Then, it discusses the data and methods. Subsequently, the research findings are summarized. Next, the findings on the theory, methods and the limitations are discussed. The paper ends by explaining the policy implications and offering conclusions.

CHAPTER 2: LITERATURE REVIEW

The relationship between individuals and the environment they live in has been debated by scholars for centuries[13]. Studies on the environment and individual relationships draw from environmental psychology, physical[14] environment and built environment scholarships. Within the field of environmental psychology, Hellpach (1911) was the first to study the environment and human relationship in terms of social, cultural and natural environment (as cited by Gunther, 2009, p.359). About half a century later, Barker (1968 as cited in Giuliani and Scopelliti 2009) studied human behavior within specific contexts as it occurred naturally, which Barker (1968) referred to as environmental ecology.

Within built environment scholarships, Bronfenbrenner (1994) and colleagues[15] were the first to study the environment in connection with learning performance. Bronfenbrenner (1994) devised a Human Performance Model to study the human-environment relationship. Bronfenbrenner (1994) presented five systems[16] within the model, which nest together to affect human development. Of the five systems in the Human Performance Model, microsystems explain the development of people and their learning within their living environment. Schools and homes are examples of built environment that facilitates individual learning.

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13 The study of relationship between built environment and human health can be tracked to 2600 years back (Satcher, Okafor & Dill,2012, p.1). Also see Hippocrates, On Air, Waters and Places, in the Genuine Works of Hippocrates, The Sydenham Society, London, UK, 1849.

14 Also referred to as ecology (Barker 1968)

15 Bronfenbrenner and Crouter (1983) and Bronfenbrenner and Morris (2006)

16 Microsystem, mesosystem, exosystem, macrosystem, and chronosystem

More recently, the built environment and learning performance nexus has gained the attention of many scholars. Using multilevel analysis, Barrett, Zhang, Moffat, and Kobbacy (2013) study elementary schools in Blackpoll County in England and find that school built environment accounts for 51 percent of total variation in student learning performance, while the classroom built environment accounts for 71 percent of total variance in student learning.

Similarly, Duran-Narucki (2008) studies New York inner-city schools and demonstrates that poor school building conditions negatively affect academic achievement and school attendance. The negative effects of poor school building conditions are stronger for students who come from poor families. The author finds that the inner-city school buildings in New York are in poor condition. School toilets are broken. Indoor air quality in classrooms is very poor and the temperature control of school building is inadequate.

Furthermore, Wall (2015) explores the influence of school built environment on learning in primary schools and finds that heating, ventilation, lighting and acoustics are significant factors affecting classroom learning environment, teacher productivity and student retention (p.37). Similarly, Barrent and Zhang (2012) explain factors making classrooms comfortable spaces for teaching and learning. Voicing teachers' opinions, the authors explain that proper lighting, acoustic, temperature, air quality, flexible space, pupil density and facilities affect proper delivery of lessons. If teaching is negatively affected, ultimately, student learning and achievement are impacted.

Vegas and Caffin (2015) study the effects of class size on academic achievement and illustrate that class size impacts learning outcomes. Students in crowded classes are

less likely to learn than if they are in classes with fewer students. Baschieri and Falkingham (2009) show the importance of school regular maintenance for the sustained quality of school built environment. The authors study conditions of school buildings in Tajikistan and report that school buildings are in shabby condition due to lack of maintenance funds. Classrooms have no heat. Windows are broken. Proper sitting arrangements don't exist because there aren't enough chairs for students. Consequently, students miss school in winter because it is too cold for them to study in classrooms with broken windows and no heat.

Within the school built environment, facilities and basic teaching aids, such as blackboards, books, a library, computer lab, storage space, water and sanitation facilities, are common sense provisions in schools in most developed countries. Such provisions are considered in the design and implementation (construction) of schools. The regular maintenance of such facilities also is considered in school yearly budgets. Therefore, scholars in developed countries study school built environment factors, beyond basic facilities. For example, scholars are examining the impact of color, texture and space management within classrooms on student learning. However, scholars studying school built environment in developing countries, such as Pakistan, show that schools lack basic facilities, including drinking water and sanitation.

Adukia (2017) studies schools in India and finds school sanitation increases enrollment among pubescent-age girls, given that toilets are sex-specific (p.24). Unisex latrines benefit younger students irrespective of their gender. Similarly, Hayat (2017) studies 36,295 schools in the Punjab province of Pakistan and finds that usable toilets in schools improved enrollment. The author also finds the relationship between toilets and

enrollment is stronger for female students and students from rural areas of the province. Hayat (2017) controls for electricity access, water supply and boundary walls and finds those factors are significant predictors of school enrollment.

Similarly, Rauniyar, Orbeta & Sugiyarto (2011) study schools in the Punjab province of Pakistan and find that not having water and sanitation (toilet) facilities in schools and homes negatively affects girls' academic achievement, regular school attendance and school retention. According to the authors, the main reason is if homes have no tap water, girls miss school or drop out to fetch water for the family. Dean (2005) explains that schools in Pakistan lack adequate facilities, including water and electricity.

For the government and other education providers, school built environment is secondary to other education-related issues, such as quality of teaching and curricula. Poor school built environment has consequences for student education. Parents do not send their daughters to school if there are no boundary walls or toilet facilities (Dean 2005; Fennell, 2008). Fennel (2008) reports that parents in Pakistan prefer to send their daughters to Madrassah (religious) schools because government schools are too far from their villages. Parents fear for girls' security, safety and *purdah* (privacy).

The literature suggests that school built environment impacts academic achievement, student retention and student attendance. Therefore, this research tests the hypotheses that:

H_1: School built environment affects student achievement among Pakistani students in grades 1 to 10.

H_2: The effects of school built environment on academic achievement vary, depending upon student gender, student age, the number of siblings, students taking paid tutoring, students' family socio-economic status (SES), school type and location, teacher training and student- teacher ratio.

Scholars, such as Barret et al. (2013), Barrent and Zhang (2012), and Vegas and Caffin (2015) have concentrated on studying the direct relationship mechanisms, thus ignoring the underlying factors that might intervene or interact with the focal relationship. Many other scholars study the underlying associative effects of built environment on learning performance.

For example, Huang et al. (2011) and other scholars[17] identify the effects of built environment on human learning performance and find that comfortable built environment makes occupants feel at ease, resulting in increased learning. However, if built environment is poor,[18] it leads to negative results for occupants. The negative stimuli result in a lack of focus and disproportionate attention spans, emotional stress and mood and decreased status among inhabitants. Built environment predicts human emotional states of being (comfort level, attention, mood, adaptability, status and belief), whereas the emotional states of being can predict learning performance.

[17] For the relationship between built environment and comfort level or ease, see Barret et al. (2013) and Mishra and Ramgopal (2013). For relationship between built environment - attention, focus and adaptability see Hasbullah et al. (2011), Mishra and Ramgopal (2013) and Evans 2003). For relationship between built environment and distress and mode see (Marchand et al. (2014). For relationship between built environment and, moral and status issues see Marchand et al. (2014) and Hasbullah et al. (2011).

[18] [that is if it is too cold, too hot, damp, dense, dusty and noisy]

The impact of built environment on learning also is conditioned by demographic and individual factors. Demographic factors, such as age, gender and geographic location, influence individual experience and behavior differently in relation to reaching objectives. Put differently, the degree of the effect of built environment on learning performance varies based on contextual and demographic characteristics of individuals. Winkel, Saegert and Evans (2009) find that multiple contextual and demographical factors, such as gender, personality, age and environmental belief, influence the effects of physical environment on individual experience and behavior. Winkel et al. (2009) assert the importance of considering the differential influence of contextual elements on the outcome of interest for different individuals in studies and analytical models.

Due to data limitation, this research is not assessing the intervening factors between built environments and learning performance. The study also does not consider the interaction of all demographic factors, except for the interactive effects of student gender and student age on the relationship between built environment and learning performance. The gender and age interactive hypotheses are:

H_3: The impact of school built environment on academic achievement is conditioned by gender, such that female students are more vulnerable than male students to the effects of variations in school built environments.

H_4: The impact of built environment on achievement is conditioned by student age, older students are more susceptible to the effects of the variations in school built environments.

Overall, the literature review shows considerable empirical studies are being conducted about the relationship between built environment and learning performance.

The literature review also demonstrates that most studies have been conducted in developed countries, such as the United States (USA) and the United Kingdom (UK). Very few studies have been conducted in developing countries from Africa and Asia. Few such examples are Adukia (2017), Hayat (2017), Rauniyar et al. (2011), Baschieri and Falkingham (2009) and Dean (2005), who study school built environment in India, Pakistan and Tajikistan. This study builds on existing literature about the research topic from the context of Pakistan.

2.1 THE THEORY

Human performance models suggest humans are goal-oriented and human behavior is teleological (Rasmussen, 1983, p.257). Drawing from this intellectual doctrine, the individual learning model assumes individuals act with an end result in mind and strive for utility maximization. However, in the real world, individual utility maximization and goal orientation are conditioned by many other factors. Even though individuals strive for utility maximization, psychological and contextual factors can hinder and/or boost the utility maximization process and, ultimately, the end results. Living environment is one of the factors. If built environment is conducive, individuals perform optimally. However, if the environment is poorly built, it can adversely affect human learning performance. Therefore, optimality and utility maximization in individual learning performance are explained, in part, by built environment.

Built environment is the space or setting where individuals live and relate to each other. An optimal setting or environment is characterized by the size, layout (related to flexibility and adjustment), the acoustic system, thermal efficiency, color and texture (Hasbullah et al. 2011; Schneider 2002). If the setting or environment is poorly built, it

lacks enough space for all occupants; the layout does not consider the comfort[19] of all inhabitants; it is unbearably hot in the summers and cold in the winters; it is dark, damp, dusty, and has poor air quality; and lacks necessary functional facilities.

Built environment affects individual learning performance in many ways. First, it provides a context for human development (Evan 2006). Without favorable environment, it would be very hard for any organism to live or perform optimally. Secondly, built environment facilitates (and/or hinders) human cognitive ability to process information (Maxwell 2010). This is especially true when dealing with new information. Overall, studies investigate the relationship between built environment and individual performance. However, few studies explore the underlying associative mechanisms between built environment and individual learning performance.

This study, therefore, aims to identify the underlying relationships between built environment and individual learning performance. The study most specifically aims to identify factors and mechanisms predicting if individual learning will improve or worsen within a built environment. The key assumption is built environment affects individual learning performance. Based on that assumption, the research questions are: Do built environment-related factors influence individual learning? If so, why and how is learning performance influenced by built environment? Also, is the influence of built environment on learning performance consistent for all individuals? If not, what are the causes of the differences? The study pays particular attention to possible gender and age differences.

Based on the key assumption and the research questions, the dependent variable is learning performance, while the independent variable is built environment. The following

[19] Comfort here is defined as "the state of mind that expresses satisfaction with the environment" (Nematchoua, Tchinda & Orsoa 2014)

is a brief conceptualization and definition of the dependent variables and independent variables.

Learning performance: Test scores serve as the indicator of learning performance in this study. Scholars, such as Barret et al. (2013) and Huange et al. (2011), study learning performance and productivity as outcomes of built environment. However, they do not conceptualize the terms productivity and performance. Rasmussen (1983 p. 257-260) conceptualizes human performance in relationship to artificial intelligence. The author develops the Human Performance Model. The model gives three levels of performances – skilled-based, rule-based, and knowledge-based. In this case, skilled-based performance is closely related to the concept of learning performance presented in the paper. Skilled-based performance assumes that perceptual motor system acts as a multi-factor control system coordinating the physical activity, such as navigating the body through the environment and manipulating external objects, in a time-space domain (p.260). Within the time-space domain, sensed information is perceived as time-space signals (p.260). For this research, sensed information is assumed to be the feeling of cold, hot, suffocation, etc., within the built environment, which travels to our brains through our senses. The brain synthesizes those sensory inputs and uses them as signals to guide our attention to peripheral (feeling of cold, hot, safety) or central (learning) goals.

Built Environment: As discussed in the literature review section, environment is defined in terms of living space in ecology, which is defined in terms of social, economic and natural environment in psychology. More specifically, scholars define built environment in terms of comfort, space functionality, adaptability and movement

flexibility. Kuskorpi and González (2011) define built environment in terms of space functionality, such as a dynamic space with movement flexibility, context-driven work methods, integration of modern needs and emphasis on individual and group learning (p.5). Barrett et al. (2013) and Barrett & Zhang (2012) include sensory comfort and esthetic sense with the space functionality of school buildings. They define built environment as a physical space with proper light, glare, acoustics, temperature, air quality, choice, flexibility, connection, complexity, color and texture.

Overall, previous literature demonstrates that school built environment encompasses more than 20 factors and within the 20 factors are more than 37 indicators (see Barrent et al., 2013 and Duran-Narucki, 2008). Some of the factors include thermal efficiency, illumination, ventilation, space management and distance to schools. Different themes emerge from previous literature on school built environment related factors. Themes include human comfort level, inhabitant safety within school buildings, availability of facilities, such as furniture for students, drinking water, functional toilets and school accessibility.

Scholars apply a variety of theoretical approaches to investigate the influence of school built environment on student achievement and retention. Barrett et. al. (2013) uses the Environment-Human-Performance (EHP) model, which takes a holistic approach to study the built environment where humans live and work (p. 678). The EHP model aims to discover and explain the impact of built environment on human well-being and performance (p. 678). Humans in this case are students, the specific work is study, and human well-being and performance are improved learning and academic achievement. The main assumption of the Environment-Human-Performance (EHP) model is that three

building design elements, including naturalness (light, sound, temperature, air quality), individualization (choice, flexibility, connection with the environment) and the appropriate level of stimulation, are important factors in brain functioning when synthesizing sensory inputs (Barrett et al., 2013, p.680 and 681).

Duran-Narucki (2008) develops a Building Condition Index (BCI) framework to assess if school built environment explains student achievement and attendance in inner-city schools in New York City. The BCI framework assumes that physical environment influences academic achievement and attendance and the effects are negative and stronger for children studying in poor, urban schools and children coming from families with lower socio-economic status. The author finds support for the assumption and discusses three potential reasons that might intervene to influence the relationship between school built environment and student outcomes. Reason one is if schools are in disrepair, with floor, urinals and toilets in bad condition, students aren't going to use them. Not using a toilet when needed creates discomfort and makes it hard for students to concentrate on lessons. To avoid such discomfort, students might miss school.

The second potential reason is social interaction within the school (Duran-Narucki 2008). Teachers and administrators might get frustrated with facing daily difficulties due to poor school buildings and lack of facilities, thus creating an unwelcoming environment for students to learn. The third potential reason, according to Duran-Narucki (2008) is the collective social and cultural meaning attached to school environment. If school building conditions are in disrepair, students and parents might feel they are not valued within the schools.

Filmer (2007) and Baschieri & Falkingham (2009) use economic theory of production function to examine if the increased supply of schools can reduce the price of schooling. According to Filmer (2007), the reduced price is measured through reduced distance to schools. Reduced distances help students by saving travel time and labor and increases security, hence a reduced price for consumers, in this case, students and parents. Baschieri & Falkingham (2009) assume investing in school buildings decreases the price of attending schools. The authors determine the opportunity costs of students attending schools, and the costs related to sicknesses while attending cold, damp and dirty classrooms.

When the above theories are compared for complexity, replicability and efficiency, it can be concluded the Environment-Human-Performance (EHP) model by Barrett et al. (2013) is more complex and complete than the others. It incorporates all the factors of school built environment. The EHP model also provides rigorous methods to test the influence of all the factors within the school built environment. For example, Barrett and colleagues test the indoor air quality, measure classroom temperature, test the illumination level in classrooms and measure the classroom size and student density. However, the EHP model, as comprehensive as it is, would need to be revised in terms of the specific built environment issues related to schools in Pakistan. The EHP model does not consider provisions of basic facilities, such as water supply and sanitation facilities issues often faced in Pakistan.

It completely makes sense while studying schools in developed countries, such as the UK, that provisions of facilities such as water and sanitation facilities are important part of school construction, but in developing countries the lack of provision and

maintenance of basic facilities, such as water and sanitation, are some of the many constraints faced by students in school. However, Duran-Narucki (2008)'s Building Condition Index (BCI) is not as comprehensive, compared to the EHP framework, but nevertheless considers the school built environment and basic facilities issues similar to those faced by schools in developing countries.

The models tested in this study are combinations of both the frameworks. EHP helps explain the focal relationship between the predictors and the outcome variables, while BCI helps explain underlying factors, such as the interactive relationship between built environment and gender and age in the causal relationship. For my research, the school condition index measuring the quality of school built environment encompasses seven indicators. These indicators are school age (year of establishment), classroom space, classroom seating arrangements, electricity access, boundary walls, drinking water and toilet facilities.

Rauniyar, Orbeta and Sugiyarto (2011) and Fennel (2008) show the impacts of poorly built and poorly maintained schools are negative and stronger for female students, compared to male students. Based on findings from Rauniyar, Orbeta & Sugiyarto (2011) and Fennel (2008), I test moderator hypotheses. Student gender and age are the moderators affecting the direction and/or strength of relationship between the independent variable, the quality of school built environment, and the dependent variables, student achievement and retention.

2.2 RESEARCH SIGNIFICANCE

Currently, little research exists on school built environment and its effect on student performance and learning, especially in developing countries like Pakistan. A

majority of studies from the United States and Europe primarily investigate school built environment issues from the perspective of active living and standpoint of hazardous construction material. Few studies also explore the relationship between schools built environment and student learning. The scope of this research is based on a review of current literature, which demonstrates a relationship between built environment of schools and academic achievement. This dissertation fills the research void identified through the literature review. The key gaps include:

1. A dearth of research on school built environment and its impact on learning performance. Scholars in Europe and the United States have recently engaged in assessing built environment of schools and its impact, but the initiatives are limited with regards to developing countries such as Pakistan. There is very little research that looks at the relationship between built environment of schools and student outcomes.
2. The studies on school built environment lack generalizability. Most scholars study the phenomena within a limited geographic location, such as schools within a city or municipality. Thus, the studies lack generalizability to nations such as Pakistan.

This study assesses the impact of school built environment on academic achievement in Pakistan. As one of the very few studies on the subject, it is an important initiative to explore school built environment issues and their relationship to student performance and student retention in Pakistan. Many aspects make this research stand out among current scholarly work on the subject coming from Pakistan. First, the analysis is theory driven. The research not only considers the direct focal relationship but also the underlying relationship mechanisms, such as moderating factors. Secondly, the current

available scholarly work does not conduct country-level analysis. In contrast, this study uses data from all the provinces and territories of Pakistan (except the few tribal territories with a small geographical area where a war on terror exists).

Figure 2 presents a heuristic model of the overall state of scholarship on education and the status of the current research topic within the scholarship. Overall, great advances are occurring in research on subject areas, such as social class, gender, geography and ethnicity and their relationship to access to school and vice versa. Also, studies exist on the effects of curriculum and teaching quality on student learning after students have access to schools. These relationships are presented with a solid (black) line in the model. However, few studies have been done within the areas of research presented in dashed (red) line, which show the relationship between school built environment and student outcomes. The current research falls within the dashed line.

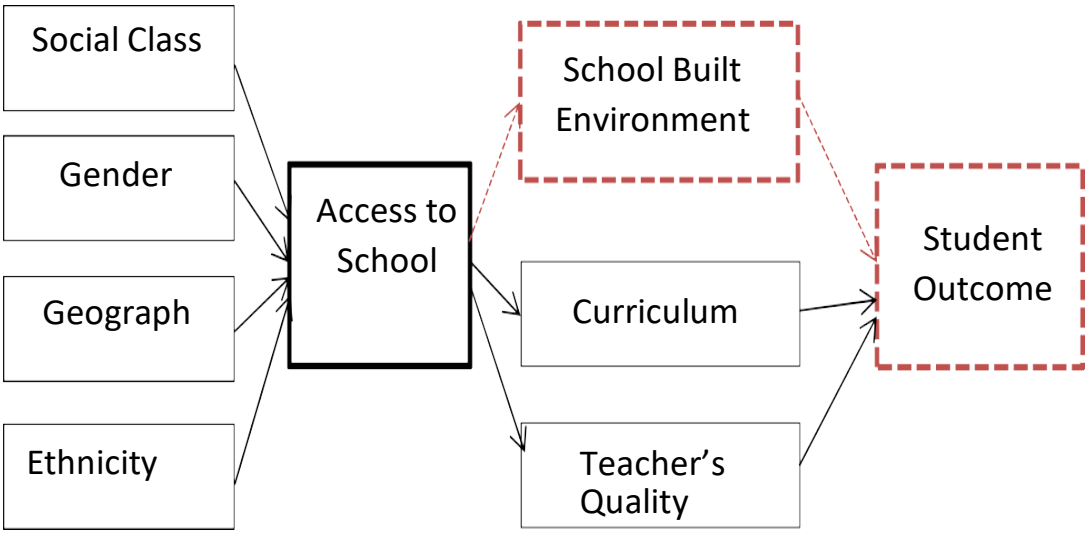

Figure 2: Heuristic Model

CHAPTER 3: DATA AND METHODS

The literature review shows that scholars have examined school built environment factors and their effects on student achievement, attendance, enrollment and retention. Studies also demonstrate a clear relationship between built environment of schools and academic achievement. However, gaps remain within the research domain, as discussed in research significance section (see chapter 2). The current study is an effort to fill the gaps in research related to school built environment in Pakistan. The following is a detailed discussion of the data and methods used in the research.

3.1 DATA AND SAMPLING

I use secondary data for the research. The data comes from Annual Status of Education Report (ASER) Pakistan. ASER has collected annual education data from all over Pakistan since 2012. I use the 2015 data. The data are about indicators related to students, parents and schools. The sample includes 286,570 students and 6,441 schools (4,621 public and 1,820 private). ASER uses two-stage sampling methods to randomly assign households (students) and schools to the sample. In the first stage, village/cities are randomly selected from a district-wide list of villages/cities, using probability proportional to size sampling methods.

In the second stage, a total of 20 households (per village/city) and two schools (one public and one private) are randomly selected from the villages. The available data provide the key constructs and variables to effectively test the research hypotheses. The student-level data comes from household surveys, while school-level data are acquired through observations of schools.

Based on my research question and hypotheses, I use a sub-sample of the dataset. I drop children age three and age four from the data because ASER does not have test data for them. I also exclude children who have dropped out of school or were never enrolled. This reduces the student data set to 196,097 observations (from 286,570). I use schools that are either for boys or girls, thus dropping co-ed schools. The sub-sample for schools is reduced to 5,621 (from 6,439).

Next, I merge the two data sets (school and student) using Stata's one to many key variable merge options. To create a unique identity number in both the data sets, I concatenated a string variable using the variables province code, district code, village code, school type (public, private) and gender (male, female). These variables are exactly matched in both the data sets. As a result, 72,843 observations merged, leaving out about 123,254 observations. Often the case with secondary data, the major issue is missing data. The missing data ranges from 0.71 percent (availability of electricity at home) to 26.07 percent (school established year). Table 1 details the percentage of missing data in the sub-sample.

Table 1: Percentage of missing data in the data sets

Variable	**Missing (%)**	**Variable**	**Missing (%)**
Owner of house	2.68	Mother's highest degree	8.33
Electricity	0.71	School established year	26.07
Television	1.68	Water	1.7
Mobile phone	1.40	Toilet	1.5
Paid tutoring	13.61	Electricity	1.95
Urdu reading and writing level	9.95	Walls	1.93
Math scores	10.58	Multi-grade	8.27
English reading & writing level	10.35	Proportion of teachers with a B.Ed. degree	12.34
No. of siblings	3.24		

3.2 CONCEPTUALIZATION AND MEASUREMENT

This section discusses the conceptualization and measurement of dependent variables, independent variable and control variables. The dependent variable is academic achievement. The key independent variables are school built environment-related factors. The control variables are type of school (1 if public 0 otherwise), school geographic location (1 if rural 0 if otherwise), state (1 if Punjab 0 otherwise), proportion of teachers with a B.Ed degree, student teacher ratio, student gender, student age, number of siblings, mother's education and family SES. The conceptual map is as given in figure 3.

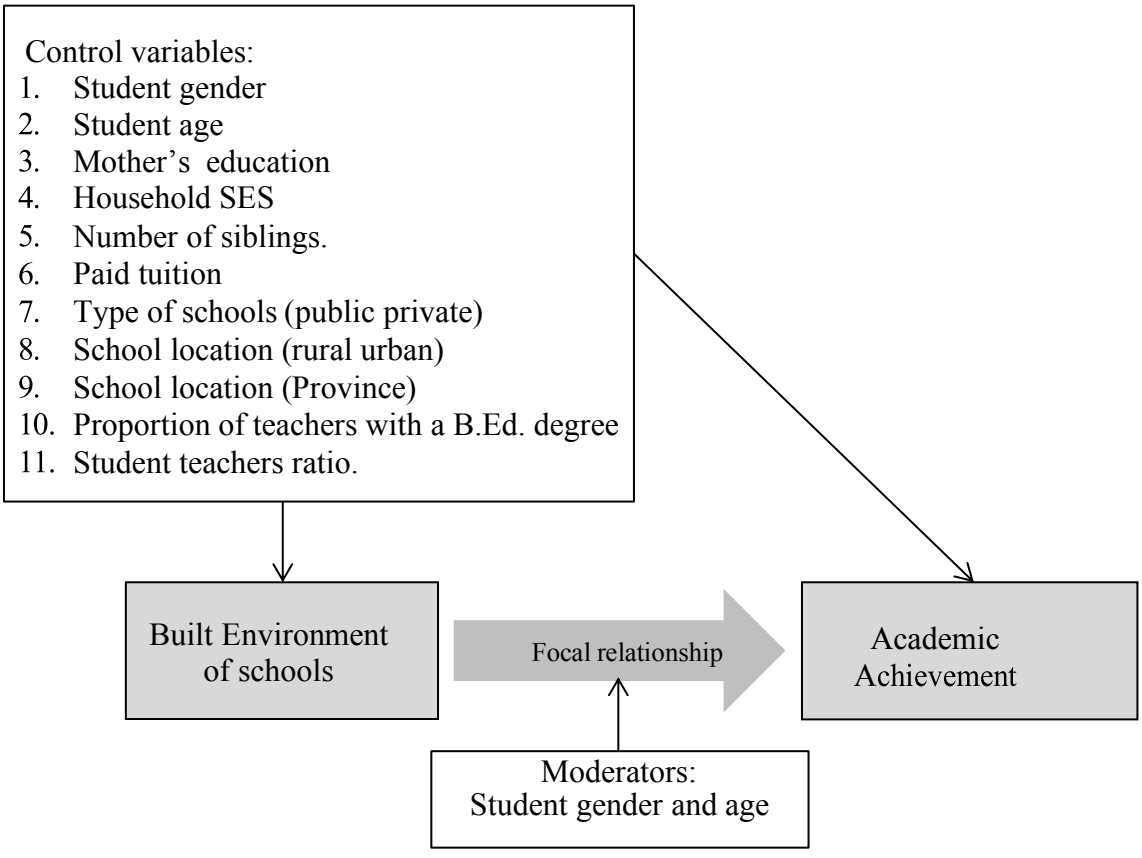

Figure 3: Conceptual map Adapted from Aneshensel (2013)

In this case, student achievement is conceptualized as student test scores attained on tests of mathematics, English reading and writing, and Urdu (or other local language) reading and writing. The test scores on math, English and Urdu are measured using standardized testing instruments related to reading, writing and mathematics skills of the sampled students. It should be noted that the ASER academic test are different than other standardized tests. ASER[20] academic tests are not based on student age or grade level but on the student's general academic achievement in the subjects tested. For reading and writing in English, Urdu and other local languages, the test levels start with simple alphabets and advance to reading and writing a story. The child is assigned a score ranging from 1 to 5. The same testing and scoring strategy is applied for the mathematic test. The test starts with recognizing and writing numbers to dividing two-digit numbers. Table 2 shows the measurement of the outcome variable.

Table 2: Measurement of outcome variables

Outcome Variables	**Measurement**
Academic Achievement	Scores – Urdu, Sindhi, or Pashto reading /writing (1-5)
	Test Scores – English reading and writing (1-5)
	Test Scores – Math (1-5)

Scholars conceptualize built environment of schools in various ways. Barrett et al. (2013) conceptualizes physical learning environment as the physical space and the quality of that living space as being comfortable and not cold, dark, dusty or with poor air quality (measured through light, sound, temperature, air quality) and space dynamic and ownership (measured by observing flexibility in rearranging the space, homey environment, such as private areas for sleep and reading).

[20] ASER website is http://www.aserpakistan.org.

Along these lines, Barrett and Zhang (2012) conceptualize physical learning environment with regard to comfort levels and functionality. Comfort level is measured through light, glare, temperature, air quality, acoustics and the impact of user's control, while functionality is operationalized through perceptions regarding flexibility, classroom size, color, facility (information technology and furniture), storage and outside environment.

Kuuskorpi and González (2011) define built environment with reference to space functionality, such as teaching space with dynamic space, flexible furniture solutions, context-driven work methods, integrated technology and emphasis on individual and group work (p.5). Duran-Narucki (2008) conceptualizes school built environment in aspects of environment and its quality. Environment, according to Duran-Narucki (2008), is an active part of the person-environment system, while the environment quality is the presence or absence of the environment, the conditions (decay and maintenance) of the environment , and quality of activities within the environment (p.278).

In Pakistan, not many scholars study the effects of built environment of schools. The few scholars (such as Lloyd, Mete and Sather, 2005; Rauniyar, Orbeta & Sugiyarto, 2011) who study school built environment effects focus on just a few of the built environment factors, such as availability of water, electricity and drinking water. For example, Lloyd et al. (2005) operationalize better physical facilities as the presence or absence of toilet facilities, electricity, drinking water and at least some chairs and desks for students (p.694). Rauniyar et al. (2011) also operationalize school built environment with reference to the presence and absence of drinking water and toilet facilities. I argue the current conceptualizations of school built environment in Pakistan are not complete

because they consider only a few (one or two) of more than 37 school built environment elements listed by Barret et al. (2013), Barrett & Zhang (2012), Kuuskorpi and González (2011), and, Duran-Narucki (2008).

I conceptualized the key independent variable – built environment of schools – based on the above literature, but more specifically on Duran-Narucki (2008)'s BCI model and Barret et al. (2013) EHP model. Previous literature conceptualizes and defines built environment of schools in terms of design, structural quality, functionality and esthetics. So, school built environment is an umbrella term encompassing more than 20 factors and more than 37 indicators. Therefore, I conceptualize school built environment in terms of school age, classroom availability and student density (multi-grade classrooms). Also, I measure the availability of built environment factors, such as drinking water, toilet facilities for students, electricity and school boundary walls. The measurements of school built environment-related variables are given in table 3.

Table 3: Measurement of School Built Environment

School Built Environment	
1	School age (school established Year)
2	Is it a multi-grade classroom (grade 2) (Yes/No)
3	Where is the class seated (classroom, Verandah, outdoors)
4	Is drinking water available? (Yes/No)
5	Are there school boundary walls? (Yes/No)
6	Is toilet facility available? (Yes/No)
7	Is electricity available? (Yes/No)

The control variables include type of school (public and private school), school location (rural or urban), mother's highest level of education, household socio-economic status (see table 4 for measurement type and levels), student gender (male and female), student age in years, and if the child is getting paid tutoring. Table 4 details the control

variables. I use house condition, ownership of house, and having electricity, mobile phone and television at home as measurements of asset index of households. Also, housing condition and ownership of durables represent the household built environment, and therefore are an intuitive control of the research.

Table 4: Measurement of Control Variables

Control variables
Student gender (male, female)
Student age (5 to 16)
Household SES: Housing condition (pucca, semi-pucca, kucha)[21] House ownership (Yes/No) Electricity (Yes/No) TV (Yes/No Mobile Phone (Yes/No)
School type (public or private)
School location (rural or urban)
State (1 if Punjab 0 otherwise)
Mother's highest education (0 to 18 years)
Paid tutoring (Yes/No)
Proportion of teachers with a B.[22] degree
Student teacher ratio

3.3 VALIDITY AND RELIABILITY

As far as the external validity of the data and the study findings are concerned, villages/cities, the primary units, are sampled with a 5 percent margin of error. The

[21] **Kucha** House which has wall / or roof made of un-burnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones, etc. **Semi Pacca**: A house that has fixed walls made up by pucca material but roof is made up of the material other than those used for pucca house. **Pucca**: House which has walls and roof made of the following: 1). Wall Material: Burnt Bricks, stones, cement concrete, timber etc.2). Roof Material: Tile, GCI (Galvanized Corrugated Iron) sheets, asbestos cement sheet, RBC (Reinforced Brick Concrete), RCC (Reinforced cement concrete) and timber etc (taken from ASER research coding manual).

[22] I used B.Ed as an indicator of teachers education and training since it is highly correlation to the proportion of teachers with masters' degree, proportion of teachers with an M.Ed, and, proportion of teachers's with a graduation (bachelor's) degree.

sample includes all districts and territories of Pakistan, so each village has the same probability of being selected. As a result, the study's findings are generalizable in the context of Pakistan. The methods used in this study are generalizable to any context because they are drawn from existing literature from developed and developing countries.

The measurement validity is high because data are collected using standardized measurement tools. The same measurement tools were used every year to collect data since 2012, so measurement tools are tested and refined. The same instruments are used in India for data collection, so there is a great deliberation in designing the tools. Moreover, enumerators are trained in using instruments and data collection is supervised. A well-documented user manual exists with each instrument. The instruments and user's manuals are both in Urdu and English.

3.4 Analysis Methods

The dissertation employs different analysis methods. Hypotheses are tested with multi-level modeling using both random intercept and fixed slope and random intercept and random slope methods. Policychoric principal component analysis (PCA) is utilized to construct composite variables for student achievement (the outcome variable) and family socio-economic status (one of the control variables). Missing values analysis is used to determine the data missing mechanisms. Additionally, multiple imputations are conducted on the data to tackle missing data issues. Following are details of the different analysis methods employed.

Polychoric PCA is used to construct composite variables of household socio-economic status using the household condition and ownership of durables. Household

condition (pucca, semi-pucca, kucha[23]) is a categorical variable. Scholars, such as Filmer and Prichett (2001), use principal component analysis (PCA) to construct asset indices. However, for categorical variables, Kolenikov and Angeles (2009) suggest using polychoric principal component analysis. According to the authors, PCA would not hold the normality assumption if used with categorical variables.

House condition, ownership of house, electricity access, mobile phone and television at home are used as measurements of asset index of the household. The asset index provides a proxy for the family socio-economic status. This is in line with Young (2012) and Johnston and Abreu, (2016), who use housing condition and ownership of durables, such as television, car and telephone variables, to construct household well-being index.

Similarly, I use a composite variable for the outcome variable, student achievement, using test scores on math, English and Urdu since the scores are highly correlated (0.9 $p<0.001$). Other data reduction methods, such as factor analysis, principal component analysis and average score methods, also are used to develop the composite outcome variable. The different scores are compared with the polychoric PCA composite scores using two-way scatter plot. The results show the different scores merge well with the polychoric PCA composite scores. The analysis results do not differ much, no matter which method is used to develop the outcome composite variable.

The study follows scholars, such as Rubin (1976), to handle missing data issues. Rubin (1976) gives three missing data mechanisms. One is not missing at random (NMAR). It is the case of NMAR when the probability of a value missing, rather than

[23]See footnote 24 for term explanations.

observed, depends on both observed and missing values (Von Hippel, 2012, p.160). The second category of missing data mechanism is missing at random (MAR). MAR is the case when the missing variables depend on the observed value, not on the missing value (Hippel, 2012, p.160). The third category of missing data mechanism is missing completely at random (MCAR). MCAR is the case when the missing variables neither depend on the missing values, nor on the observed values (Hippel, 2012, p.160).

Multiple Imputations (MI) are the widely recommended mechanisms for dealing with missing data (Lüdtke, Robitzsch, & Grund, 2017; Rubin, 1976). MI can be used when the data missing mechanism is MAR. Little's MCAR test helps in determining if multiple imputations are the required methods to handle missing data mechanism. Little's MCAR tests the hypothesis that the values are MCAR (Hippel, 2012, p.160). I ran the missing value analysis technique in SPSS to test Littles MCAR test on the sample. The test result shows that Little's MCAR hypothesis is rejected($\chi^2 = 1887.969, DF = 28, P < 0.01$). Hence it is concluded that the data missing mechanism is MAR by design. Therefore, I use multiple imputations with 30 imputations in STATA.

To test if there is a hierarchical structure in the data, I calculate the intraclass correlation (ICC). Following Anguinis et al., (2013) for notations, the ICC coefficient is:

$$p = \tau_{00}/[\tau_{00} + \sigma^2]$$

Where τ_{00} is the intercept variance at the school-level and σ^2 is the within-group variance in the null model. In this case, the ICC is 0.247. It means the differences across schools account for 24.7 percent of the variability in academic achievement of students. Hence, the data is nested in structure and requires multi-level modeling for analysis. Not considering hierarchical structure of the data in the analysis can result in conceptual

fallacy or ecological fallacy[24] and unreliable estimates, resulting in misguided educational policies and programs (Raudenbush & Bryk, 2002; Wang & Bird, 2015, p.72).

Therefore, I use multi-level analysis with random intercept and fixed and random intercept and random slope model to test the hypothesis. Again, following Anguinis et al. (2013) for notations, the equation (1) for the basic model is as given.

$$Y_{ij} = \gamma_{00} + \gamma_{01}(W_j) + \gamma_{10}(X_{ij}) + \mu_{0j} + \mu_{1j}(X_{ij}) + r_{ij} \quad (1)$$

Where Y_{ij} is student achievement for the i^{th} student in school j. X_{ij} represents the student-level predictors for the i^{th} student in school j. r_{ij} is the student level residual term. γ_{00} is the intercept and γ_{01} is the coefficient for school level predictors. W_j represents the school-level predictors for the j^{th} school. μ_{0j} is school-level residual terms. γ_{10} slope for student-level predictors and μ_{1j} is the residual terms.

The predictors are scaled using group mean centering for meaningful interpretation (Raudenbush & Bryk, 2002; Hox & Roberts, 2011[25]). The model with group mean centering is as presented in equation 2.

$$Y_{ij} = \gamma_{00} + \gamma_{01}(W_j - \bar{W}) + \gamma_{10}(X_{ij} - \bar{X}_j) + \mu_{0j} + \mu_{1j}(X_{ij} - \bar{X}_j) + r_{ij} \quad (2)$$

Where Y_{ij} is student achievement for the i^{th} student in school j. X_{ij} represents the student level predictors for the i^{th} student in school j and is centered by the respective j^{th} school average $\bar{X}_j$. r_{ij} is the student-level residual term. γ_{00} is school-level group intercept and γ_{01} is the coefficient for the school-level predictors. W_j represents the

[24] A correlation between the group level variable cannot be used to make assertions about the individual level relations.

[25] Centering also helps in reintroducing mean in the HLM such that the mean of a variable can be used as a level 2 predictor (Hox & Roberst, 2011).

school-level predictors for the j^{th} school and $\overline{W}$ is the average across all schools. μ_{0j} is school-level residual terms. γ_{10} is the school-level group mean slope and μ_{1j} is the residual term.

The interaction model tests if student gender and age moderate the relationship between the school built environment factors and student academic achievement. The interaction model is as given in equation 3

$$Y_{ij} = \gamma_{00} + \gamma_{01}(W_j - \overline{W}) + \gamma_{10}(X_{ij} - \bar{X}_j) + \gamma_{11}(W_j - \overline{W})(X_{ij} - \bar{X}_j) + \gamma_{12}(X_{ij} - \bar{X}_j)(X_{ij} - \bar{X}_j) + \mu_{0j} + \mu_{1j}(X_{ij} - \bar{X}_j) + r_{ij} \quad (3)$$

where Y_{ij} is student achievement for the i^{th} student in school j. X_{ij} represents the student level predictors for the ith student in school j and is centered by the respective j^{th} school average $\bar{X}_j$. r_{ij} is the student-level residual term. γ_{00} is school-level group intercept and γ_{01} is the coefficient for the school-level predictors. W_j represents the school-level predictors for the j^{th} school and $\overline{W}$ is the average across all schools. μ_{0j} is school level residual terms. γ_{10} is the school-level group mean slope and μ_{1j} is the residual terms. γ_{11} is the coefficient for the cross-level multiplicative term. It shows that change in the slope of the respective built environment factor on academic achievement when the average age of student increases by 1 point. γ_{12} is the coefficient for the direct level multiplicative term. It shows that change in the slope of the respective built environment factor on academic achievement if the student is female.

CHAPTER 4: FINDINGS

The research inquires if school built environment-related factors, including water, toilet, electricity and boundary walls, affect academic achievement of Pakistani students in grades 1 to 10. Based on the research question four, hypotheses are tested using multi-level models. The first hypothesis is school built environment affects student achievement among Pakistani students in grades 1 to 10. The second hypothesis is the effects of school built environment on academic achievement vary depending upon number of siblings, students getting paid tutoring, school type, school location and socio-economic status of the student's family. The third hypothesis is the impact of school built environment on academic achievement is conditioned by student gender, such that female students are more vulnerable to the effects of variations in school built environments. The fourth and last hypothesis is the impact of school built environment on academic achievement is conditioned by student age, such that older students are more susceptible to the effects of variations in school built environments

Owing to availability of data, seven built environment-related factors could be tested in this case. The seven built environment factors include availability of water and sanitation facilities in schools, the presence (or absence) of school boundary walls, school established year, a multi-grade classroom and student seating arrangements (if students are seating in classrooms, outdoors or in school verandas).

The student-level covariates include student gender, student age, mother's education, number of siblings, paid tutoring and family socio-economic status. The school-level control variables are type of schools (public/private) and geographic location

of schools. Table 5 gives summary statistics of variables, whereas table 8 in Appendix 1 gives the description of variables in the model.

Table 5: Descriptive summary of variables

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Student achievement	64,092	-0.2279	1.49438	-2.9214	1.66883
Water	71,594	0.69936	0.45854	0	1
Toilet	71,714	0.64024	0.47993	0	1
Electricity	71,423	0.70243	0.45719	0	1
Student seating arrangement	72,843	1.28507	0.58768	1	3
Multi-grade classrooms	72,843	0.78572	0.41033	0	1
Boundary walls	71,435	0.71878	0.4496	0	1
School established year	53,854	1991.79	14.5303	1900	2015
Gender	72,843	0.34432	0.47515	0	1
Paid tutoring	62,926	0.14036	0.34736	0	1
Number of siblings	70,483	3.78494	1.5382	0	10
Mother's education	66,775	2.89108	4.45775	0	18
Public or Private School	72,843	0.72799	0.445	0	1
Geographic location (rural)	72,843	0.912401	0.282713	0	1
Family SES	69,502	-0.0421	1.03483	-3.1125	0.87462
State	72,843	0.236454	0.424907	0	1
Student teacher ratio	72,843	33.07402	26.17559	0.6153846	477
Percentage of teachers with B.Ed. degree	63,857	30.78101	27.10281	0	100

4.1 FINDINGS

Multi-level regression with random intercept and fixed slope, and random intercept and random slope model is used to estimate the model. The random intercept and fixed slope is used to estimate the school-level direct relationship, while random

intercept and random slope model is used to estimate the student and school-level relationship. The research investigates the effects of the school built environment-related factors separately, so as to determine their unique effects on academic achievement.

Model 1 in table 6 illustrates the estimates of the random intercept and fixed slope model, which tests the effects of the school built environment-related variables without the non-structural control variables. All the estimates are statistically significant at the 0.05 or lower levels, except for school established year, which is statistically significant at the 0.10 level. School boundary wall is not statistically significant. The results in the model suggest that availability of water in schools increases student achievement, on average, by 0.23 points. The model also demonstrates that availability of toilet facilities leads, on average, to 0.25 additional points in academic achievement.

Furthermore, electricity access in schools increases, on average, student achievement by 0.18 points. Student achievement decreases, on average, by 0.20 points if students sit in multi-grade classrooms. Along the same lines, students sitting in classrooms perform better, compared to students sitting in the school veranda or outdoors, since student achievement increases, on average, by 0.09 points. Two models (see model 6 in table 9 and model 8 in table 10 in Appendix 1), similar to model 2, are estimated separately for female and male students. The results are similar to model 1. However, student seating arrangement is not significant for female students. The effect sizes of water supply, toilet facility, and multi-grade classrooms are larger for female students, while the effects of electricity access on student achievement is larger for male students.

Model 2 (in table 6) estimates the effect of built environment-related factors after controlling for school-level characteristics, such as school location (rural/urban), state, proportion of teachers with a B.Ed degree, student-teacher ratio and school type (public/private). All the built environment related variables are statistically significant at 0.05 or lower levels, except for school boundary walls and school established year. The effects size and effects direction of the built environment-related variables on achievement are almost the same as in the base case (model 1), and therefore are not reported here. School type, school location and proportion of teachers with B.Ed degrees are statistically significant at the 0.001 level. State is statistically significant at 0.10 level, while student-teacher ratio is not statistically significant.

The results demonstrate that all being equal, student attending a public (government) school have, on average, 0.18 points less academic scores as compared to students who attend a private school. Similarly, attending schools in rural areas is associated with lower average achievements of 0.16 points. On the other hand, students attending schools in the Punjab province have, on average, higher scores of 0.05 points, compared to students who attend schools in other provinces. Additionally, the higher the proportion of teachers with a B.Ed degree in the school, the higher are average academic achievement. Student-teacher ratio is not a statistically significant predictor of student achievement in model 2.

Model 3 in table 6 estimates the effects of school built environment-related factors after controlling for school characteristics and student- level variables. The student-level covariates include student gender, student age, student family socio-economic status, mother's education, number of siblings and paid tutoring. In this model,

three of the school built environmental-related variables, including available water, toilet facility and multi-grade classrooms, are statistically significant at the 0.001 level. The results show that availability of water in schools is associated with an average increase of 0.10 points in student achievement.

Additionally, student achievement increases, on average, by 0.10 points if there are toilet facilities in schools. The findings also suggest that when students get lessons in multi-grade classrooms, student achievement decreases, on average, by 0.11 point. Electricity access, boundary walls, student seating arrangement and school established year are not statistically significant in model 3.

A student attending a public (government) school has lower average achievement of 0.13 points, compared to a student who attends private school. Furthermore, a student who attends a rural school has higher average achievement of 0.09 points, compared to a student who attends school in an urban area. This finding contradicts the finding in model 2, where rural schools have negative effects on student achievement. This means that student-level characteristics, such as student age, student gender, family SES and mother's education, make up for the negative effects of school location.

At the school level and student level, all the covariates are statistically significant at the 0.05 level or lower. However, student gender is statistically significant at the 0.10 level. Female students have 0.04 points higher average scores, compared to male students. Student age has a positive effect on achievement. At the student level, results demonstrate that a one-year increase in student age is associated with 0.28 points increase in student achievement. At the school level, a one-year increase in student age is associated with 0.26 points increase in average academic achievement.

Student getting paid tutoring (after-school tuition) has positive effects on student achievement as well. At the student level, student achievement increases by 0.25 points if the student is getting paid tutoring. At the school level, paid tutoring increases average student achievement by 0.07 points. Number of siblings has a positive effect on student achievement at the student level, such that an additional number of siblings is associated with an increase of 0.012 points in academic achievement. However, at the school level an additional number of siblings is associated with a decrease of 0.07 points in average student achievement.

Mother's education has a positive and statistically significant ($P<0.01$) effect on student achievement. At the student level, a one-year increase in mother's education is associated with 0.003 points increase in achievement. At the school level, a one-year increase in mother's education is associated with an average increase of 0.04 points in achievement. Student family socio-economic status also has a positive effect on student achievement. At the student level, a point increases in socio-economic status of student family is associated with 0.07 points increase in achievement. Similarly, at the school level, a point increase in family SES is associated with an average increase of 0.09 points in achievement. Two similar models are estimated separately for female student and male students. The results are as given in table 8 and 9 in Appendix 1.

Model 4 in table 7 includes interaction terms between gender (1 if female) and the dichotomous built environment related variables, including running water, toilet facilities, electricity access, multi-grade classrooms, seating arrangement and boundary walls. The gender interactive terms are statistically significant at the 0.05 or lower levels, except for the interaction between gender and walls, and gender and school established year. Thus,

the results provide evidence in support of the tested interaction effects, such that the relationship between available water and achievement becomes stronger by 0.17 points if the student is female. The same effects can be observed for the interaction between having toilet facilities in schools and student gender. Female students attending a school with toilet facilities have, on average, 0.14 points higher scores.

In contrast, results show a negative interaction effect occurs between electricity access in schools and student gender (1 if female). Therefore, the relationship between electricity access and average student achievement is weaker by 15 points if the student is female. Similarly, female students who take their lessons in multi-grade classrooms score, on average, 0.08 points less. Additionally, results suggest there is negative interaction between students getting their lessons in classrooms and student gender. Female students who get lessons in classrooms (instead of school veranda or outdoors) have, on average, 0.11 points lower academic achievement. The effect size and direct of the effects of the covariates in the models are almost similar to model 3, therefore, are not reported here.

Model 5 in table 7 estimates the effects of the interaction between student age and the built environment-related variables, including water supply, sanitation facility, electricity access and boundary walls, on student achievement. The effects of the interaction between the student age and having toilet facilities at schools is statistically significant at 0.05 levels. Therefore, as student age increases, the effects of having toilet facilities in schools on student achievement increase, on average, by 0.04 point. The age interaction with other school built environment factors is not statistically significant. The

age and school established year interaction is significant at the 0.01 levels however the effect size is zero.

Table 6: Slopes and standard errors from multilevel modeling predicting student achievement

Student achievement	Base case 1	School characteristics 2	Full model 3
Student Level			
Student age			0.279***(0.002)
Paid tutoring			0.245***(0.020)
No. of siblings			0.012***(0.004)
Mother's education			0.003***(0.002)
Student family SES			0.071***(0.009)
School Level			
Water supply	0.234***(0.032)	0.205***(0.032)	0.104***(0.027)
Boundary walls	-0.038 (0.029)	-0.040 (0.029)	-0.013 (0.025)
Toilet facility	0.245***(0.032)	0.180***(0.033)	0.100***(0.028)
Electricity access	0.182***(0.030)	0.161***(0.029)	0.028 (0.024)
Multi-grade class	-0.197***(0.025)	-0.178***(0.025)	-0.109***(0.018)
Seating arrangement	0.086***(0.028)	0.055** (0.028)	0.000 (0.023)
School established year	0.001* (0.001)	0.000 (0.001)	-0.001 (0.001)
School type (public)		-0.160***(0.031)	-0.143***(0.029)
Location (state)		0.049* (0.027)	0.079***(0.024)
Location (rural)		-0.173***(0.039)	0.077***(0.033)
Teacher with B.Ed.		0.002***(0.000)	0.001***(0.000)
Student teacher ratio		-0.001 (0.000)	0.000 (0.000)
Student gender			0.037* (0.021)
Student age			0.261***(0.006)
Paid tutoring			0.067* (0.037)
No. of siblings			-0.066***(0.010)
Mother's education			0.044***(0.003)
Student family SES			0.094***(0.014)
Intercept	-0.243*** (0.011)	-0.249***(0.011)	-0.238***(0.009)
Variance Components			
Student age			0.113**(0.003)
Paid tutoring			0.340**(0.035)

No. of siblings			0.093**(0.006)
Mother's education			0.025**(0.003)
Family SES			0.166**(0.014)
Intercept /stand deviation	0.683**(0.009)	0.673**(0.009)	0.551**(0.007)
Within - school (Level 1) standard deviation	1.298**(0.004)	1.299**(0.004)	0.942**(0.004)
Note: *p<0.1, **p<0.05, ***p<0.01. Values in the parenthesis are standard errors N=72,843			

Table 7: Slopes and standard errors from multi-level modeling predicting student achievement with gender and age interaction

Student achievement	Gender interaction 4	Aga Interaction 5
Student Level		
Student age	0.279***(0.002)	0.279***(0.002)
Paid tutoring	0.245***(0.020)	0.245***(0.020)
No. of siblings	0.012***(0.004)	0.012***(0.004)
Mother's education	0.003**(0.002)	0.003** (0.002)
Student family SES	0.071***(0.009)	0.071***(0.009)
School Level		
Water supply	0.094***(0.027)	0.102***(0.027)
Boundary walls	-0.021 (0.025)	-0.016 (0.025)
Toilet facility	0.081***(0.029)	0.102***(0.028)
Electricity access	0.035 (0.024)	0.031 (0.024)
Multi-grade class	-0.108***(0.018)	-0.106***(0.019)
Seating arrangement	0.020 (0.024)	-0.002 (0.023)
School established year	-0.001 (0.001)	-0.001 (0.001)
School type (public)	-0.160***(0.029	-0.147***(0.029)
Location (state)	0.085***(0.024)	0.078***(0.024)
Location (rural)	0.074**(0.033)	0.077** (0.033)
Teacher with B.Ed.	0.001***(0.000)	0.001***(0.000)
Student teacher ratio	0.000 (0.000)	0.000 (0.000)
Student gender	0.031 (0.021)	0.038* (0.021)
Student age	0.261***(0.006)	0.262***(0.006)
Paid tutoring	0.067* (0.037	0.067* (0.037)
No. of siblings	-0.061***(0.010)	-0.067***(0.010)

Mother's education	0.044***(0.003)	0.044***(0.003)
Student family SES	0.093***(0.014)	0.093***(0.014)
Gender*water	0.166***(0.054)	
Gender* toilet	0.132***(0.052)	
Gender* walls	-0.003 (0.051)	
Gender*electricity	-0.182***(0.048)	
Gender*multi-grade	-0.083**(0.039)	
Gender*seating	-0.108***(0.045)	
Gender*school age	-0.001 (0.001)	
Age*water		-0.019 (0.016)
Age*walls		-0.023 (0.015)
Age*toilet		0.039** (0.017)
Age*electricity		0.000 (0.015)
Age*multi-grade		0.011 (0.012)
Age*seating		-0.023* (0.014)
Age*school age		0.000***(0.000)
Intercept	-0.239***(0.010)	-0.236***(0.010)
Variance Components		
Student age	0.113**(0.003)	0.113**(0.003)
Paid tutoring	0.340**(0.035)	0.340**(0.035)
No. of siblings	0.093**(0.006)	0.093**(0.006)
Mother's education	0.025**(0.003)	0.025**(0.003)
Family SES	0.166**(0.014)	0.166**(0.014)
Intercept/stand deviation	0.546**(0.007)	0.550**(0.007)
Within - school (Level 1) standard deviation	0.942**(0.004)	0.942**(0.004)
Note: *p<0.1, **p<0.05, ***p<0.01. Values in the parenthesis are standard errors. N=72,843		

CHAPTER 5: DISCUSSIONS

This study investigates if school built environment factors, such as student seating arrangements, school established year, multi-grade classrooms, and the availability of water supply, sanitation facility, boundary walls and electricity, affect student achievement. The study also explores if the effects of school built environment on student achievement are conditioned by gender and age. Using multi-level modeling, the study brings out important insight on the subject. The following is a detailed discussion of the findings regarding the significance of various built environment factors, the model frameworks, theory, methods and overall limitations of the study.

5.1 WATER

As reported in chapter 4, the study finds evidence that availability of water supply in schools improves student achievement. The findings also indicate the effects of having water in schools on achievement are higher for female students. These findings are consistent with reports of international organizations, such as World Bank and United Nations Children's Fund (UNICEF). For example, UNICEF (2004) finds availability of water and sanitation facilities in schools increases student attendance by 12 percent in Tanzania. Similarly, Alexander et al. (2014) find that water, sanitation and hygiene facilities in schools reduce absenteeism among students in Kenya. The authors demonstrate that not having WASH facilities in schools can result in lack of attention in classrooms, reduced attendance and increased dropout rates and can create a lack of confidence among female students.

So, why is it the case? To understand this question, we need to explore the underlying mechanisms that explain the relationship between access to running water in

schools and student achievement. The U.S. Centers for Disease Control and Prevention (CDC)[26] recommends daily intake of enough drinking water for health. CDC also concludes that if enough water is not consumed, dehydration may occur. Dehydration then leads to many health issues, including unclear thinking, change in mood and body-overheating (Fanz, 2007). All these health issues can affect student learning and, ultimately, their achievement.

Students spend at least six hours daily in schools in Pakistan. If there is no water in schools, as is the case with at least 30 percent of schools, it's not clear if they have alternative water sources. The issue needs further investigation. One speculation is students bring water bottles. In this case, the majority of students come from rural areas, where parents could not afford pencils and notebooks for their children. Therefore, parents might not be able to afford to buy water bottles for them either.

Water also is needed for handwashing in schools. Studies (Talaat et al., 2011; Freeman et al., 2012) show that mechanisms to promote handwashing practices in schools can reduce absenteeism due to diseases, such as diarrhea and influenza, especially among female students. Again, with 30 percent of schools not having access to running water, students would not be able to wash their hands. Hence, having water at school can reduce absenteeism and increase student achievement.

Having water supply in schools also is needed to keep toilet facilities operational. The data show that 24 percent of schools have neither water supplies nor toilet facilities, 7 percent of schools have toilet facilities but not water supplies, and 12 percent of schools do not have toilet facilities but have water supplies. This shows that about 42 percent of

[26] https://www.cdc.gov/nutrition/data-statistics/plain-water-the-healthier-choice.html

schools do not have toilet facilities at all or if there is toilet facility, it might not be operational due to non-availability of water. Next section (Toilet Facility), discusses the importance of having toilet facilities in schools.

All that said, it is important to note that when the complete model (model 3 in table 6) is estimated separately for male students (school for boys), the relationship between availability of water and student achievement is not statistically significant (see model 11 in table 10 in Appendix 1). In the absence of any study, it is hard to make any suppositions for the underlying factors behind the phenomenon. However, looking at the south Asian context of male-dominant society, especially in Pakistan, mobility for boys is easier (not necessarily safer). This means it is easier for boys to get out of school and get water. Hence, not having water in schools does not matter much for boys, compared to girls.

In view of the above discussion, access to running water in schools is a very important factor in improving student achievement.

5.2 SANITATION

The study provides evidence that the presence of toilet facilities in schools helps increase student achievement. The relationship between toilet facilities in schools and student achievement becomes stronger if students are female. The findings reassert the importance of having toilet facilities for educational outcomes. The findings also are in line with the reports of other scholars. For example, Duran-Narucki (2008) and Raunyar et at. (2011) show that school sanitation improves student achievement, lowers dropout rates and increases enrollment. In the case of Pakistan, Hayat (2017) shows sanitation facilities in schools increase student enrollment.

However, the findings contradict Adukia (2017). Similar to this study, Audkia (2017) uses ASER India data to investigate the effects of school latrines on student test scores. Adukia (2017) finds that school latrine availability does not increase student test scores. The author finds, though, that school participation increases if toilet facilities exist in schools.

Many reasons are evident that show the availability of toilets has a positive effect on student achievements. One reason is privacy, especially for pubescent-age girls (Adukia, 2017, p.25). Having toilets in schools can help girls better manage their menstrual hygiene (Birdthistle, 2011). This is very important in the case of Pakistan, where even talking about menstrual periods is a taboo. Parents might not let girls go to school if there are no toilet facilities or girls may miss schools during their menstrual periods.

A second reason is safety. Not having toilet facilities in schools can force students to practice open defecation. To find a safe open space outside the school for defecation can be hard. Female students might face the potential of rape while defecating in the open. A third reason is health. Open defecation is a cause of major contamination. Waste contamination can be avoided if toilets are used. Additionally, student health can be compromised if the student has to wait longer for urination and defecation, due to not having toilets.

Based on the above discussion it is very important toilet facilities are available in schools.

5.3 STUDENT SEATING ARRANGEMENTS

Multi-grade classrooms have statistically significant and negative effects on student achievements across-the-board. That is true for all students, irrespective of their gender. Students sitting in multi-grade classrooms have lower academic achievements, compared to students who sit in monograde classrooms. This is an important finding because students do not have enough space to sit in Pakistani schools. The descriptive analysis of ASER data show that students have seats in multi-grade classrooms in 37 percent of schools. Female students have seats in multi-grade classrooms in 35 percent of schools, while male students are in multi-grade classrooms in 41 percent of schools. In public schools, 42 percent of students study in multi-grade classrooms, but about 26 percent students of private school students study in multi-grade schools.

The findings of the research are not astonishing when we study education policies of Pakistan in the last seven decades. The 7th education policy for the year 1988 to 1993 identifies that 29,000 primary schools are without buildings, while 16,000 primary schools have just one classroom. In the 7th education policy, the number of classrooms is planned to change from one to two. The national education policy paper of 2009 (the last publicly available policy paper) also indicates primary schools consist of two classroom buildings.

A greater policy implication exists for policymakers in the public and the private sectors. Policymakers from organizations, such as the USAID, World Bank and UNICEF, fund communities to build schools in Pakistan. The organizations must consider quality, not just the number of school buildings. Adukia (2017) reports that schools built by the World Bank do not have toilets in some instances.

Studies that investigate the effects of multi-grade classrooms on cognitive and non-cognitive skills are limited and dated. Studies also have mixed findings. Consistent with this study, Rawley (2006) finds that students in multi-grade classrooms have lower academic achievement, compared to students in monograde classroom. The author investigates the effects of multi-grade classrooms on student achievements by surveying teachers in Pakistan. Mariano and Kirby (2009) find significant, negative, but small effects of multi-grade classrooms on student achievement in the Los Angeles unified school district. In contrast, Lincoln (1981) finds evidence to support that multi-grade classrooms increase student achievement. Lincoln (1981) recommends multi-grade classrooms for effective learning.

Another variable related to pupil density within built environment of schools is student seating arrangements. The findings suggest that student seating arrangement is a significant predictor of student achievement when the estimates are modeled with just school built environment and school level covariates. However, student seating arrangement is not a significant predictor of student achievement when the effects are estimated with student level covariates.

This raises the question of why no differences exist between achievements of students who have lessons in classrooms from those who have lessons outdoors and in school verandas. One possible reason is that classrooms lack access to electricity. In summers, it would be very difficult to sit in hot classrooms without fans. So, students might prefer to sit in school verandas or outdoors. Secondly, if classrooms are multi-grade, they are congested and crowded, making it hard for students to learn in the

classrooms. Therefore, students would learn best or at least not the worst in school verandas or outdoors.

5.4 ELECTRICITY ACCESS

For electricity access in schools, the findings in model 1 and 2 suggest that electricity access in schools has positive and statistically significant effects on student achievement. However, when other student level covariates are included, the effect of electricity access on achievement is not statistically significant anymore. But the model estimated using data just for male students suggests that having electricity in schools has positive and statistically significant ($\propto = 0.01$) effect on achievement of male students (see model 11 in table 10 in Appendix 1).

Therefore, it is important policymakers ensure the provision of a continuous supply of electricity in schools. This is especially important when Pakistan faces an all-time hike in power cuts for rural as well as urban areas. A power outage occurs for five to six hours a day in urban areas and more than eight hours a day in rural areas (Dunya, 2017). The temperatures in Pakistan are extreme, both in summers and winters, especially in southern Pakistan where majority of the population lives. In the south, the temperature reaches up to 45^{o} C (113^{o} F) in summers. Electric ceiling fans are the only source of cooling in classrooms. Therefore, if there is no electricity supply in schools, classrooms can be unbearably hot.

Electricity is not only needed to keep classrooms cool and illuminated. It also is needed so children can use computers and learn in labs. It is so sad that schools do not have access to electricity in this age of technology. Around the globe, especially in developed countries, daily pedagogy is shifting to chrome books and computers, while

Pakistani schools are struggling with access to electricity. Under these circumstances, what kind of future workforce does the country envisage to produce?

5.5 SCHOOL BOUNDARY WALLS AND SCHOOL ESTABLISHED YEAR

School established year and boundary walls are not significant predictors of student achievement in this study. For school boundary walls, the expectation was that it would be a significant predictor of achievements especially among female students. Contrary to the study findings, scholars such as Fennell (2008) report the importance of having school boundary walls for female students' educational outcomes, particularly in Pakistan. Some plausible reasons for this finding are that boundary walls affect student enrollment, not necessarily student achievement. Absenteeism and enrollment have been used as a proxy for educational outcome by many scholars. Therefore, once female students are enrolled in schools, having or not having school boundary walls would not matter much.

5.6 FRAMEWORKS, METHODS AND THEORY

The two frameworks that guide the modeling of the study are Barrett et al. (2013)'s Environment-Human-Performance (EHP) and Duran-Narucki (2008)'s Building Condition Index (BCI). The EHP model pilots the direct relationship between the school built environment and student achievement, while the BCI guides the underlying mechanisms, such as student age and gender, that moderate the relationship between school built environment and student achievement. The study findings are in line with both the frameworks for built environment factors, such as running water, toilet facility, electricity access and multi-grade classrooms. Nonetheless, the findings contradict the frameworks for factors, including school established year and school boundary walls.

As far as the employed methods are concerned, the multi-level regression model helps in controlling for school and student level contextual factors. It also helps in determining the unexplained variation in the intercept and coefficients. For example, based on the variance of the intercept, student achievement ranges from -1.31 to 0.847 points in 95 percent of schools. The same trend can be observed for student age, paid tutoring, family SES and mother's education. Based on the coefficient of student age, student achievement ranges from 0.06 to 0.50 in 95 percent of the schools. These variances are in addition to the variation explained by the school and student level variables in the model. Possible reasons for the heterogeneity could be not controlling for important factors, such as teacher gender.

Overall, the findings provide evidence in support of the theory of the individual learning model. The individual learning model holds that individuals are goal-oriented and aim for utility maximization. However, psychological and contextual factors can condition utility maximization and optimality. School built environment is one such factor. The study findings suggest that school built environment factors, including availability of water, presence of toilet facility and electricity, have significant positive effects on student achievement. The effects of water availability and toilet access are stronger for female students, while the effects of electricity access are stronger for male students. Multi-grade classrooms have significant and negative effects on student achievement. The reduction in achievement due to sitting in multi-grade classrooms is higher for female students, compared to male students. Therefore, it is important that policymakers consider school built environment in education policies and yearly plans.

5.7 LIMITATION

Any study, such as this one using secondary data collected in a nation with poor infrastructure, prevailing poverty, frequent manmade and natural disasters and lack of access to all its territories, suffers from some limitations. Some limitations relate to the data, sample size and operationalization of the key constructs.

ASER sampling is based on the 95 percent error margins and changes in different variables. However, the sampling does not consider that contextual variations, such as the distribution of rural and urban population based on the government data. ASER considers the actual condition and characteristics of school locations. For example, the Federal Bureau of Statistics reports that 37 percent of the population lives in urban areas, however, just 7 percent of schools are considered to be located in urban areas. The rest of the school locations are considered rural, even though some are located in urban slums.

Additionally, the school and household (student) level data are part of one survey, but there is no variable that can connect the two data sets at the individual level. In its 2012 survey, ASPER includes a variable that connects students to the schools they attend. However, in later yearly surveys, this variable is dropped. Hence, there is no built-in connection between the two data sets at the individual level. So, the data are merged based on the assumption the surveyed school represents all schools in the village. Not having a key identical variable on the individual level in both data sets makes matching difficult. It also results in dropping many observations, thus reducing the study sample size.

Despite these possible limitations, the study makes valuable contributions because it is the first attempt to investigate how school built environment related factors, such as

running water, toilet facility, electricity access, school boundary walls, multi-grade classrooms and student seating arrangements, effect student achievement with appropriate data and analytic strategies. Future research needs to be done to replicate and extend the study.

5.8 FUTURE RESEARCH

This study employs multi-level analysis with two levels, including student and school. Future studies should incorporate the classroom level in multi-level analysis to determine the effects of micro-systems not only at student and school levels, but also at the classroom level (Maxwell, 2016). Adding the classroom level in the multi-level model will help produce a more in-depth and holistic picture of social and physical conditions that combine to impact student achievement.

Due to unavailability of data, this study could not control for teachers' gender, a school-level characteristic, while studying the gender specific effects of school built environment. Future research should consider controlling for teacher gender. Future studies also can explore how school built environment affects school attendance, school retention and school participation.

CHAPTER 6: POLICY IMPLICATIONS AND CONCLUSIONS

6.1 POLICY IMPLICATIONS

The United Nation's universal primary education of the 2015 Millennium Development Goals (MDG) and the post 2015 MDG of education for all provide the policy context the study. The study highlights the importance of having conducive school infrastructure and built environment for student learning. The findings show that built environment of schools affect student achievement. The findings have greater policy implications, in general, for overall education in Pakistan and for policy decisions, in particular, regarding quality of school built environment. The following are the key policy implications, related policy recommendations and the envisaged benefits of implementing the recommendations for students and their communities.

Policy Implication 1: The first policy implication is that provisions of water supply, sanitation facility, electricity access and proper seating arrangements for students in schools do affect student achievements. Students benefit when they study in quality built schools that have regular provisions of amenities. However, great disparities are apparent in provisions among schools in Pakistan. For example, 30 percent of schools do not have running water. About the same percentage of schools do not have electricity access. A total of 36 percent of schools do not have toilets. In 42 percent of schools, students sit in multi-grade classrooms, while 21 percent of students do not even have classrooms.

This is due to the fact that primary schools in Pakistan have only two classrooms. Six grades (pre-kindergarten to grade five) share the two classrooms. Evidence does not exist of school building protocols and standards regarding building

size for primary schools to indicate different circumstances. Education policies of 1988-1993 discuss upgrading primary schools from one classroom to two classrooms and one veranda (Bengali, 1999). The same number (two) of classrooms for primary schools is again cited in education policy in 2009. Achievement decreases when students are in multi-grade classrooms, compared to single-grade classrooms. Under these circumstances, students attending schools with poorly built-in infrastructure and built environment achieve less. Therefore, the following policy recommendations should be considered for national, provincial and local governments in Pakistan, and also for private entities, such as for-profit organization and non-government organizations.

Policy Recommendations:

1. It is recommended that policymakers ensure provision of water supply in all schools throughout Pakistan.
    a. In some areas, such as Northern Pakistan, a precursor policy recommendation is that schools will not have access to water supplies unless the school neighborhood or community has improved water supply systems. Therefore, it is recommended that communities be provided with water supply systems. Eventually, schools would have access to these services.
    b. In other areas, such as Southern Pakistan, schools can have water supplies if wells are dug near schools. Therefore, it is recommended that the provision of water supply be ensured, even if local governments have to dig wells.

c. Local policymakers should not only ensure provision of water supplies, but also ensure regular operation and maintenance cost. Moreover, local people should be trained in operating and maintaining water supply systems to ensure their sustainability and durability.
d. When providing water supplies through a proper system takes time, an intermediary policy recommendation is that students be provided with easy-to-use, easy-to-carry (age appropriate), re-useable, recyclable, environment-friendly, and health-friendly water bottles. The bottles should be designed to carry hot and cold water.
e. Another intermediary policy recommendation is providing classrooms with water coolers (containers). This is an easy fix for drinking water issues, however, the maintenance and daily cleaning and filling of the water containers for each class also should be considered.

2. It is also recommended that policymakers ensure provision of improved sanitation facility in all schools.
    a. If water is not available in the schools, local policymakers should ensure that eco-friendly sanitation facilities, not requiring a lot of water, be provided in schools.
    b. Policymakers should ensure toilet facilities have proper handwashing mechanisms in place in all schools.
    c. Girls' schools, especially, should have toilet facilities that help them manage their menstrual hygiene.

3. Another recommendation is policymakers ensure provision of regular electricity supplies in all schools.
    a. Pakistan is located in sun-rich geographic location (Fawz-ul-Haq, Jilan & Haq, 2005). Therefore, it is feasible to provide electricity through solar energy in schools during power outages or if electricity is not available at all.
4. It is also recommended policies related to school building protocols, standards and practices be revised and updated, especially regarding seating arrangements. Policymakers should consider building schools, so the number of classrooms at least matches the number of grades taught in the school.

Policy Implementation Benefits: The benefits of the recommended policies are a lot higher than they might costs. Benefits are apparent not just for individual students, but for the community at-large. A school with improved built environment will help students stay at school, thereby helping students complete their education. Improved built environment also will help to reduce student vulnerability to exploitations, such as child marriage, child labor and sexual abuse, and to violence, including suicide attacks.

A school with a water supply, sanitation facility, electricity access and comfortable space will keep students healthy. Students will wash their hands frequently, thereby reducing chances of getting diseases, such as diarrhea and influenza. Students also will drink enough water. Doing so will help them stay hydrated and focused during their lessons. Lighting levels in classrooms will improve

with electricity access. Classrooms will be more comfortable with proper seating arrangements.

The community-level benefits of having quality built schools are profound. A few of the likely benefits for families, schools, neighborhoods, the nation, and the global community a-large are: better future employability chances for students; increased enrollment rates; reduced absenteeism among students, especially females; modern skilled workforce; increased employment rates, especially among women; narrow earnings gaps between women and men; increased development indicators; reduced global burden of diseases; and attained universal/national education goals.

Policy Implication 2: A second policy implication is the impact of school built environment on academic achievement is conditioned by gender, resulting in female students being more vulnerable than males to the effects of variations in school built environments. Female students will benefit more if schools have running water, sanitation facilities and proper seating arrangements. Yet, just 69.34 percent of schools for girls have access to water supplies, compared to 70.25 percent of boys' schools. A total of 59 percent of schools for girls in rural areas have access to running water, compared to 84 percent of schools for girls in urban areas.

Similarly, 40 percent of girls' schools do not have toilet facilities, compared to 33 percent of boys' schools. A total of 26.9 percent of girls' schools have students seated outdoors or in school verandas to do lessons, while 19 percent of schools for boys have outdoors seating for classes (ASER, 2015). To reduce the gender-gap in access to quality built schools, the following policies are recommended to policymakers:

Policy Recommendations:

1. Policymakers should take affirmative action in narrowing the gaps in providing quality school infrastructure for girls in Pakistan.
2. Policymakers should especially make sure that girls' school have access to toilet facilities and running water is available year-round.
3. Girls' schools, especially, should have toilet facilities, which help them manage their menstrual hygiene.
4. Boys' schools, especially, should have electricity access to help keep them in schools.

Policy Implementation Benefits: For girls, the benefits of providing a conductive school built environment are a lot higher. A conducive school built environment can help increase enrollment rates, reduce absenteeism and raise the chances of female students staying in schools (Rauniyar, Orbeta & Sugiyarto, 2011; Dean, 2005; Fennel, 2008). Thus, girls can avoid child marriages, child labor and other exploitations.

Girls' education is central to women's development and their well-being. UNESCO (2013) provides a succinct list of benefits associated with girls' education in this regard. According to the organization, maternal deaths can be reduced by two-thirds if all girls complete primary education. Educated women are more likely to work. Citing Pakistan as an example, UNESCO (2013) also reports that women who have completed primary (elementary) school earn 51 percent of men's earnings, but women who have achieved secondary education earn 70 percent of men's wages. Thus, girls' education can help reduce gender wage gap in Pakistan. Girls' education also can

save lives through reduced child deaths, increased child nutrition, reduced underage motherhood and lower birth rates. Therefore, policymakers should treat "girls' right to education as a human right" as is according to Malala Yousafzai. Malala Yousafzai is a well-known Pakistani female education activist and the youngest Nobel Prize laureate.

Policy Implication 3: A third policy implication stemming from the study methods is the weakness of scientific and modern knowledge-base that informs educational policymaking in Pakistan. As evident from the literature review, a huge gap is apparent between existing scientific knowledge and policy making in Pakistan. In addition, little information is available on school built environment related factors. It is hard to find school building codes and standards and related regulations online and match them to current construction practices. One exception is the building seismic provisions of 2007[27], which were developed as a result of the 2005 earthquake that killed more than 70,000 people, including 30,000 students while they attended schools. Other building policies and regulations regarding thermal efficiency of school buildings, classroom size, school building size and provision of electricity are not publically available.

Research also is limited about the issue of school built environment. Organizations such as ASER and Alif Alan[28] are initiating research on education in Pakistan, but these efforts are limited to descriptive information covering limited education indicators. Therefore, research knowledge does not inform policies and regulations in Pakistan. This research helps inform policies on at least some of the

[27] http://www.pec.org.pk/building_code_pakistan.aspx#
[28] http://www.alifailaan.pk

school built environment related factors and their relationship with student achievements. Thus, the study is an important contribution for informed policymaking.

Policy recommendation: Two recommendations can be drawn regarding informed policymaking and transparency in information on school built environment.

1. Policymakers should make information available on school built environment related factors, especially policies regarding school building codes and regulations and their implementation status.
2. School building codes should be revised and made up-to-date.

Policy Implementation Benefits: Reducing the information gap between policy and practice can help devise innovative solutions for education problems. Having school building codes and regulations that are current will also help reinforce regulations for public and private schools. Also, school building codes and regulations can provide yardsticks for assessing school built environment.

6.2 CONCLUSIONS

Education is considered an important instrument to help individuals pursue a quality life. Giving children access to schools is a first step toward a better quality of life and national development. And national development is unlikely without the education of the majority of the population, especially women. However, the number of children out of school is high in Pakistan. Possible reasons include not having access to school, lack of spending on education, poverty, and the poor quality of school buildings. A plethora of research exists studying all the factors affecting education attainment, except for school built environment and its effects on student outcomes. This is the focus of my research.

School built environment has many characteristics in terms of design and structural quality, functionality and esthetics. Previous studies show a relationship between built environment and student outcomes. A gap in literature is apparent in terms of understanding the relationship between school built environment and student achievement in developing countries. The current studies that investigate the relationship between school built environment and student achievement are mostly from developed countries, such as the United States and United Kingdom.

Because the effects of poor school built environment have greater consequences for students from developing countries, it is important to investigate these effects. This research helps accomplish that goal. This study explores the effects of school built environment on academic achievement of Pakistani students in grades 1 to 10.

Using secondary data (collected in 2015), the research finds that availability of water supply, sanitation facility and electricity access has positive effects on student achievement. If students receive lessons in multi-grade classrooms, their achievements significantly decrease. The study also suggests that the effects of school built environment related factors are conditioned by gender. That is, female students benefit more if schools have running water, toilet facility and proper seating arrangements. Male students benefit more if schools have access to electricity. School established year and school boundary walls do not have any significant effect on student achievement. The study findings provide evidence supporting the individual learning model theory by showing that built environment of schools hinders and/or boosts student achievement.

Findings are generalizable for Pakistan because the study covers all four provinces, the Federally Administered Tribal Areas, Gilgit-Baltistan and Azad-Kashmir

regions. The findings also can be generalizable to other south Asian countries, such as Bangladesh, India and Nepal, where the cultural context surrounding children's education, water supply, sanitation access and school building qualities is similar.

Overall, the study highlights the importance of school built environment and its effects on student achievement. It is envisaged that findings will help provide informed policymaking regarding school built environment in Pakistan. It is recommended that policymakers should ensure running water, toilet facility, electricity access and proper seating arrangements for students, as well as take affirmative actions in providing these necessities to girls' schools. Pakistan has very limited funds to spend on education. Therefore, since quality school buildings can have positive effects on student outcomes, policymakers can strategize ways to use their very limited educational budgets to achieve educational goals.

The current geo-political situation, limited spending on education, and the rise in religious fundamentalism are some of many barriers to implementing the recommendations in contemporary Pakistan. However, the hope is this study will initiate conversations among stakeholders and policymakers prior to them making policy changes that ultimately must be made.

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APPENDIX 1: TABLES

Table 8: Description of variables in the models.

Variables	Descriptions
Dependent variables	
Academic Achievement	A composite of three variables: English, math and Urdu test scores. Academic achievement is a continuous variable ranging from -3 to 2.
Independent variable	
Key independent variables	
Water	A dichotomous variable 1 if water is available in school, 0 otherwise. Water is school-level variable, centered at the school level.
Boundary walls	A dichotomous variable 1 if water is available in school, 0 otherwise. Boundary walls is school-level variable, centered at the school level.
Toilet facility	A dichotomous variable 1 if water is available in school, 0 otherwise. Toilet facility is school-level variable, centered at the school level.
Electricity access	A dichotomous variable 1 if water is available in school, 0 otherwise. Electricity access is school- level variable, centered at the school level.
Multi-grade classroom	A dichotomous variable 1 if water is available in school, 0 otherwise. Multi-grade classroom is school-level variable, centered at the school level.
Seating arrangement	A dichotomous variable 1 if students take their lessons in a classroom, 0 otherwise (student taking their lessons in school veranda or outdoors). Seating arrangement is school-level variable, centered at the school level.

School established year	A continuous variable ranging from 1900 to 2015. School established year is school-level variable, centered at the school level.
Control variables	
Student gender	1 = female, 0 = male. Gender is centered at the school level.
Student age	A continuous variable ranging from age 5 to age 16. Student age is grouped at the student and school level.
Paid tutoring	A dichotomous variable 1 if students taking paid tutoring, 0 otherwise. Paid tutoring is student-level variable and is centered at the student and school level.
No. of siblings	A continuous variable ranging from o to 10. Number of sibling is student-level variable and is centered at the student and school level.
Mother's education	A continuous variable, ranging from 0 to 18 years. Mother's highest level of education is student-level variable and is centered at the student and school level.
Student family socio-economic status.	A composite of five household level variables including housing condition, housing type, ownership of TV, electricity access, and access to telephone. Student family SES is centered at the student and school level.
School type	1 if public/government school, 0 otherwise. School type of centered at the school level.
Geographic location	1 if the location is rural, 0 otherwise. Rural is centered at the school level.
Teacher's education	Percentage of teachers with a B.Ed. degree.
Student teacher ratio	Student teacher ratio.

Table 9: Slopes and standard errors from multi-level models predicting student achievements - female students

Student achievement (Female students)	Base case	School characteristics	Full Model
	6	7	8
Student Level			
Student age			0.273***(0.004)
Paid tutoring			0.238***(0.038)
No. of siblings			0.022***(0.007)
Mother's education			0.001 (0.003)
Student family SES			0.054***(0.014)
School Level			
Water supply	0.339***(0.050)	0.315***(0.050)	0.193***(0.040)
Boundary walls	-0.076 (0.048)	-0.088* (0.048)	-0.017 (0.039)
Toilet facility	0.305***(0.051)	0.243***(0.052)	0.162***(0.042)
Electricity access	0.139***(0.048)	0.102** (0.048)	-0.057 (0.040)
Multi-grade class	-0.245***(0.043)	-0.225***(0.042)	-0.157***(0.033)
Seating arrangement	-0.002 (0.040)	-0.010 (0.040)	-0.045 (0.032)
School established year	0.000 (0.001)	0.000 (0.001)	-0.001 (0.001)
School Type (public)		-0.099 (0.071)	-0.070 (0.058)
Location (state)		0.186***(0.047)	0.128***(0.042)
Location (rural)		-0.157** (0.072)	0.146** (0.059)
Teacher with B.Ed.		0.002***(0.001)	0.001***(0.001)
Student teacher ratio		0.000 (0.001)	0.000 (0.001)
Student age			0.259***(0.009)
Paid tutoring			0.055 (0.069)
No. of siblings			-0.068***(0.014)
Mother's education			0.057***(0.005)
Student family SES			0.034* (0.020)
Intercept	-0.323***(0.019)	-0.302***(0.022)	-0.233***(0.018)
Variance Components			
Student age			0.130**(0.004)
Paid tutoring			0.220**(0.154)

No. of siblings			0.112**(0.012)
Mother's ed.			0.023**(0.029)
Family SES			0.161**(0.012)
Intercept /stand deviation	0.705**(0.015)	0.695**(0.015)	0.557**(0.012)
Within - school (Level 1) standard deviation	1.273**(0.007)	1.273**(0.007)	0.940**(0.008)

Note: *p<0.1, **p<0.05, ***p<0.01. Values in the parenthesis are standard errors.

Table 10: Slopes and standard errors from multi-level models predicting student achievements - male students

Student achievement (Male students)	Base case 9	School characteristics 10	Full Model 11
Student Level			
Student age			0.283***(0.003)
Paid tutoring			0.246***(0.023)
No. of siblings			0.007 (0.005)
Mother's education			0.004** (0.002)
Student family SES			0.079***(0.010)
School Level			
Water supply	0.153***(0.042)	0.118***(0.042)	0.045 (0.035)
Boundary walls	-0.019 (0.038)	-0.011 (0.038)	-0.030 (0.032)
Toilet facility	0.169***(0.042)	0.106***(0.043)	0.034 (0.036)
Electricity access	0.217***(0.038)	0.198***(0.038)	0.076** (0.031)
Multi-grade class	-0.184***(0.032)	-0.155***(0.032)	-0.074***(0.025)
Seating arrangement	0.147***(0.038)	0.106***(0.039)	0.048 (0.032)
School established year	0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)
School type (public)		-0.186***(0.040)	-0.197***(0.034)
Location (state)		-0.030 (0.034)	0.053* (0.028)
Location (rural)		-0.173***(0.046)	0.032 (0.039)
Teacher with B.Ed.		0.002***(0.001)	0.001 (0.000)
Student teacher ratio		-0.001 (0.001)	0.000 (0.001)
Student age			0.265***(0.008)
Paid tutoring			0.068 (0.043)
No. of siblings			-0.058***(0.013)
Mother's education			0.034***(0.004)
Student family SES			0.142***(0.018)
Intercept	-0.190***(0.015)	-0.217***(0.015)	-0.251***(0.013)
Variance Components			
Student age			0.102**(0.003)
Paid tutoring			0.357**(0.040)
No. of siblings			0.086**(0.007)
Mother's education			0.025**(0.004)
Family SES			0.167**(0.016)

Intercept /stand deviation	0.657**(0.012)	0.647**(0.012)	0.535**(0.009)
Within - school (Level 1) standard deviation	1.311**(0.005)	1.311**(0.005)	0.943**(0.004)

Note: *p<0.1, **p<0.05, ***p<0.01. Values in the parenthesis are standard errors.