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Gendered Distances: A Methodological Inquiry into Spatial Analysis as an Instrument for Assessing Gender Equality in Access to Secondary Schools in Mukono District, Uganda

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A dissertation submitted to the faculty of
Brigham Young University
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Doctor of Philosophy

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ABSTRACT

Gendered Distances: A Methodological Inquiry into Spatial Analysis

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This study focused on how accessibility to secondary schools in the Mukono District of Uganda is related to the sex and gender of the student and the distance that separates the student's home from the school they attend. This research is a methodological inquiry exploring the use of spatial analysis, specifically how cognitive and metric distances can be used as alternatives to gross enrollment rates (GER) and net enrollment rates (NER) for assessing gender equality in realized accessibility to secondary schools.

Student home locations were collected for 756 secondary students, including 437 boarding students and 319 day students from 8 different secondary schools in Mukono District of Uganda. A school accessibility model is presented that suggests that educational policy and delivery efforts to provide school access are mediated by the distances, real and perceived, between students' home locations and available schools. In addition, the relationship between distance and accessibility is moderated by certain characteristics of the schools and the students.

Male boarding students were found to travel significantly further than female boarding students indicating that distance more acutely limits their school choices. However, the Ordinal Linear Regression analyses comparing cognitive distance perception with Euclidean, travel and time distances did not find evidence that male and female students perceive the distances they travel to school differently. These findings suggest that building additional quality government schools in urban areas would be an efficient strategy for improving school accessibility in Uganda in general. However, given the particularly restrictive range of travel of many rural female students, additional female-only schools in rural areas would be needed to improve school accessibility for female students living in rural areas.

Keywords: education, school access, gender, equality, Geographic Information Systems, GIS, distance, spatial analysis, Education for All, EFA, Uganda, Africa

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My children were also a constant inspiration and motivation for me. Christian with his indomitable sense of loyalty and fearless approach to new experiences helped me to keep moving forward and trust in the promise of my future. Haley's love for learning, the beauty the world, and spirit of BYU has often reminded me of Heavenly Father's great gifts to me. Haley was also my most reliable and welcome library study companion. Nathan's insatiable desire to learn about the world around him is a constant reminder that knowledge is most useful when shared with others. Casey's heart is full of giving and constantly focused on the needs of those around her. Her bright eyes and smiling face never failed to re-energize me when it seemed too difficult to continue.

As my doctoral committee chair, Steven J. Hite has been critically important as a mentor, advocate and friend throughout this process. Much of the credit for the quality of this document can be directly attributed to his careful and persistent guidance. An enormous debt of gratitude

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Chapter 1: Introduction

The United Nations Educational, Scientific and Cultural Organization (2002) stated in its

2002 Global Monitoring Report,

> The intrinsic human value of education – its ability to add meaning and value to
>
> everyone's lives without discrimination – is at the core of its status as a human right. But
>
> education is also an indispensable means to unlock and protect other human rights. It
>
> provides some of the scaffolding necessary for the achievement of the rights to good
>
> health, liberty, security, economic wellbeing and participation in social and political
>
> activity. Where the right to education is guaranteed, people's access to and enjoyment of
>
> other rights is enhanced and the imbalances in life chances are lessened. (p. 30)

The statement above powerfully claims that universal access to education is a means to

and product of ensuring universal human rights. The converse of the last sentence of the above

statement is equally powerful. That is, where the right to education is *not* guaranteed, people's

access to and enjoyment of other rights is *more restricted* and the imbalances in life chances are

increased. Where the right to education is not guaranteed and access is more restricted the

serious consequences of hindered or denied access to education on individuals, families, social

groups, communities, nations and the entire world in their pursuit of personal and community

development are apparent.

In a general sense, *accessibility* is the ease to which a place can be reached, or a service

obtained (Johnston, 2000). This study began with the assumption that schools (as a place or a

service) are not universally accessible. If this assumption is valid, the question of whose

educational access is more hindered naturally arises. There is substantial evidence that there are

many factors that contribute to the variation in school accessibility (Lewin, 2007; Pizzolato,

Barcelos, & Nogueira Lorena, 2004; Shabaya & Konadu-Agyemang, 2004; Shrestha et al., 1986)

but this study focused on how accessibility to secondary schools in the Mukono District of

Uganda is related to the *sex* and *gender* of the student and the distance that separates the

student's home from the school they attend. In other words, this study explored how distance is

related to *gender equality* in access to secondary schools in Uganda.

In order to compare accessibility to secondary schools by gender, a measure of

accessibility must be obtained. This study discusses the inadequacies of relying only on existing

measurement instruments that utilize data on the ratios of boys and girls enrolled in school as the

primary indicator of complete gender equality of access to school. As an alternative, this study

compared the distances students of each gender travel to school in Mukono, Uganda to determine

if boys and girls are equally empowered and motivated to overcome the cost of traveling those

distances in order to obtain an education.

In addition, through conducting a short survey of S4 and S6 level students (equivalent to

American 10th and 12th grades) at a wide variety of secondary schools in Mukono, more was

learned regarding the student's perceived cost of the traveling to school. Boys and girls may

travel different distances to school. Similarly, boys and girls may feel differently about the cost

of that required distance, impacting their family's decision as to which school, if any, the student

should enroll at. A difference in perception of the magnitude of distance as an obstacle may be

evidence of imbalanced accessibility, and therefore gender inequality of school accessibility.

The unique approach of this study required bringing together three different theoretical

perspectives (Figure 1). The first perspective encompasses the international acknowledgement

that education is a basic human right, and that the world community is obligated to establish the

mechanisms for measuring progress, thereby holding all nations accountable for providing equal

access to education for everyone. The second perspective is focused on the idea that gender

inequalities exist at many levels of all societies resulting in male dominated power relations that

leave females disadvantaged. This study considered how these disadvantages may be related to

uneven educational access for girls. Third, *spatial analysis* of accessibility uses spatial theory to

explore the relationship of distance on the cost of accessibility. Simply stated, this spatial theory

would hold that the greater the distance between the student's home and the school, the greater

the cost to overcome that distance. The overlapping content areas of these three theoretical

perspectives allowed this study to examine the relationships between the policies oriented toward

providing educational access with the realities of the impact of gender and distance. A deeper

understanding of the relationships between gender and distance on accessibility to secondary

schools better informs policies that seek to improve access, particularly to girls.
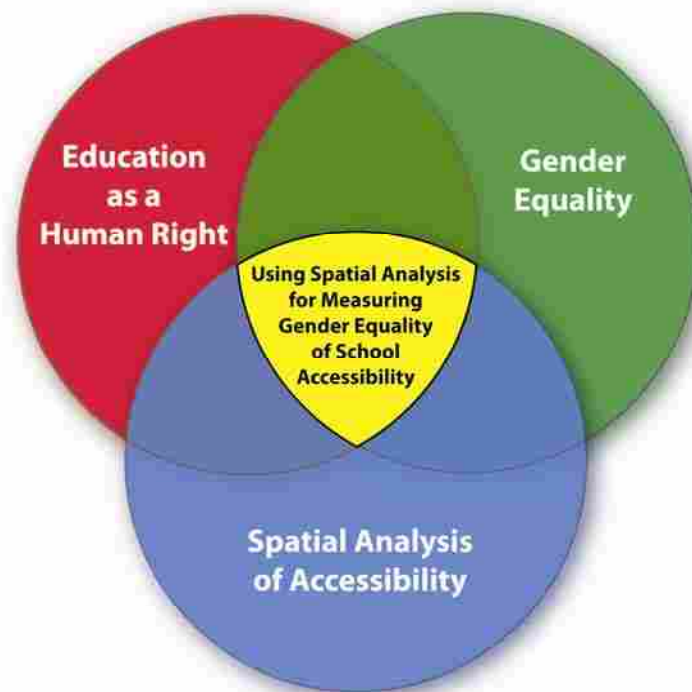
Figure 1. The Convergence of Three Theoretical Perspectives

Education as a Basic Human Right

Cultures and societies have long wrestled with the idea of human rights. Many philosophers throughout the world record ideas of human relations based on an individual's value and function to a community (Holt, 1992, p. ix; King Hammurabi of Babylonia, 1966; Tutu, 1999). The aftermath of the Second World War revealed incredible atrocities against human rights in many parts of the world which served as a solemn reminder that not all humans were considered of equal value to some communities. Consequently, a consensus began to emerge among many nations that the world community had a responsibility to reaffirm universal human value and protect the basic rights of all individuals. In December of 1948 the United Nations drafted the Universal Declaration of Human Rights (UDHR). Among the rights enumerated by this important document was the right of a basic education for all people that is *equally accessible* [italics added] (United Nations, 1948).

Four decades after the 1948 UDHR had passed it became clear that merely declaring education as a basic human right did not guarantee its universal and equitable availability to all people in many areas of the world. By the 1980s, most developing countries in South Asia and South America, and particularly sub-Saharan Africa continued to struggle with significant barriers to provide accessible and equitable basic education (UNESCO, 2002, 2003/4, 2008, 2009).

In 1990, in tacit acknowledgment of this fundamental failure to deliver on UDHR principles, the United Nations Educational, Scientific and Cultural Organization (UNESCO) convened a broad coalition of nations, international development agencies and civic groups in Jomtien, Thailand for a conference to develop an international strategy for improving equitable access to education for children throughout the world. This conference produced an initiative

called "*Education for All*" (*EFA*) which was designed to rid the world of mass illiteracy by providing universal, equitable and compulsory access to education for all school-aged children. UNESCO was tasked to coordinate and monitor the progress of the EFA efforts and initiatives globally (WCEFA, 1990).

Measures of Gender Equality and Educational Access

Feminist literature has long argued that sex and gender are not synonymous (Oakley, 1972; Renzetti & Curran, 1989). The literature contends that "sex" as a classification should only be used to describe the biological differences between men and women. That same literature asserts that "gender" refers to social roles, obligations and expectations society artificially assigns to individuals based on their sex. Feminists argue these artificial social constructions of gender often place females at a competitive disadvantage to men by restricting their life choices and opportunities as well as their access to community services and resources.

It can also be argued that gender differences are so integrally embedded in many cultures in diverse and complicated ways that it is an oversimplification to view all gender differences as universally and inherently unfair. However, in terms of safeguarding the opportunity for receiving an education, which is the delimited focus of this study, issues of unfairness related to the gender of the student are less complicated than issues of gender facing societies in general. The disadvantages facing female students are undeniable, and a particular concern in developing countries where resources are scarce and the competition for access to services such as education is fierce. The international community recognizes these "deep and persistent disparities based on wealth, *gender, location* [italics added], ethnicity … are acting as a major barrier to progress in education" (UNESCO, 2009, p. 6) and have made a strong commitment to removing those disparities where possible.

Current EFA measures of gender parity and gender equality. EFA establishes two

goals regarding equalizing accessibility of education for both genders. The first goal established

2005 as a deadline for reaching *gender parity* for all schools globally. According to EFA

standards established by its action agenda and subsequent Global Monitoring Reports (GMR),

gender parity means that the same proportion of boys and girls, relative to their respective age

groups, would enter the education system and participate in its different cycles (UNESCO, 2000,

2002, 2003/4, 2008, 2009). Therefore, gender parity is most commonly conceptualized as a

quantitative measure.

The most common instruments for assessing progress toward gender parity are a variety

of types of enrollment rates (Unterhalter & Brighouse, 2003). Enrollment rates are appealing as

accessibility measures of gender parity because the data are typically available, even in poorer

countries, and provide a general picture of school enrollment ratios. These ratios are also easy to

compare within various contexts including local, national and regional scales. However, these

indicators only measure student enrollment, not student participation or student completion

(UNESCO, 2003/4, 2009). As such, relying on enrollment measures alone can mask important

deficiencies in more meaningful educational outcomes such as enrollment retention and skill

attainment. In addition, the data used to calculate these ratios are usually self-reported and are

difficult to verify in many cases, calling into question their reliability (Unterhalter & Brighouse,

2003).

The Dakar Framework for Action Plan (2000) established 2015 as the deadline for

reaching the second and more ambitious goal of *gender equality* in educational access. When

gender equality is attained, boys and girls will experience the same advantages or disadvantages

in educational access, treatment and outcomes. Insofar as gender equality goes beyond questions

of numerical balance, equality is more difficult to define and measure than gender parity

(UNESCO, 2000, 2003/4, 2009).

While there have been some attempts to develop a measuring instrument for some aspects

of gender equality, none have been universally accepted or adopted (UNESCO, 2005). By

EFA's own definition of gender equality, the simple quantitative approach of measuring

accessibility by tracking enrollment ratios is inadequate (UNESCO, 2003/4). Complete gender

equality would mean that boys and girls are offered the same educational opportunities,

curriculum, treatments, and even eventual job opportunities based on their academic

achievements, all free from gender biases (UNESCO, 2003/4, 2009). In short, any gender-based

barriers to educational access and outcomes would be removed.

Therefore, the simple gender parity indicators of comparative enrollment figures cannot

begin to describe the deeper social, cultural, and physical processes that affect gender equality in

terms of educational access (Mehta, 2004; Shabaya & Konadu-Agyemang, 2004). While useful

indicators of gender parity, enrollment ratios are at best blunt instruments when determining the

accessibility of an education system.

Although this study detailed the shortcomings of enrollment rates and other gender parity

measures, the focus was on the exploration of better methods of measuring gender equality. In

order to effectively measure progress toward gender equality, indicators must identify specific

gender-based barriers and measure their impedance to educational access.

Distance as a measure of gender equality in access. In its simplest form, spatial

analysis is the study of the space, or distance, that separates the objects of inquiry (Abler,

Adams, & Gould, 1971; Johnston, 2000). Accounting for distance when measuring general

accessibility to services in developing countries has been dominated by work in the area of

health services. Global health crises such as the HIV/AIDS epidemic, malaria and malnutrition have demanded careful and urgent consideration regarding the distribution of health services in poor and afflicted areas (Meade & Earickson, 2005).

In comparison to health services, accessibility studies related to education services that attempt to account for the effects of distance have been under-represented. Many of the education accessibility studies that have been published have focused on aspatial variables (variables not directly related to distance or location) such as parental education attainment, socio-economic status, family structure and size, gender, cultural taboos, school staffing size and/or ability, school size, school facilities, school types, etc. (Mannathoko, 1999; Shabaya & Konadu-Agyemang, 2004), but few explicitly investigate the effect of distance on accessibility. The few studies that have included distance as a factor employ a variety of methodologies. Most of these studies rely on statistical analyses of aggregated household survey sample data and census information in conjunction with incomplete and unverified field data regarding school locations and distances (UNESCO, 2003/4, 2008, 2009).

There has been some research completed on accessibility and equality in Uganda. Kasente (2003) found that distance was a significant reason for Ugandan boys to not attend school, second only to the monetary cost of attending school. Other research of school accessibility by Hite, Hite, Mugimu and Rew (2007) with the assistance of the Ugandan Ministry of Education compared the impact of several types of distances (*Euclidean*, road network distances) between schools and their effect on non-financial resource exchange relationships.

In a pilot study looking at the relative catchment ranges of various types of Ugandan schools, Wawro, Hite, Hite, and Mugimu (2008) found that the average distances that both boys and girls traveled to schools varied widely from school to school. There was some evidence that

certain characteristics of schools such as urban/rural location, large/small student body, and

private/public school may be related to that variability and therefore should be considered in

future studies involving distance and school accessibility.

Borrowing from geography's substantial literature of spatial theory of distance, the

approach for measuring accessibility to schools can be expanded beyond counting enrolled

students and the available capacity of schools by considering the effect of distance between

student's villages and the schools. However, because the surface of the earth varies with

topography and transportation infrastructure, the cost of overcoming distance differs

considerably from place to place. Therefore, when considering accessibility it is often useful to

expand the concept of distance beyond conventional units of metric physical distances such as

kilometers, or travel time, to include more abstract ideas of distance such as network distances

(the number intermediary connections needed to obtain a network resource), social distances

(differences in social classes) or ordinal distance (near, far) measures (W. Tobler, 2004).

In addition, researchers have recognized that people, depending on their own social,

economic or culture characteristics, often perceive the costs of distance differently. These

researchers distinguish between *cognitive distance* (how far something feels), and *metric*

distance (how far away something is in distance or time units) (Cadwallader, 1975). It is

common for people to think and communicate their ideas of distance and spatial relations in

ordinal terms such as near, close, far, very far, etc., rather than in quantifiable distance measures

of miles or minutes (Yao & Thill, 2005). Cognitive distances expressed as linguistic ordinal

measures are, by their very nature, imprecise and generalized. These linguistic measures

expressing cognitive conceptions of distance (near, far) need to be interpreted if they can be used

within an analysis model (Montello, Goodchild, Gottsegen, & Fohl, 2003).

Comparing cognitive perceptions of distances with metric distances may be a fruitful approach to evaluating accessibility because the difference between cognitive distance measures and metric distance measures may be a better indication of the overall cost of overcoming distance (Cadwallader, 1979). Evidence of gender differences in the perceived cost of distance to attend school would add a rich new dimension to an accessibility measure that metric distances alone cannot.

This approach is potentially much less complicated than alternative spatial models that attempt to explicitly account for every variable that could affect accessibility. Reducing the number of variables when investigating accessibility and *equity* of education in developing countries can dramatically improve monitoring and assessment capabilities.

Research Questions and Hypotheses

Two research questions guided this study's approach to exploring gender equality in education accessibility:

Research Question 1. Do male or female students travel further to school in Uganda and how are school characteristics related to those distances?

Research Question 2. Do male and female students perceive the cost of distance differently and how are school characteristics related to those perceptions?

Before the possible relationships between metric distances and gender equality in educational access could be statistically analyzed, accurate metric distances between a student's home village and school had to be acquired. In order to learn directly about a student's cognitive perception of distance, each student was asked to assess the distance they traveled to school on an ordinal scale of *very near*, *near*, *far*, or *very far*.

However, as cognitive distance measures are not independent of metric distances, this research proposed testing several hypotheses regarding how students' perception of the distance between home and school was related to the three different types of metric distances, including:

Hypothesis 1. Cognitive distance measures between the student's home village and school are significantly related to their *Euclidean distances*,

Hypothesis 2. Cognitive distance measures between the student's home village and school are significantly related to their *travel distances*,

Hypothesis 3. Cognitive distance measures between the student's home village and school are significantly related to their *time distances*,

Hypothesis 4. Cognitive distance measures between home village and school are significantly related to *student characteristics*, and

Hypothesis 5. Cognitive distance measures between home village and school are significantly related to *school characteristics*.

Each hypothesis was examined by gender using the inferential statistical procedure of *Ordinal Logistic Regression*. The OLR model also allows for other explanatory variables such as school characteristics to be included resulting in evidence of significance, direction and strength of these variables.

Significance of Study

Enrollment and participation ratios are inadequate measures of EFA's higher standard of gender equality. The spatial analysis techniques utilized in this study are designed to explore a potentially better instrument for measuring gender equality in regards to education access in small-scale study settings.

Acknowledging that the effect of distance on school accessibility may vary with student characteristics (especially in terms of gender) and school characteristics has the potential to facilitate a much deeper understanding of equality in school accessibility in many education settings. A better appreciation of the role of distance could result in a more efficient distribution of education resources. For instance, if girls are more disadvantaged by distance than boys, there may be better strategies employed to compensate for these disadvantages. Perhaps, in order to attain full gender equality in school access more funding should go toward building (perhaps small) quality day schools for girls in locations more easily accessible to female students, or in providing gender-preferred subsidies specifically for high quality boarding schools.

The spatial analysis approach proposed by this study required the acquisition of precise distance measurements of student homes and schools and other specific information not typically or reliably captured in general household surveys. These requirements make this approach unfeasible as a wholesale replacement to current gender parity indicators for most large scale EFA assessment efforts. However, if properly scaled as a sample, this approach can be utilized even in developing countries to validate other indicators of gender parity and gender equality.

Because the costs associated with this highly specialized approach are quite low in comparison to large data collections of household surveys, and because this technique can yield extremely precise and categorically varied distance measures, this spatial analysis approach has great potential as a precise accessibility measure for EFA assessments. Its portability allows its use in many settings throughout the world. Most importantly, it may be able to capture some of the elusive but important complexities of gender equality in school accessibility better than any existing instrument or measure.

Chapter 2: Review of Literature

There are many ways to approach a summary of the literature and intellectual contributions that have led to current conceptualizations of gender equality in school accessibility. This chapter first presents a brief outline of the historical progression toward a global consensus that access to an education is a human right. The most prominent literature on gender equality is then highlighted. As the area of gender equality is broad, the researcher has delimited the focus of this literature review on basic issues of gender equality, and how progress toward gender equality in school access is currently monitored internationally. Finally, this chapter introduces the basic principals of spatial analysis, and how analyses of distance have the potential to add considerably to school accessibility research.

Progression Toward Universal Education Rights

While seldom recognized, the seeds of today's internationally accepted idea that education should be available to everyone, male and female, can be traced back historically to many civilizations in different areas of the world. These historic trends grew within the context of the larger development of the expectation of the universality of human rights.

History of human rights. In order to better understand the context and mandate of the Education for All (EFA) movement, it is important to recognize the philosophical landmark that the Universal Declaration of Human Rights (UDHR) of 1948 represents in terms of the *expectation* for universal human rights protection. The necessity for societies to protect certain human rights has a long history. For thousands of years, forward-thinking civic authorities, inspired religious leaders, and great philosophers in many parts of the world have called for formal and informal codes of conduct as the most effective and enduring means of protecting the stability and coherence of the community. Unfortunately, the large majority of human-kind has

not historically enjoyed any semblance of equal protection of their human rights. In fact,

typically these "formal and informal codes of conduct" actually only protected the rights of a

very select few at the considerable expense of most others in their societies.

There is, however, evidence that threads of ideas about the value of protecting the rights

of individuals and groups found in many different historical cultures and societies, however

exclusively enjoyed in their time, eventually began to codify into a more expanded expectation

of the universality of human rights as officially expressed in UDHR 1948. One example of this

type of cultural value is the ancient African concept of "Ubuntu" which can be loosely translated

as the idea that a person can only reach their potential through their positive relationships with

others. Archbishop Desmond Tutu (1999) beautifully defined Ubuntu as the following,

> A person with Ubuntu is open and available to others, affirming of others, does not feel
>
> threatened that others are able and good, for he or she has a proper self-assurance that
>
> comes from knowing that he or she belongs in a greater whole and is diminished when
>
> others are humiliated or diminished, when others are tortured or oppressed. (p. 31)

Historical records regarding the importance of protecting the rights of individuals appear

at least as early 1760 BC in ancient Babylon, where the Code of Hammurabi proclaimed that

laws were essential to protect the weak from the strong (King Hammurabi of Babylonia, 1966).

Archeologists have translated inscriptions written on ancient pillars in India which record what is

known as the "Edicts of Asoka" which were apparently personally issued by a powerful king

named Asoka the Great of India between the years of 272-231 BC. The inscriptions plead for

religious tolerance and clarify that the King considers all members of his kingdom to be his

children, and that he desires the best for the welfare and happiness for every one in his kingdom

(Smith, 2006).

In 622 AD, the Constitution of Medina, also known as the Charter of Medina, was written under the direction of Muhammad.   It guaranteed significant rights to all the tribes of Medina, including Muslims, Jews and Pagans. Under the Charter, non-Muslim tribes were afforded equal military protection from invaders, as well as freedom of religion. In return for these freedoms and protections, these non-Muslim tribes were required to serve in the military in the time of war and share the costs of that service, unless it was a "Muslim War", in which case they would have no obligation for support (Ahmad, 1979).

In the 13th Century the Magna Carta was enacted in England, which essentially declared that certain rights of the people could not be violated, even by the King of England. The Magna Carta introduced the writ of *habeas corpus* which became an important instrument for the safeguarding of individual freedom against arbitrary state action. In most respects the Magna Carta did not accomplish what it was created for, at least in the short term. It did not in actuality guarantee that the King or other English government officials would not violate the rights of those less powerful than themselves, but it did create the precedent for an expectation of equal rights under the law (Holt, 1992). Partially as a result of the long-reaching influence of the British Empire, the Magna Carta has become an important foundation for international and constitutional law today.

This progression toward universal rights reached another milestone in 1772 in England when the English courts rules that a slave named James Somerset should be released under the argument that he was unlawfully imprisoned in violation of English common law and the writ of *habeas corpus* (Paley, 2006). This case represented the end of slavery in England.   By ruling in favor of a slave, the Somerset Case became an important legal precedent that established that all people had a right to equal protection of the law.

Thomas Jefferson may have been emboldened by the progressive thinking that resulted in

the release of the slave James Somerset when he and the Continental Congress boldly declared in

the United States Declaration of Independence that "We hold these truths to be self-evident, that

all men are created equal, that they are endowed by their Creator with certain unalienable Rights,

that among these are Life, Liberty and the pursuit of Happiness" (Congress of the United States,

1776). These assertions of human rights were reinforced and advanced by the writings of

philosophers such as Thomas Paine in his *Age of Reason* during the 18th and 19th centuries

(Paine, 1807).

Revelations of atrocious violations of human rights in the First and Second World Wars,

however, reminded the world community that the belief in universal human rights alone does not

guarantee their protection. Many throughout the world felt that something more needed to be

done (Morsink, 1999). The Allied Powers agreed to create the United Nations, and its members

developed much of the discourse and the bodies of law which now make up international

humanitarian law and international human rights law.

One of the first orders of business the United Nations attended to was the construction

and adoption of the Universal Declaration of Human Rights in 1948. The purpose of this

document was to explicitly declare an international expectation of protection of "the inherent

dignity and of the equal and inalienable rights of all members of the human family" (United

Nations, 1948, preamble). Most importantly, this document establishes the rationale to hold

members nations accountable to a common standard of conduct regarding the recognition of the

rights outlined in the document and the commitment to secure these rights.

Human right to an education. Differences in wealth and power have always been

central to educational access (Cole, 2006). The idealistic aims of the UDHR, however, did not

change the reality of differential education opportunities based on the wealth and power of the

student's social positioning. Paragraph One of Article 26 (1948) of the UDHR states, "Everyone

has the right to education. Education shall be free, at least in the elementary and fundamental

stages." This language represents an important recognition regarding the standards of access to

education, i.e. everyone has the right to have an accessible education that does not require fees or

tuition to gain admission, at least at the primary grade levels.

Yet, in 1948 millions of people had little or no access to an education, whether at the

primary, secondary or tertiary levels (Cole, 2006). Much of the world's social fabric and

physical infrastructure was decimated or at least seriously impacted by the destruction and

aftermath of World War II. *How* the United Nations and their members were to provide that

educational access was, and is, an important and difficult question. But a more important

question is w*hy*. Why did they believe access to an education was a basic human right when

education had historically been made available to so few (Donders & Volodin, 2007; UNESCO,

2003/4)?

Article 26 of the UDHR (1948) adds conditions, purposes and justifications for the type

of education all people have the right to obtain:

Education shall be directed to the full development of the human personality and to the

strengthening of respect for human rights and fundamental freedoms. It shall promote

understanding, tolerance and friendship among all nations, racial or religious groups, and

shall further the activities of the United Nations for the maintenance of peace.

(Paragraph 2)

According to the language of Paragraph Two, an education is essential for *human*

development as well as gaining an understanding of human rights and the importance of their

protection as a means to establishing freedom. That is, an education is necessary to ensure the

realization of freedom, another human right. In addition, this education should be especially

tasked to teach students tolerance that can promote peace between nations.

      Education for All and Millennium Development Goals. Fifty-two years after the 1948

UDHR had passed it became clear that merely declaring education as a basic human right did not

guarantee its universal and equitable availability to all people in many areas of the world. By the

late 1980s, "only half the rural children in most countries (and as few as 10 percent in some

others) have the opportunity to complete four years or more of schooling" (WCEFA, 1990, p.

55). The socioeconomic gap between the poor uneducated and the wealthy educated was

expanding rapidly, isolating huge numbers of people from the ability to improve their situation

or play a role in shaping their societies. At the same time, most developing countries in South

Asia and South America, and particularly sub-Saharan Africa had accrued immense national

debts. National rates of expenditures on education sectors were declining. Many nations faced

serious internal political turmoil and some were experiencing open wars. These countries

struggled with significant and complex barriers, leaving them unable to provide accessible and

equitable basic education without large-scale international assistance (UNESCO, 2002, 2003/4,

2008, 2009).

      In 1990, the UN acknowledged this fundamental failure to deliver on UDHR principles.

On behalf of the UN, the United Nations Educational, Scientific and Cultural Organization

(UNESCO) convened a broad coalition of nations, international development agencies and civic

groups in Jomtien, Thailand. The Jomtien conference named, "The World Conference for

Education for All" (WCEFA) attracted over 150 nations and a similar number of international

organizations. These nations and organizations discussed the best way to improve equitable access to education before the end of the century.

While there were many obstacles to accomplishing the goals of providing free and universal primary education and reducing illiteracy, the coalition had reasons to feel optimistic for success. For example, a growing international consensus that human development, which the WCEFA documents defined as "the concept which views the general well-being of humans as the focus and purpose of development action; it involves the application of learning to improve the quality of life" (WCEFA, 1990, p. ix), was a critical ingredient to reducing poverty and promoting peaceful international relations.

Reducing poverty and promoting international peace are central to the UN's purpose. In terms of reducing poverty, research abounds to support the claim that education levels are related to improved health and social conditions such as lower morbidity, reduced infant mortality and improved nutrition (Cochrane, 1979; Cochrane, Leslie, & O'Hara, 1980). Higher education attainment has also been tied to increased productivity (Lockheed, Jamison, & Lau, 1980). One of the conditions identified in several Asian nations' rapid rise as economic powers was good access to schools (World Bank, 1993). Because universal education was considered essential to human development, the coalition felt that this consensus could be leveraged into a stronger international effort to improve international commitment behind universal education.

However, making the case that a quality education system promotes peace is more difficult than showing impact in things such as morbidity, nutrition, and productivity. Researchers cite only indirect evidence that education can build an awareness of the interconnected nature of the world and build a rationale for tolerance of other cultural, political, religious and ethnic differences. But the belief persists, and is powerful, in asserting that

education can build an awareness and rationale in these domains which could lead to political

and economic stability and prosperity (UN Millennium Project, 2005; UNESCO, 2000, 2009;

WCEFA, 1990).

Other reasons for optimism in the post-Jomtien era included technological advances in

communication networks and computers that could assist education delivery and improve

reporting. In addition, the end of the cold war eased tensions considerably in many parts of the

world and the world economy was on an upswing potentially making more resources available

(WCEFA, 1990).

The Jomtien Conference produced an initiative called "Education for All" which

provided a strategic focus for the UN's efforts to rid the world of mass illiteracy by providing

universal, equitable and compulsory access to education for everyone by the year 2000. As the

core of its educational agenda, UNESCO was tasked to coordinate and monitor the progress of

the EFA efforts and initiatives globally (WCEFA, 1990).

Within a few years it became clear that the goal of providing universally equitable access

to education by the year 2000 was unrealistic, or at least unattainable within the initial

timeframe. Continued unsatisfactory and inconsistent national and regional rates of progress

toward the Jomtien EFA goals resulted in a reassessment of EFA's strategy and timetable. By

the time another conference was called in 2000 in Dakar, Senegal to reaffirm and recalibrate the

commitment to provide universal and equitable access to education, over 130 million children

were estimated to not be attending school at all (Lewin, 2007).

The Dakar Conference was attended by 189 countries. After considering the challenges

and progress to date, the conference participants determined that EFA's objectives should be

more refined and better integrated into the UN's overall strategy. The Dakar Framework for

Action was produced from this conference which established six specific EFA goals, two of

which focus directly on education access and gender equality issues. Goal 2 states that "all

children, particularly girls, children in difficult circumstances and those belonging to ethnic

minorities, have access to and complete, free and compulsory primary education of good quality"

(UNESCO, 2000, p. 8). Goal 5 targets 'eliminating gender disparities in primary and secondary

education by 2005, and achieving gender equality in education by 2015, with a focus on ensuring

girls' full and equal access to and achievement in basic education of good quality' (UNESCO,

2000, p. 8).

Both of these goals were echoed by the similarly worded *United Nations Millennium*

Development Goals (*MDG*), also passed in 2000 (United Nations, 2000). The MDG targets for

education, however, do not mention 'free and compulsory' primary schooling, and only require

the elimination of gender disparities in education rather than requiring the achievement of the

more demanding standard of gender equality required by the Dakar Framework.

Challenge of Measuring Gender Equality in Access

To have access is to have the ability to reach a place or to obtain something desired.

Having access is to have something within reach, even if it is obtained at a cost. It is true that

UDHR of 1948 proclaims that an education should be free, but abolishing all tuition and entrance

fees to schools does not remove all the costs associated with obtaining and education.

Transportation costs, time away from the family, and time not earning a wage are just a few of

the many sacrifices that are required of many students who attend school. It is not possible to

remove all of these costs, but it may be possible to equalize them.

Providing equal access to schooling for everyone is the central tenant of the EFA

mandate. While EFA is a commitment to improve access to all who are systematically hindered

(socially, economically, culturally, and physically) from obtaining an education, it specifically

emphasizes the need to improve access for girls. Therefore, gender equality is a particularly

important dimension of the general idea of equality of access to education that EFA is striving to

achieve.

Faced with massive educational deficiencies in many parts of the world resulting in

estimates of up to 862 million illiterate adults worldwide (UNESCO, 2003/4), full gender

equality in educational access seemed a daunting and perhaps unreasonable immediate goal to

the architects of EFA. As a result, an intermediate goal of gender parity was established.

Gender parity in education refers to the same proportion of boys and girls, within their

age groups, actually being enrolled in the education system. That is, if a population had 51

percent girls and 49 percent boys who are of school age, gender parity would be achieved if 51

percent of students enrolled were girls. Most data used to track EFA access progress is focused

on demonstrating gender parity. This is especially true of data used to compare progress

between countries, and between and within regions internationally.

Gender equality is much more difficult to measure than parity because a simple ratio

comparison cannot capture the data needed to determine equality. Gender equality would only

be achieved if boys and girls experienced the same advantages or disadvantages in educational

access, treatment and outcomes. The 2003/4 GMR states, "Gender equality requires the

achievement of equal outcomes for women and men, notwithstanding that they are starting from

different positions of advantage, and are constrained in different ways" (UNESCO, 2003/4, p.

116).

UNESCO (2003/4, p. 44) prescribes four conditions for assessing gender equality as

paraphrased as follows,

1. *Equality of opportunities*: girls and boys are offered the same chances to access
    school. Parents, schools and society impose no gender-based attitudes that influences
    the decision of where, when or even if the student should attend school.

2. *Equality in the learning process*: girls and boys experience the same curriculum,
    receive the same treatment and attention from teachers, administrators and policy-
    makers. Girls and boys experience the same teaching methods and the learning
    environments are free of gender biases. Both genders are offered academic
    orientation and counseling not affected by gender biases, and benefit from the same
    quantity and quality of appropriate educational infrastructures.

3. *Equality of outcomes*: learning achievements, length of school careers, academic
    qualifications and diplomas would not differ by gender.

4. *Equality of external results*: job opportunities and the salaries of men and women
    with similar qualifications and experience, would be equal.

While issues of gender equality in access potentially interact with each of the aspects
identified in UNESCO's rubric, this study will focus its attention on the standards prescribed of
the first in the above list; *equality of opportunities*.

Limitations of GER and NER. The two most widely used indicators of gender parity in
school access are *gross enrollment rates* (*GER*), and *net enrollment rates* (*NER*) (Unterhalter &
Brighouse, 2003). GER are calculated as the number of students enrolled in primary, secondary
and tertiary levels of education, regardless of age, as a percentage of the population of official
school age for the three levels. NER is defined as the number of students enrolled in a level of
education who are of official school age for that level, as a percentage of the population of
official school age for that level (UNESCO, 2009).

The dependence of GER and NER as indicators of progress toward gender equality of access to education have come under criticism over the last decade (Unterhalter & Brighouse, 2003). Because GER data include underage and overage children at each schooling-level without discrimination, they can result in rates exceeding a hundred percent (more than 100 percent of the children are enrolled in school) in many locations. These results give an artificially inflated indication of progress toward gender parity. This potential for over-estimating enrollment casts universal doubt on GER's accuracy and reliability.

NER include only the students who are age-appropriately enrolled in school. When available, using NER not only avoids the over-estimation danger of GER but also gives some indication of out-of-school rates. However, NER cannot account for students who are still enrolled but not in the age appropriate cohort. Therefore, NER has the tendency of underestimating enrollment (Sack, 2003). In addition, calculating NER requires detailed data on children's ages which is often unavailable in many developing countries. Sack goes further and questions the advantages of NER as a policy tool as it excludes a significant portion of older and repeating students who, under EFA policy, should be included.

Collectively, enrollment rates only capture one of many important aspects of educational access. While enrollment is a critical condition, student attendance, participation, completion, and knowledge and skill attainment are more important objectives of receiving an education than enrollment alone. World Bank and other agencies use gross completion rates for this reason, but as Lewin (2007) argues, "Completion rates, another widely used indicator are also insufficient both because of the difficulties of calculating them and because completion may occur at any age and often without any criterion referenced level of achievement."

While the limitations of GER, NER and completion rates are considerable, the most significant weakness is the unreliability of the data used to calculate them. The data needed are often difficult to obtain. At times, local officials may not understand why the data are being collected, or suspect that over-reporting the number of students will secure additional resources for their area (Unterhalter, 2006). Accountability and oversight over the data acquisition remain a major concern (Mehta, 2004).

The rudimentary measurements of GER and NER measure enrollment ratios are widely accepted as gender parity measures, but they are limited in their ability to monitor what factors are facilitating or inhibiting access to schools. A critical need exists for the distinctions between the concepts of gender parity and gender equality to be clearly understood. Data and methods designed to assess gender parity should not be misunderstood as demonstrating gender equality. As UNESCO (2004) declared,

> The challenges of achieving parity do not end with the achievement of equal numbers of boys and girls in school, although that does represent a significant step towards the achievement of gender equality in education. As this chapter shows, gender equality is not a purely quantitative goal – it relates to the wider issues of equal opportunity, treatment and outcomes in education and in society more generally. (p. 153)

Distance as an accessibility measure. In general, the further something is away, the less likely people will travel to it (W. Tobler, 1969). The simple implication is that potential students that are farthest away from schools are the most disadvantaged in terms of access. While there are many potential obstacles to accessibility besides distance, accessibility usually requires movement, and movement implies a cost (Claval, 1998). Therefore, distance is very often relevant in accessibility discussions. In some cases, the movement costs (in energy, fuel, time,

etc) are not only relevant - they represent the most significant cost to achieving access (Pitt, Rosenzweig, & Gibbons, 1993).

While many researchers studying accessibility acknowledge distance as being important, few researchers are careful to specifically conceptualize access in a way that explicitly accounts for distance. Borrowing from geography's substantial literature of spatial theory of distance (Khan & Bhardwaj, 1994; Kwan, Murray, O'Kelly, & Tiefelsdorf, 2003; Recker & Schuler, 1981; W. R. Tobler, 1970; Wilson, 1975; Worboys, 2001), the approach for measuring accessibility can be expanded beyond counting potential users and the available capacity of resources or services by considering the effect of distance between potential users and resources.

Accessibility as a function of distance has its roots with the works of German geographer Walter Christaller and his "Central Place Theory" (Christaller, 1966). Originally published in 1933, Christaller developed this theory to describe orders of influence he observed emanating from large cities to their surrounding hinterlands. His basic premise was that the further away from the city (central place) the less influence that city exerted on a location. In order for the central place theory to work, Christaller made two assumptions; first, humans will always purchase goods from the closest place that offers the good, and second, whenever demand for a certain good is high, it will be offered in close proximity to the population.

Many have maligned Christaller and the central place theory for its obvious over-generalization of complex spatial relationships and unrealistic assumptions, but others saw it as a foundation from which more robust models could be built (Hansen, 1959; Hoyt, 1939; Losch, 1954). Eventually the idea of an inverse relationship between distance and influence was formalized into operational models called "gravitational' models (Wilson, 1967, 1975).

Also referred to as "*Spatial Interaction Models*," *gravity models* get their name from conceptual similarities with Isaac Newton's Law of Gravitation (Abler et al., 1971; Gatrell, 1983). They attempt to predict movement of people, information, and commodities between cities and regions by taking into account the population size of two places and their distance. In their most basic form, gravity models assess the relative strength of a bond (i.e. the potential for interaction and/or access) between two locations by multiplying the population of one city by the population of another city and then dividing the product by the distance between the two cities squared. This can be expressed in the following formula:

$$\text{Potential Accessibility} = \frac{(\text{Population1}) \times (\text{Population2})}{\text{Distance}^2}$$

More complex gravity models were found useful for estimating general trade areas within definite geographic boundaries by estimating probabilities of accessing locations based on these principals of spatiality. However, such models are limited because they merely calculate the "potential" for access and have difficulty accounting for personal choice, social or other aspatial variables (Wang, 2006).

Some researchers have argued that accessibility can best be approached as the relationship between supply and demand over space. As such, Gatrell (1983) tried to incorporate the influence of personal motivation when he defined accessibility as *the ability* and *the desire* to overcome the spatial separation between resource supplies (in education this could be something like seats in school) and user demand (again, in education this could be something like families and students seeking a better school). Supply and demand ratio models have two important limitations. First, because the data must be regionally aggregated, they cannot explain spatial variations within the region, which can be significantly large (Wang & Luo, 2005). Second, they

assume that the demand is met by the supply area.   In the case of education, it is often unrealistic

to assume that schools (particularly in developing countries) only enroll students from a

designated catchment and often localized area (Wawro et al., 2008).

Recognizing that these concepts of accessibility were too simple, Khan (1994) surmised

that only measuring the 'potential for access' and demand did not adequately capture the

multidimensional characteristics of accessibility. He suggests that at least four dimensions must

be considered when assessing accessibility. These dimensions include *potential accessibility*,

realized accessibility, *spatial access*, and *aspatial access*.

Potential accessibility measures seek to ascertain the probable use of a service.   The

gravity models previously described are one mechanism for accomplishing this. *Realized*

accessibility involves measuring the actual use. In an EFA setting, realized accessibility could

be measured by student participation, completion or enrollment data. *Spatial accessibility* is a

measure of spatial separation between the supply and the demand for a service. In the case of

school accessibility, the distance between the student's home and the school. *Aspatial*

accessibility would attempt to account for non-geographic variables that may inhibit or facilitate

access. These could include socioeconomic, cultural or political variables (see Figure 2).

This study will be examining students already enrolled in school and accordingly, the

yellow shaded portion of Figure 2 indicates that this study will be concerned with only the

realized accessibility portion of the Khan's typology. The value of Khan's typology is that it

allows for a more complex modeling of accessibility by incorporating both spatial (distance) and

aspatial (socio-cultural) variables without assigning a hierarchy of importance to either. A

limitation of this typology is its inability to express any relationship between spatial and aspatial

variables.

	Spatial (Geographic)	Aspatial (socio-economic, cultural, political,)
Potential	**I** Potential Spatial/ Geographic Access	**II** Potential Aspatial/ Social Access
Realized	**III** Realized Spatial/ Geographic Access	**IV** Realized Aspatial/ Social Access

Figure 2. Khan's Accessibility Typology

Cognitive distance. Geographical space is not isotropic (uniformly flat and

unchanging), making the cost of overcoming distance uneven and generally not equal to the

physical distance that divides them. Therefore, when considering accessibility it is often useful

to expand the concept of distance beyond conventional units of metric physical distances of

kilometers, or travel time, to include network distances, social distances and ordinal distance

measures (W. Tobler, 2004). In addition, researchers have recognized that people, depending on

their social, economic or culture characteristics, often perceive the effects of distance differently.

These researchers distinguish between cognitive distance (how far something 'feels'), and metric

distance (how far away something 'is' in distance or time units) (Cadwallader, 1975).

People commonly think and communicate their ideas of distance and spatial relations in

ordinal terms such as near, close, far, very far, etc., rather than in quantifiable distance measures

of miles or minutes (Yao & Thill, 2005). Cognitive distances expressed as linguistic ordinal

measures are, by their very nature, imprecise and generalized. These linguistic measures

expressing cognitive conceptions of distance (near, far) need to be interpreted if they can be used

within an analysis model (Montello et al., 2003).

Comparing cognitive perceptions of distances with metric distances may be a fruitful approach to evaluating accessibility because the difference between cognitive distance measures and metric distance measures may be an indication of the overall cost of overcoming distance (Cadwallader, 1979). This approach is potentially much less complicated than alternative spatial models that attempt to explicitly account for every conceivable variable that could affect accessibility. Reducing the number of variables when investigating accessibility and equality of education in developing countries can dramatically improve monitoring capabilities.

Sex, gender, and unequal access to education. UNESCO's 2003/2004 Global Monitoring Report (2004) declared,

> In no society do women yet enjoy the same opportunities as men. They work longer hours and they are paid less, both in total and *pro rata*. Their choices as to how they spend their time, in both work and leisure, are more constrained than they are for men. These disparities generate substantial gaps between how much women and men can contribute to society, and how much they respectively share in its benefits. (p. 25)

The international community continues to plead for progress towards an equally accessible education in all nations. Gender inequality is seen as the both cause and consequence of gender-unbalanced education systems (UNESCO, 2003/4). If the vicious, auto-reaffirming pattern of male-dominated power relations is to be appropriately rebalanced, women must have as equally accessible educational opportunities as men.

As stated earlier, UNESCO acknowledges that measuring gender parity (appropriate boy/girl enrollment ratios) is easier than measuring gender equality (gender-free educational outcomes) (UNESCO, 2009, p. 11). Gender parity measures are static, comparable, and they are easier to obtain, understand and defend. However, UNESCO also acknowledges an important

limitation of gender parity measures is that "a focus on quantitative balances reveals nothing

about the processes by which they are being secured, nor about the qualitative changes that

would be necessary if gender parity is to lead to full equality" (UNESCO, 2003/4, p. 116).

Measuring gender equality, which encompasses much more than enrollment ratios,

requires a different approach. It requires that the researcher understands that the unequal power

relations between women and men are largely a result of artificial social constructions that lead

to distinct disadvantages for women.

Feminists have been arguing for decades that explicit distinctions between ideas of "sex"

and "gender" are important (Davidson & Kramer Gordon, 1979; Oakley, 1972; Wharton, 2005).

They agree that biological differences between the sexes are real and do result in somewhat

different capacities. However, gender differences, they maintain, are artificial, and socially

constructed. Gender differences have more to do with the expectation and assignment social

roles based on their sex. The roles assigned to women have almost uniformly devalued women's

contribution while limiting their opportunities for personal growth (UNESCO, 2003/4).

An important contribution of feminist research is the acknowledgement that sex and

gender contribute to an individual's perspective on the social and physical environments they

live in (Oakley, 1972; Renzetti & Curran, 1989). Research has shown that gender-based

attitudes may produce different concepts of the costs associated with overcoming the distances to

schools (Bommier & Lambert, 2000; Filmer, 2004; Gertler & Glewwe, 1992; UNESCO,

2003/4). Therefore, an analysis that compares cognitive distances with metric distances can also

be used to investigate issues of gender equality in educational access. Gender differences in the

perceived cost of distance to attend school may add a rich new dimension to an accessibility

measure that metric distances alone cannot.

The biological trait of sex (Renzetti & Curran, 1989) is similar to the spatial notion of metric distance in that they are both notions of 'absolute' measurement or objective 'reality'. On the other hand, gender (Davidson & Kramer Gordon, 1979) corresponds with cognitive distance in that they are both expressions of affective or sociological constructions. In the minds of most people, however, both gender and cognitive distance remain functionally inseparable from notions of sex and metric distance. Nonetheless they are and should be separable and distinct in their usage and implications. Comparing cognitive estimates of distances and metric distances can account for both separately.

Spatial analyses of gender equality in access in developing countries. Spatial approaches to measuring accessibility in developing countries have flourished over the last twenty years in several areas of social services research. Abundant research exists, particularly in the area of health services, to assist policy-makers plan and evaluate the effectiveness of the distribution and access to health services. Growing awareness of global health crises such as the HIV/AIDS epidemic, malaria and malnutrition are terrible reminders that many parts of the world are tragically impoverished and the question of "where" to concentrate assistance must be carefully considered. These needs have even produced the development of a subcategory of spatial analysis called health or medical geography (Meade & Earickson, 2005).

Despite the successful utilization of spatial analyses in the area of accessibility to health services, considerably less effort has been made to investigate more effective measures of gender equality in access to educational resources in developing countries. This gap is unfortunate, as the principle of accessibility to health care services would seem to be easily transferable to addressing accessibility to schools. Furthermore, most of the education accessibility studies have focused on aspatial variables such as parental education attainment, socio-economic status,

family structure and size, gender, cultural taboos, school staffing size and/or ability, school size, school facilities, school types, etc., (Mannathoko, 1999; Shabaya & Konadu-Agyemang, 2004) but few explicitly investigate the effect of distance on accessibility. A few studies observed that distance was a factor but treated this finding with little rigor, as if the researchers were surprised to find spatial influences on accessibility and were unprepared to account for it.

Shrestha et al. (1986) found the second most significant determinants for participation in school among Nepalese children was the distance to the school from their home. That study also found that Nepalese households were more consistent with establishing a maximum distance threshold for sending girls than for boys. The author surmised that because education was seen more as a luxury for girls in Nepal, rather than a necessity, that girls' participation would be more universally effected by suspected determinants than boys who seemed more expected to attend school regardless of their circumstances. But the Nepalese study only asked one question explicitly regarding distance, losing the opportunity to delve deeper into the richer complexities of the relationship between proximity and accessibility.

Some research does exist that specifically evaluated the role of distance to accessibility to schools in developing countries. The majority of these studies examined effects of distance on the supply and demand of schools. In this regard, research has shown that distance to public service locations effect the access of those services (Mayer, 1983). A retrospective study by Esther Duflo (2001) of a large-scale school construction program in Indonesia between 1973 and 1980 found that additional schools led to higher average education attainment. The program, which resulted in increasing the number of schools by more than 1 per 500 children, resulted in the order of .2 to .4 additional years of schooling for those children in Indonesia. The results were even stronger in poorer regions. In rural Ghana, a bigger distance to all types of schools

reduced the probability that a child aged 5 to 12 had ever been to school, and reduced the number

of years a child would spend in school (Lavy, 1996). A panel data study of over 4,000

households in rural India between 1971 and 1982 found that the new construction of a school in

a village significantly increased the probability that a child aged 5 to 14 was enrolled (Foster &

Rosenzweig, 1996). Bommier and Lambert (2000) found that distance to schools in Tanzania

not only effected initial enrollment, but influenced how many years students stayed in school.

Other researchers looked at how distance effected enrollment by gender. Not

surprisingly, they found girls were at a disadvantage (UN Millennium Project, 2005; UNESCO,

2003/4, 2009). Gertler and Glewwe's (1992) study found that Peruvian households were more

willing to send their boys further to school than their girls. They were not certain if that was

attributable to the fact that they wanted to give their boys the best education possible or if they

wanted to keep their girl's closer to home so they could continue to be available for housework,

or some combination of both.

A few studies disputed the strengths of these earlier findings. Handa (2002) argued that

although distance was a significant condition to accessibility, building more schools was less a

productive investment, in terms of rates of return, than improving the quality of existing schools.

Filmer (2004) agreed with Handa, and Filmer's regression analysis also found distance

statistically significant, but with distance only accounting for a 2 or 3 percentage point increase

in enrollment associated with a 1 kilometer reduction of distance.

Filmer's (2004) study used aggregated Demographic and Health Surveys (DHS)

conducted in the 1990s, which were not designed for educational assessments. The distance

variable used in Filmer's analysis was the respondent's guess of the distance to the closest school

with no information of the quality of that school. Since quality of the school is usually found to

be a significant factor in school choice (UNESCO, 2005), and most African schools have open

enrollment, it is reasonable to expect that at least some students will not enroll in the school

closest to them. This would make it appear that distance is less of a factor, when in reality the

student still chose the best school within an accessible range.

      Gender equality in access to secondary schools in Uganda. Research has examined

the gender equality of educational access in Uganda. Deborah Kasente (2003) reported findings

from the most recent DHS survey conducted in 2001 by the Ugandan Bureau of Statistics. The

survey indicated that distance was the most common reason for Ugandan girls to not attend

school. The Ugandan households surveyed indicated safety of the girls and the need for her

labor at home as the reasons distance to schools concerned them most. She also found distance

was a significant reason for Ugandan boys to not attend as well, second only to the monetary cost

of attending school.

      Other research of school accessibility by Hite et al. (2007) compared the impact of

several types of distances (Euclidean, road network distances with impedance factors for road

quality, topographic obstructions, etc) between schools and the effect of those distance types on

school non-financial resource exchange relationships. One important finding of that study was

that schools that were close to a paved road were better positioned to share qualified teachers

with other schools. This is an important advantage over the more remote rural schools, as there

are acute shortages of qualified teachers (particularly science teachers) throughout Uganda.

      Wawro et al. (2008) contributed to education accessibility research in Uganda by

comparing the average distances that boys and girls travel to two boarding schools in Mukono

District, Uganda. The findings of this small pilot study demonstrated that student home village

location data can be accurately collected which may potentially open doors for better distance

cost analyses than were previously available from aggregated DHS and census data. The study also showed that catchment ranges can vary considerably according to school size, type and location of the school as well as the gender of the student.

Summary of Literature

The Education for All (1990) initiative represents the global expectation that all children have the right to an education. However, measuring progress toward the goal of providing equal access has proved difficult. While the data collected indicates significant progress has been made regard gender parity, it is much more of a challenge to accurately assess progress toward measuring gender equality.

Accessibility is not easily conceptualized and many researchers inappropriately neglect the influence of distance while others rely on poor distance estimates, aggregated survey data, and incomplete location data for their analyses, which very often result in unclear findings. The most reliable studies acknowledge that accessibility measures must include both spatial (geographic) and aspatial (non-geographic) variables in order to capture a more complete picture of the conditions that influence school enrollment, participation and learning. Despite their deficiencies, the existing research largely agrees that distance matters, and that girls are more impacted by distance costs than boys.

Two important gaps appear to exist in both the literature and the accessibility measures currently used for EFA assessment in developing countries. The first is the obvious lack of accurate location data of both schools and students that have been used in distance-related analyses. This deficiency is understandable, as collecting this type of location data can be expensive and is logistically very challenging on a large scale. However, if conducted in specific

sample locations, these data can provide important opportunities to validate or reconsider our understanding of accessibility processes observed with aggregated data.

The second gap involves the acknowledgement that distances and the costs associated with the travel necessary to attend school may be perceived differently according to gender or other individual or household characteristics. By comparing actual metric distances with perceived distances in the form of ordinal classifications like near and far, researchers may gain a deeper understanding of the variability of the cost of accessing an education. This type of measurement has the potential to provide more solid evidence of progress toward the gender equality standard of EFA than the methods currently utilized.

Chapter 3: Methodology

To determine gender equality in regards to education access, this study used spatial analyses of distance between students' homes and the schools they attended. The types of spatial analyses utilized in this project included *visualizing* the spatial distributions of student home locations around each school, *identifying* the real (metric) distances that separate the students' homes from the school they attend, and then *comparing* those metric distances to the perceived (cognitive) distances of secondary students attending school in the Mukono District of Uganda.

Purpose and Research Questions

The objective of these analyses was to determine if either of the types of distances measured, metric or cognitive, were found to be discernibly different between male and female students in Uganda. Differences may be an indication of gender inequality of educational access. In order to *visualize* the spatial distribution, the researcher calculated and plotted maps illustrating the *Standard Distance Deviations* (*SDD*) for each of the surveyed schools. Using GIS technology, the researcher *identified* Euclidean, travel and time distances the students had to overcome in order to attend their school. The researcher *compared* the distances male and female students travelled to school, and how far those distances were cognitively perceived by male and female students using multiple inferential statistical methods including two-sample *t*-tests, ANOVAs, and Ordinal Logistic Regression (OLR).

Two research questions guided this study's approach to exploring gender equality in education accessibility:

Research Question 1. Do male or female students travel further to school in Uganda and how are school characteristics related to those distances?

Research Question 2. Do male and female students perceive the cost of distance

differently and how are school characteristics related to those perceptions?

The first question focused the research on acquiring information regarding the actual or

metric distances students in Uganda travel from home to school. Acquiring this information

directly addressed the first research gap discussed in the literature review: namely, the lack of

precise distance data used for assessing the role of distance in school accessibility (Duflo, 2001;

Lavy, 1996; Shrestha et al., 1986).

The second research question attempted to address the second gap identified in the

review of literature which could not find any research on school accessibility which attempts to

account for different perceptions of distance based on student characteristics or school

characteristics. In order to learn directly about a student's cognitive perception of distance, each

student was asked to assess the distance they traveled to school on an ordinal scale of *very near*,

near, *far*, or *very far*. However, as cognitive distance measures are not independent of metric

distances, this research proposed testing several hypotheses regarding how students' perception

of the distance between home and school was related to the three different types of metric

distances, including:

Hypothesis 1. Cognitive distance measures between the student's home village and

school are significantly related to their *Euclidean distances*,

Hypothesis 2. Cognitive distance measures between the student's home village and

school are significantly related to their *travel distances*,

Hypothesis 3. Cognitive distance measures between the student's home village and

school are significantly related to their *time distances*,

Hypothesis 4. Cognitive distance measures between home village and school are

significantly related to *student characteristics*, and

Hypothesis 5. Cognitive distance measures between home village and school are

significantly related to *school characteristics*.

These hypotheses effectively break up the study's research questions into parts testable

by the inferential statistical procedure of Ordinal Logistic Regression. The OLR model also

allows for other explanatory variables such as school characteristics to be included resulting in

evidence of significance, direction and strength of these variables.

Spatial Analysis as a Method of Studying of Gender Equality of School Accessibility

The name of the largest international effort in history aimed at improving education

access, *Education for All* (1990), communicates both the reality that schools are not currently

equally accessible for everyone and the global commitment for improvement. Who is most at

risk of exclusion? According to the Dakar Framework for Action, and subsequent EFA policy

and reporting documents that have continued to place a special priority on achieving gender

equality of educational access, one population of particular priority and concern in this regard is

girls (UNESCO, 2000, 2003/4, 2008, 2009). UNESCO's 2003/2004 Global Monitoring Report

(2004) states,

> Gender equality requires the achievement of equal outcomes for women and men,
>
> notwithstanding that they are starting from different positions of advantage, and are
>
> constrained in different ways. Women differ from men both in terms of their biological
>
> capacities and in the socially constructed disadvantages they currently face. (p. 116)

This statement recognizes that women are different from men in both biological (sex) and

socio-cultural (gender) senses. Gender parity measures of GER and NER capture enrollment

ratios but are limited in their capacity to examine the deeper social processes affecting accessibility, while spatial analysis allows for the purposeful inquiry of the role of distance in human relations. Accessibility can be succinctly defined as the level of ease to which a place or service can be reached. But, this simple definition belies the actual complexity of potential or realized accessibility as there are many physical, social, cultural, and economic factors to accessibility, such as gender (Lewin, 2007; Shrestha et al., 1986).

Gatrell (1983) explicitly included distance in his definition of accessibility when he stated that accessibility could be defined as the ability and the desire to overcome the spatial separation between resource supplies and user demand. Gatrell's definition suggests that it would be unwise to consider accessibility without accounting for the influence of distance. While Gatrell's statement explicitly identified distance as a barrier to accessibility, he did not state that distance was the only barrier or argue that distance was the most important determinant of achieving access.

In their attempt to refine the conceptual understanding of accessibility to health care facilities, Khan and Bhardwaj (1994) provided a more comprehensive conceptualization of accessibility that recognized that distance can be either a barrier (when far) or a facilitator (when near) to accessibility. Khan and Bhardwaj also formally distinguish between the spatial (distance-based) dimension and aspatial (social-based) dimension of accessibility. Aspatial factors would include non-geographic factors such as political or economic conditions. They may also include cultural factors such as language or religious climates. Because the economic, political and cultural conditions of the study area are reasonably homogenous in the study area of Mukono District, this study isolates its focus on the socially constructed notion of gender as the most salient aspatial factor.

An adaptation of Khan and Bhardwaj's (1994) model of spatially dimensioned accessibility to the context of education can be found in Figure 3. The yellow-shaded portion of Figure 3 demonstrates the conceptual model of four core mediating factors of gender equality in accessibility explored by this study. While this "School Accessibility Model" has its roots in Khan and Bhardwaj's general accessibility model, it expresses more explicitly the role of distance as a mediating variable for the production of gender equality in school access and it anticipates that gender may mediate the effect of distance on the production of gender equality in school accessibility (Figure 3).
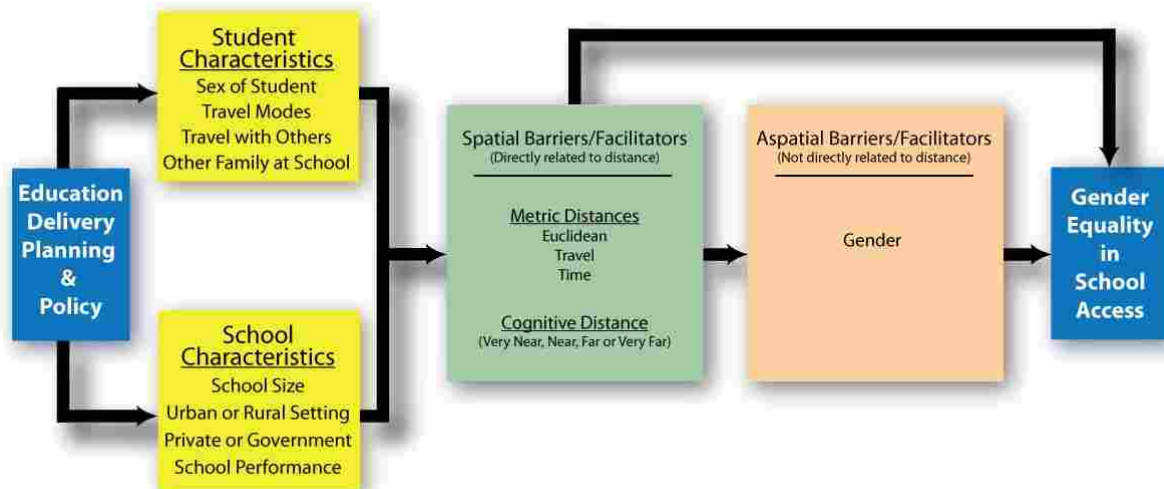
Figure 3. School Accessibility Model

The School Accessibility Model describes how educational policy and delivery efforts to support and provide for schools that are in accessible locations for both male and female students are continually mediated by the characteristics of the schools and the students, the reality of the various types of distances between students' home locations and available schools, and suggests the socially-constructed idea of gender may affect the perceptions of the cost of school access.

Consequently, gender preconceptions regarding the perceived cost of distance may be related to

a parent's willingness to send their sons and daughters different distances to school.

While many student characteristics could have be measured, this study considered four

student characteristics (a) the sex of the student, (b) the mode of travel to the school, (c) whether

the students traveled with others, and (d) whether the student's had other family members who

attended the school. Other student characteristics may have also played a significant role in

affecting accessibility but this study was limited by data collected through student surveys

conducted at school locations, therefore, the data were limited to the knowledge and perception

of the students. Household incomes, for instance, could not be reliably determined from this

type of student survey.

The school characteristics that were considered included (a) the school's size, (b) whether

the school is located in an urban or rural environment, (c) whether the school was privately

funded or received government subsidies to sustain itself, and (d) the school's performance level

on national exams. The possible significance of school characteristics were demonstrated in a

previous pilot study looking at the relative catchment ranges of various school types in Mukono

District, Uganda (Wawro et al., 2008) and the definitions of these school characteristics are

discussed more fully later in this chapter when the sampling strategies are outlined.

The final school characteristic of school performance was not a consideration during the

school sampling stage as the research team did not have school performance information at the

time the schools were selected for participation in the study. Two days before the research

team's departure from Uganda, the Uganda Ministry of Education and Sports provided school

performance data in the form of an Access database that reported how all students performed on

the national Uganda National Education Board (UNEB) exams from 2001 through 2008. Included in the information was the school the student attended at the time they took the exam.

The School Accessibility Model includes multiple ways that distance (spatial barrier/facilitators) can be conceptualized. These alternative conceptualizations provided deeper insights into the relationship between the costs of different types of distance and accessibility, and whether those costs are equally born by the subjects, particularly in terms of gender equality. This study focused on four separate types of distance; the first three are classified as *metric distances* and they include Euclidean distance (as-the-bird-flies), travel distance (along the most direct road pathway), time distance (the time it takes to journey between home village and school as reported by the student). The final distance is the ordinal *cognitive distance* measure of *very near, near, far,* and *very far* (as reported by the students). Of particular interest are the comparisons between the first three distance measures and the last, cognitive distance measure.

Study Setting

This study was an extension of the research conducted in Uganda since 2000 by Dr. Steven J. Hite, Professor at Brigham Young University and Dr. Julie M. Hite, Associate Professor at Brigham Young University. In particular, this study extended the exploratory spatial analysis of data produced from a pilot study conducted in Mukono District in Uganda in 2008 with the assistance of Patrick R. Wawro, Ph.D. candidate at Brigham Young University and a team of undergraduates from BYU who utilized GPS technology to locate and collect data on more than 250 secondary schools in the district, in addition to home village location data for secondary students at two of those schools.

Mukono District is one of approximately 80 provincial districts in Uganda. It is located in southern Uganda on the northern shores of Lake Victoria about 30 kilometers east of the

national capitol, Kampala (see Figure 4). Mukono District has a population of 800,000 (Uganda Bureau of Statistics, 2002). Mukono, like most of Uganda, has an equatorial tropical climate but its elevation of 1,370 meters (4,500 ft) keeps year round temperatures moderate around 27 degrees Celsius (approximately 80 to 85 degrees Fahrenheit).

Accessibility to the study area was an important factor for choosing Mukono District as the study site. It is close to the international airport at Entebbe and the capital city of Kampala and is therefore financially and practically more accessible for the study team than the more remote outlying districts.

Mukono District presents a balance of urban and rural school environments and through extensive numbers of secondary boarding schools (n=224) draws a wide variety of students from most districts in Uganda, as well as from all neighboring countries. Due to these characteristics, Mukono District was considered not only a reasonable area to study but also presents important characteristics useful for a wide variety of sampling approaches and study contexts.

Sampling Strategy

Subjects for this study were chosen using a non-randomized two-stage cluster sampling technique. Using the school characteristic information obtained from the 2008 pilot study, all mixed gender secondary schools, with both day and boarding components in Mukono District were stratified on the basis of the following criteria: 1) urban or rural, 2) government or private, and 3) large (500 students or more) and small (less than 500 students). The 2008 pilot study results suggest that school size may be important as larger schools often have more resources, and larger student bodies and staffs have a naturally larger potential for various social, political and economic networks to be developed.
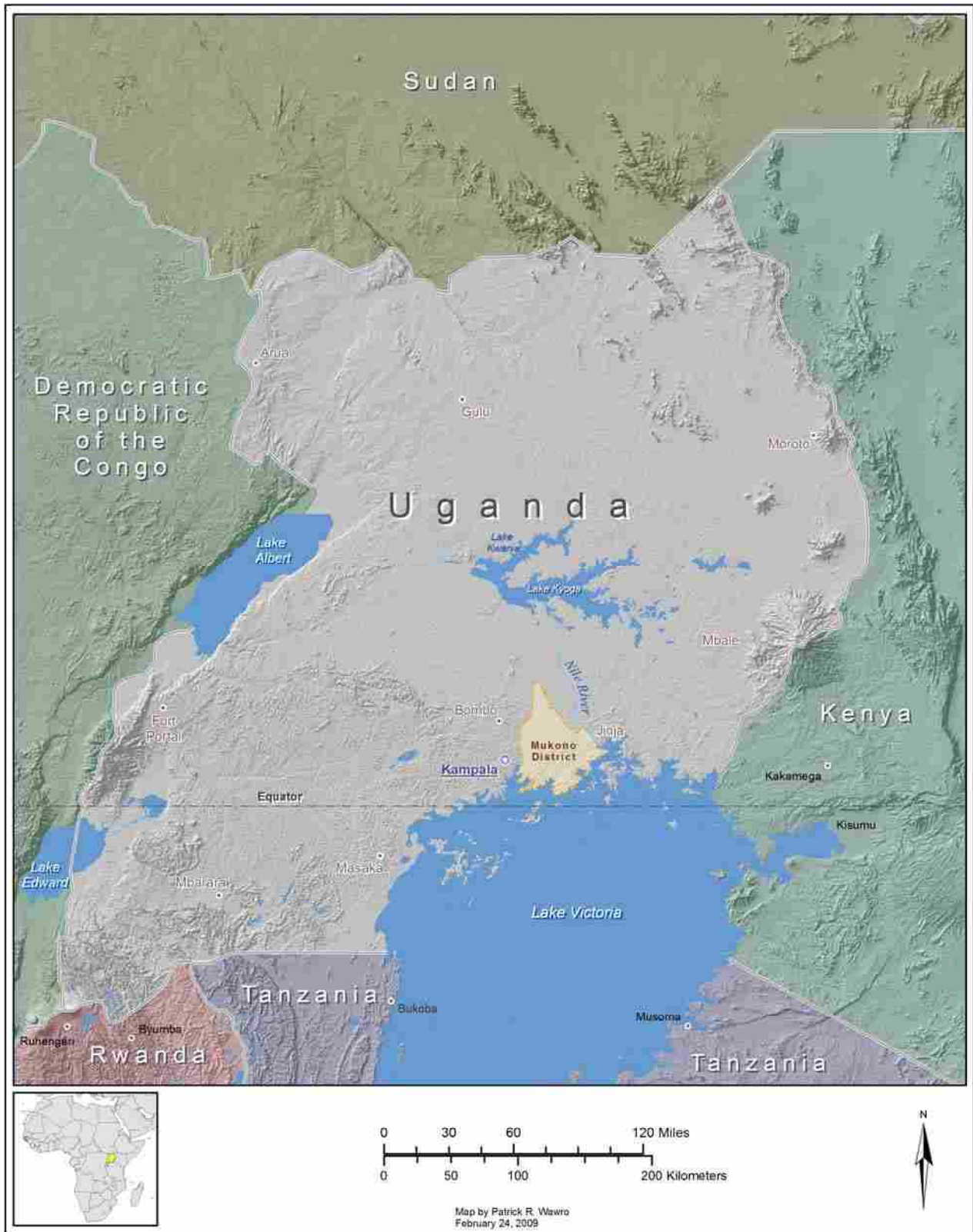
Figure 4. Uganda Base Map

Schools in urban environments are surrounded by more developed traffic infrastructures than schools found in rural environments. Better roads and public transportation services such as taxis may increase the range of students. For the purposes of this study, urban schools were determined to be within 5 kilometers of the Mukono Town Center which is the largest metropolitan area within Mukono District. Although smaller than Mukono Town, there were three other regional population centers in Mukono District that this study considered an urban setting including Lugazi, Nakifuma, and Mbiko (Figure 5).

Lugazi is the most populous municipality in Mukono District east of Mukono Town and is an important trading center. All schools located within 2.5 kilometers of the Lugazi Town Center were considered urban. Both Nakifuma and Mbiko are smaller than Lugazi, but they are both located on main tarmac roads and represent regional centers of activities in Mukono District. Schools located within 2 kilometers of their respective town centers were considered urban schools. All schools in Mukono District located outside of these four population centers were considered to be in a rural setting.

For the purposes of this study, government schools are defined as schools that the Uganda's government provides partial or full financial support through its Ministry of Education and Sports. Government schools are older than most private schools and are often more well-known. Government subsidies that government schools receive may also increase the perception among the families of enrolled and potential students of school stability, possibly increasing the school's attractiveness to potentially enrolling students.
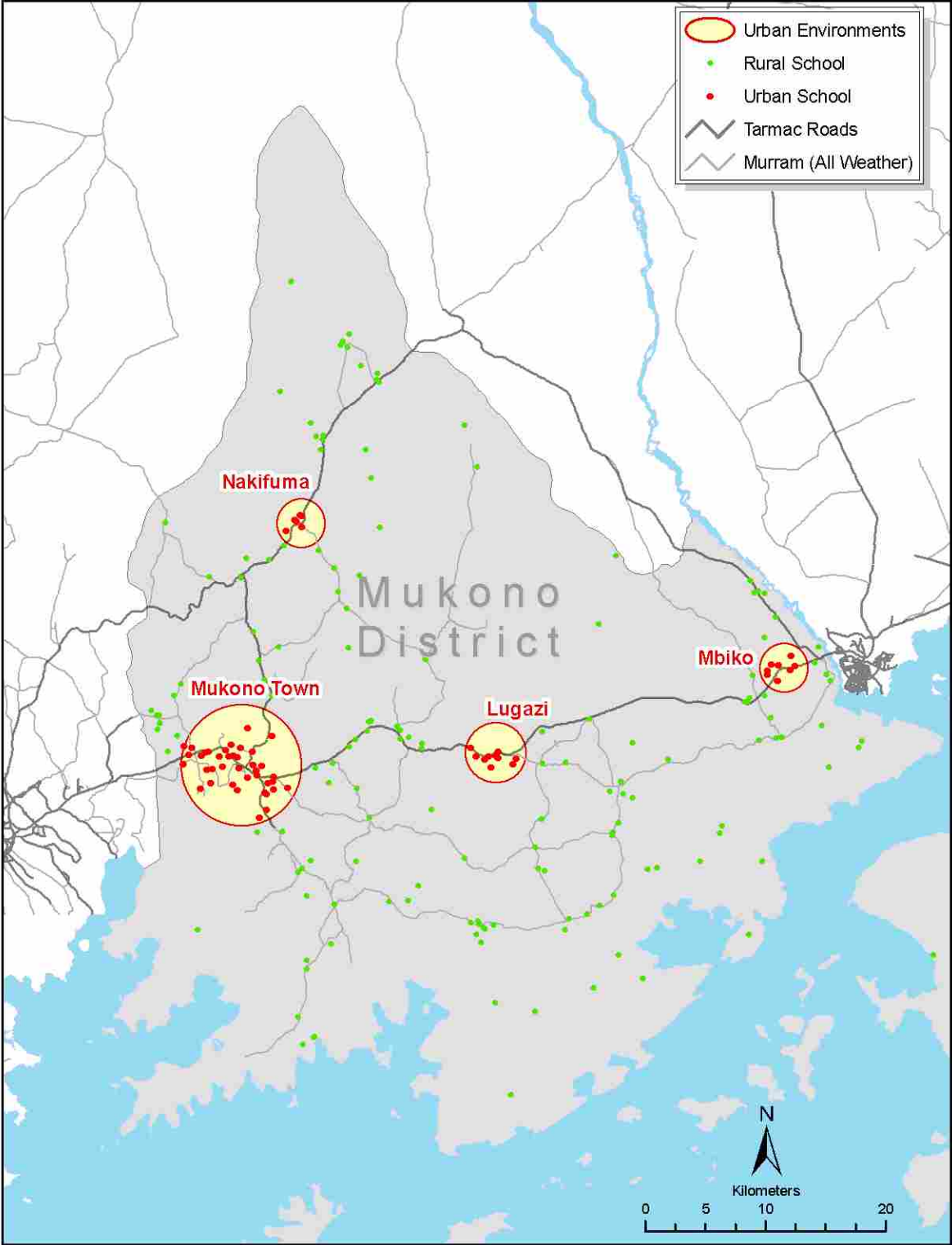
Figure 5. Mukono District Urban Environments

A school from each of the eight categories of school characteristics (urban/rural,

government/private, small and large) was identified and visited by the research team (Table 1).

On these initial visits, the research team met with the head teacher to ascertain first, whether the

school still maintained the desired characteristics (the appropriate number of students, both boys

and girls, and both day and boarding components) and second, whether the school's

administration were willing to participate in the study.

Every school contacted was willing to participate but one school had discontinued their

boarding component and therefore no longer qualified for this study. Another school in that

same category was identified and once the characteristics of that school were confirmed and their

willingness to participate assured by a site visit, the date of the study visit was scheduled.

Table 1

Sampled Schools by School Type, Size, and Setting

	Government		**Private**	
	Urban	**Rural**	**Urban**	**Rural**
Small	School 39	School 151	School 137	School 304
Large	School 11	School 66	School 252	School 28

* *Note*. The school names in this table and throughout this paper have been replaced by the school identification number used in the 2008 pilot study in order to preserve student anonymity.

The small and purposeful selection of schools does impose a limit on the power of the

inferential statistical analyses and the generalizability of the results to larger populations.

However, school cooperation in the form of complete access to all the S4 and S6 students

(equivalent to American 10th and 12th grades) at each school was extremely important and

provided a considerable sample population of students adequate for the needs of this exploratory

study. All things carefully considered, accessibility to schools and the student participants in the

prevailing difficult conditions were considered more critical than the consequent inferential

limitations. Certainly others might make different decisions in this regard, but the author of this

study determined this tradeoff to be the best course of action for this particular exploratory

inquiry.

A last selection criteria for the schools was purposefully but informally imposed in the

sampling decisions. Schools were chosen from as wide of geographic range as possible with the

Mukono District. While three schools were in or near Mukono Town the other five were spread

throughout the District with each directional region represented by at least one school (Figure 6).

It was not practical for the research team to collect data from every student enrolled at

each of the selected the schools. The second stage of the stratified cluster sample involved the

decision of which students to focus the study on. The researcher determined that between 100

and 120 students at each of the schools would be sufficient for the purposes of this study. At the

smaller schools (schools with less than 500 overall students enrolled) all students from grades S4

and S6 attending school on the day of the data collection were included in the study, thus each

school is a cluster, with the school type and student characteristics of grade level, sex, and

day/boarding status being the primary strata. At the larger schools where there were more than

500 students enrolled, a convenience sample of approximately 100 to 120 S4 and S6 students

was selected to participate, with the intent that each student type of the strata (grade level, sex,

and day/boarding) would be evenly represented at these larger schools.

The decision to focus on S4 and S6 grades is based on the particular academic

characteristics unique to the two levels of secondary study in this context. S4 and S6 are the

grade levels when students prepare and sit for their national exit exams.   The researcher believed

that, in general, students attempt to be enrolled at the highest quality school possible based on

their prior academic performance and their family's financial ability.
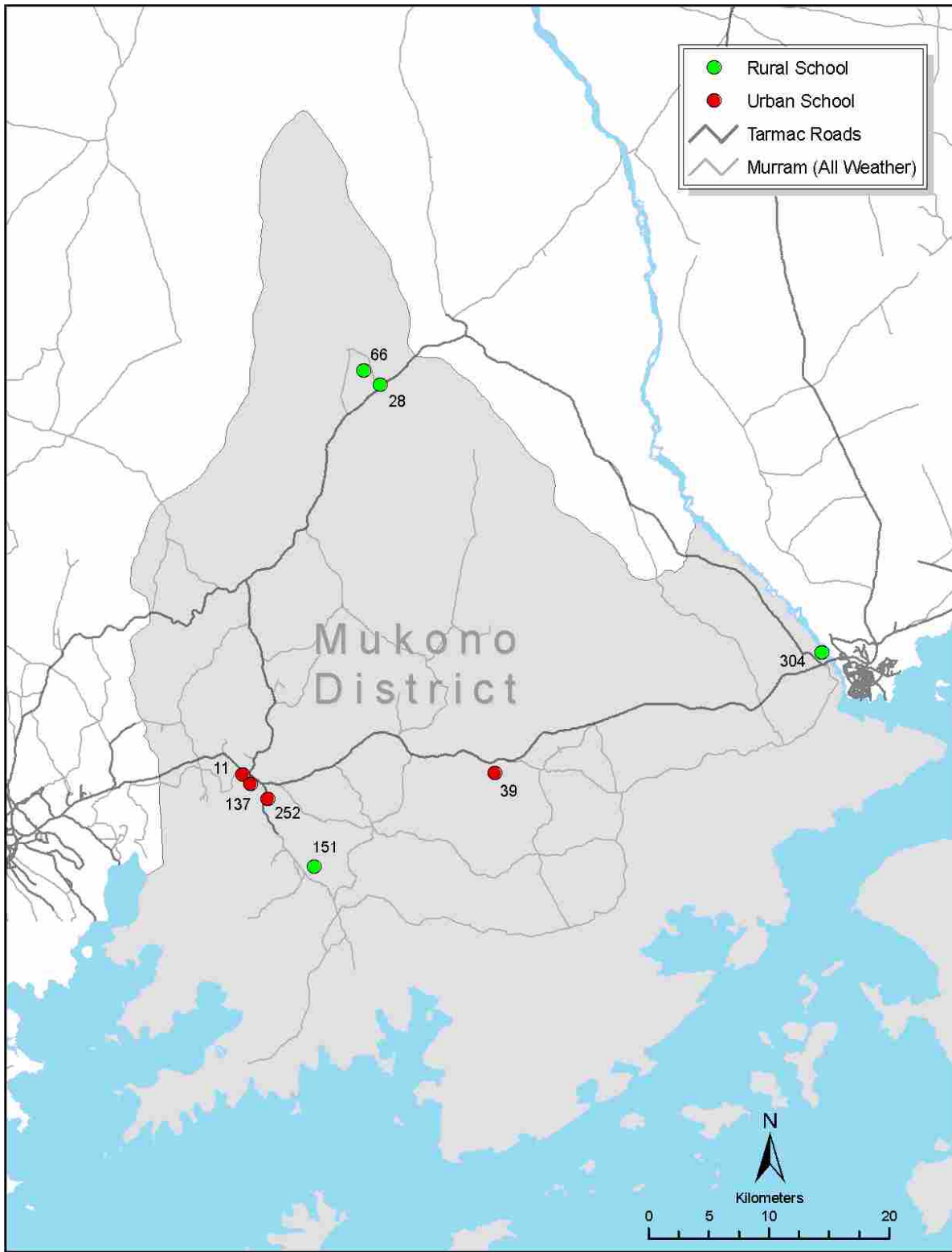
Figure 6. Geographic Spread of Sampled Schools

Because the stakes are high for both the student (high test scores improves future educational and employment access) and the school (high test scores improve the status of the school, improving enrollment demand) during these grades, this population of students likely represented the best data appropriate for assessing the gender equality of educational access in this research setting.

Students in S4 and S6 also tend to be more stable at their school in those years than in other grades due to issues surrounding the national exit examinations. Briefly, many (if not most) Ugandan S1, S2, S3, and S5 students tend to be 'nomadic' in order to avoid payment of school fees, and to search for the best academic environment possible for the least cost (reducing the burdens on family incomes during the less 'critical' years of schooling). Consequently, the greater locational stability of S4 and S6 students allowed the researcher to obtain more consistent information regarding student travel patterns back and forth from their home village.

Because the data collection methods at the schools required a significant disruption of regular school activities for a whole day, it was anticipated that not all school headmasters would be eager to participate. The team brought incentives for schools to help compensate for the inconvenience. These incentives include teaching materials such as instructor's text books, athletic equipment, and a map of the Mukono District with the location of all the secondary schools displayed. The head teacher selected the students at their school who would receive the scholarship and after the study was concluded the research team and the school administration held a short award ceremony to announce the scholarship to the student and then the money was paid directly to the school's bursar.

Data Collection Methods and Research Team Roles

The research team included Ph.D. candidate Patrick R. Wawro, two full-time BYU professors, Dr. Steven J. Hite and Dr. Julie M. Hite, and two undergraduate students, Caleb

Baldwin and Cortney Evans. Each member of the team performed specific and essential roles in

regards to data collection.

Prior to arrival, Patrick R. Wawro, hereafter referred to as the researcher, designed the

sampling strategy needed for the study. The researcher also designed the core questions of the

student survey needed to obtain student home village location, mode of travel and perceived

ordinal distance measures from each student. Each member of the study team lived with

Ugandan families in their homes. This arrangement proved very fruitful to the purposes of the

study as it allowed the researcher to pilot the survey questions on appropriately-aged members of

the Ugandan family hosting him during his stay in Uganda. Their feedback was instrumental for

adapting the questions to the local vernacular of Ugandan students as well as identifying other

potential student characteristics that may impact school accessibility levels. A few questions

were added to the survey to help to capture additional student information on tribal affiliation,

primary and secondary language competencies, and anxiety over paying school fees.

Also prior to arrival in Uganda, the researcher created the mapping data support system

for the study team using ESRI's ArcGIS software platform. The mapping database was updated

with the latest and most up-to-date data of the study area, complete with color relief mapping of

Eastern Africa, roads, city and town names, district and other administrative boundaries as well

as every secondary school in Mukono District located during the 2008 pilot study. The mapping

system was sufficiently detailed to accurately locate student home villages throughout Uganda,

and at least approximate their home location if they were international students (there were seven

students in the sample from outside of Uganda). The researcher also prepared and laminated

full-color wall maps containing information already gathered in Uganda on school types and

locations to present to national and local government officials and to the schools as incentives for participation and support.

Dr. Steven Hite coordinated the logistical efforts of the research team including securing housing for each member of the team, appropriating and driving a rental vehicle to transport the research team and acquired a power inverter capable of supplying six to eight hours of electricity necessary for two laptop computers and a projector at schools where electricity were not available (five of the eight schools did not have electricity on the day of our scheduled visit). Dr. Steven Hite also constructed a lightweight mobile projector screen out of a king-sized white bed sheet with grommets sewed in, two long rods and some rope. Dr. Steven Hite was the primary ambassador for the research team with Uganda's Ministry of Education to ensure their support and cooperation. He also arranged a meeting for the research team with Dr. Yusuf K. Nsubuga, the Director of Basic and Secondary Education in the Uganda Ministry of Education and Sports. The team was well received and Dr. Nsubuga supplied a letter of Ministry support that the research team took to each school to demonstrate that the Ministry of Education and Sports was aware of our study, valued its potential for advancing our knowledge of accessibility, and urged all schools to assist this study in what ever way possible. An equally crucial role Dr. Steven Hite performed was to secure participation from each of the school's administrators selected by the research team.

Once a school was selected and that headteacher agreed to participate in the study, a day was scheduled for the research team to conduct the data collection from the students. The research team arrived at each of the schools at approximately 9:00 am and met again with the school administrators to go over the process and needs. With the assistance of the school administrators, an appropriate room was selected and the team proceeded to set up two

computers, a projector and a screen. If necessary, the team would connect to the power inverter if electricity was not available that day.

At each of the schools, the researcher assumed the responsibility of setting up the computer equipment in an appropriate classroom location and preparing the mapping software and database for recording student's home village location. The researcher used this software to produce and project a scalable and fully manipulatable map of Uganda and the East Africa region on the screen. As the students determined the location of their home on the map, the researcher added a location point to the mapping database as well as the student's unique identifying number. Another computer was set up and operated by Dr. Julie Hite for recording student survey data and to provide a redundant student location database. If either computer system failed, the data could be recovered from each independently.

Undergraduate student Caleb Baldwin organized the S4 and S6 students into small groups of approximately ten students, sometimes with the help of the HeadBoy and HeadGirl of the school. Caleb brought the student groups into the classroom for the written survey and home village location exercise. Undergraduate Cortney Evans proctored the surveys, answered any of the student's questions, and screened each survey for completeness before sending the students with their completed surveys to Dr. Steven Hite at the projection screen for the mapping exercise.

Dr. Steven Hite welcomed each student individually to the mapping exercise to help them feel at ease and then quickly looked over the location information on the completed student survey before handing the survey to the researcher and Dr. Julie Hite for data entry. Dr. Steven Hite then asked each student, one at a time, to identify on the projected map the location of their

home village. As needed, the researcher scaled, panned and otherwise manipulated the projected

map to aid Dr. Steven Hite and the student in more easily locating their home village.

When a student's home village location was identified on the map, the mapping

coordinates and student sequential identification number were observed vocally and recorded by

the researcher in the mapping database and confirmed and recorded by Dr. Julie Hite in her

Access database. Once the students were finished identifying their home village locations Dr.

Julie Hite again reviewed their written survey for completeness before releasing the student back

to class. In total, data from 756 students were collected (Table 2).

Table 2

Total Sampled Students by Type

	Females [n = 378]		Males [n = 378]		
Grade Level	**Day**	**Boarding**	**Day**	**Boarding**	**Totals**
S4	85	174	126	115	500
S6	40	79	68	69	256
Totals	125	253	194	184	756

The most surprising result of the sample totals was the lack of female day students and

the large number of female boarding students essentially doubling the number of female day

students. Conversely, the ratio of day and boarding among male students remained collectively

balanced across the entire sample of schools.

On June 8th, 2009, the study team arrived at school 39 for data collection. School 39 was

the first school scheduled and data from 111 students were collected (Table 3). As it was a small

urban government school, the research team collected data from every S4 and S6 student

attending that day. There was no electricity available at the school that day and so the

preparations for the power inverter proved critical for the study's success at the very first

collection site.

Table 3
School 39 Sampled Students by Type

Grade Level	Females [n = 53]		Males [n = 58]		
	Day	Boarding	Day	Boarding	Totals
S4	11	30	22	23	86
S6	6	6	5	8	25
Totals	17	36	27	31	111

Many students struggled with portions of the survey and the mapping exercise. The

research team was also challenged with efficiently dealing with the flow of students while

making sure the survey form were filled out correctly and completely before the student would

leave the study area.

An interesting complication arose when collected data from School 39 as it became clear

that a small number of students who were classified as "day" students did not live with their

parents while attending school but instead had moved in with a relative or friend near the school

while attending. These students are therefore "boarding" with relatives although officially

attending school as a day student. Because they take on characteristics of both boarding and day

students, in this study they are referred to as "Day-Boarders". It is unclear if any, most, or all of

these day-boarder students have financial obligations to their new host family but it certainly

could represent a cost-cutting strategy for families looking for access to better schools.

Unfortunately, although the day-boarding students were indentified, and represented a

small portion (less then 10 percent) of the total data collected at school 39 and every school that

followed, it was at times unclear if the cognitive distance measures provided by these day-

boarder students referred to their parent's home location or the new host family location. These

data points were isolated during data analysis to account for their possible confounding effect on

the data analysis of the rest of the data. An additional question was added to the survey asking

students "If you are a DAY student, and you do NOT live with your parents, raise your hand now

and wait for help." At that point, one of the research team would ask more questions of the

student to ascertain if they were a "Day-Boarder" and recorded the appropriate home location

information.

School 137, a small urban private school was the second school visited. There was no

electricity available and the power inverter was required to run the computer and projector

equipment. Even though it was a minor national holiday called "Sports Day," the school was

still open for classes although much of the day was dedicated to outdoor athletic competitions

among the students. The school officials did allow some day students to go home early but they

assured the research team that the majority of students remained to participate in the holiday

activities, however, the holiday may help to account for the low numbers of day students

recorded at this school. The team collected data from 78 students (Table 4).

Table 4

School 137 Sampled Students by Type

| Grade Level | Females [n = 41] | | Males [n = 37] | | |
	Day	Boarding	Day	Boarding	Totals
S4	3	20	1	16	40
S6	1	17	5	15	38
Totals	4	37	6	31	78

School 151 was the third school visited. The team collected data from all 93 S4 and S6

students attending the small, rural, government school that day (Table 5). For the third time in a

row, there was no electricity available at the school on the day we visited.

Table 5

School 151 Sampled Students by Type

| | Females [n = 57] | | Males [n = 36] | | |
Grade Level	Day	Boarding	Day	Boarding	Totals
S4	17	24	23	3	67
S6	6	10	8	2	26
Totals	23	34	31	5	93

On Thursday, June 11th, the team visited the fourth school, School 304. School 304 was a small private rural school near the shores of the Nile River. Again, there was no electricity on the day we arrived to collect data at the school. This was the smallest school of the selected schools and there were only 63 S4 and S6 students available at the school (Table 6).

Table 6

School 304 Sampled Students by Type

| | Females [n = 35] | | Males [n = 28] | | |
Grade Level	Day	Boarding	Day	Boarding	Totals
S4	7	19	7	15	48
S6	4	5	2	4	15
Totals	12	23	9	19	63

The researchers concluded the week on Friday June 12th, 2009 by collecting data at school 28. School 28 was a large rural private school in northern Mukono District. Although the school reported to have over 700 students enrolled, the research team collected data from every S4 and S6 student attending that day which totaled only 81 students (Table 7).

The Headteacher reported that the school had been recently accused of cheating on the national exams which hurt their reputation causing a sizable number of families to pull their children and enroll them in other schools. Especially challenging was obtaining female S6 day

students at the school as there were only 2 in attendance. When asked, school officials reported

that female day students were discouraged at this school because of safety concerns over their

commuting each day. This discouragement may have been a result of the Islamic religious

culture of the school. However, there were a relatively plentiful number of S4 female day

students (n=17).

Table 7

School 28 Sampled Students by Type

| | Females [n = 34] | | Males [n = 47] | | |
Grade Level	Day	Boarding	Day	Boarding	Totals
S4	17	10	25	6	58
S6	2	5	11	5	23
Totals	19	15	36	11	81

For the fifth school in a row, the team needed to rely on the power converter to provide

electricity to the room where data collection occurred. This school had a large contingent of

Islamic students and even had their own mosque on the school property. Consequently, the

research team had to take a break from data collection from 10:00 am to about 11:30 to allow

students to attend prayer sessions at the mosque. Christian students also had a prayer meeting

during this time in one of the classrooms. Once the meetings were over, the data collection

recommenced without interruption.

The team visited the largest school of the sample on June 15th, 2009. School 11 was a

large urban government school with over 2000 students enrolled and the first school with

electricity available. The team selected a sample of 123 S4 and S6 students rather than

collecting data from them all (Table 8).

Table 8

School 11 Sampled Students by Type

| Grade Level | Females [n = 58] | | Males [n = 65] | | |
	Day	Boarding	Day	Boarding	Totals
S4	13	19	25	13	70
S6	14	12	14	13	53
Totals	27	31	39	26	123

An additional day/boarding classification challenge came to light at school 11 as the team became aware that several students lived at hostels owned by the school that operated near the school's grounds but the school considered the students to be day students. Given that students were living away from home in hostels located adjacent to the school, these students were reclassified in this study as boarding students as their situation more closely resembled that of traditional boarding students than that of day students.

School 66 was the seventh school visited by the research team. Located in the far northern reaches of Mukono District, school 66 was a large rural government school. The team collected data on 100 students (see Table 9) and, similar to nearby sampled school 28, school 66 had very few female day students (n=4).

Table 9

School 66 Sampled Students by Type

| Grade Level | Females [n = 47] | | Males [n = 53] | | |
	Day	Boarding	Day	Boarding	Totals
S4	2	35	8	23	68
S6	2	8	13	9	32
Totals	4	43	21	32	100

School administrators agreed that there were reports of concern from parents regarding the safety of female students walking back and forth to school each day, sometimes before and/or after dark. The team collected data from all S4 students in attendance that day but some S6 were unavailable as they were attending a special presentation by a guest speaker. Electricity was available.

The last school visited by the research team was school 252. The team collected data from 107 students attending the large urban private school that day (Table 10). Aided by the experience of collecting data at the other 7 schools, the data collection at this school was the smoothest and most efficiently handled of all the schools. However, there again was a lack of S6 female day students available for the survey at the school. One possible explanation may be that the S6 class is commonly encouraged to board during that year to better prepare for the national exams. Electricity was available at this school.

Table 10

School 252 Sampled Students by Type

Grade Level	Females [n = 53]		Males [n = 54]		Totals
	Day	Boarding	Day	Boarding	
S4	15	17	15	16	63
S6	5	16	10	13	44
Totals	20	33	25	29	107

Methods of Data Preparation

Immediately after completing the final school visit, and before returning from Uganda, the researcher scanned every original survey sheet into digital electronic documents in Adobe's Portable Document Format (PDF) files. Several digital copies of all research data were dispersed throughout the research team to ensure a complete copy of the data returned home for

analysis. The researcher maintained possession the original surveys and several electronic copies on separate media storage devices during the trip home.

Once home, the researcher transcribed the remaining survey data into the Microsoft Access database that was partially populated by Dr. Julie Hite during data collection. The completed Excel spreadsheet and a full set of scanned surveys were sent to the other members of the research team for additional quality and accuracy verification of the data. The original survey sheets were given back to Dr. Julie Hite for secure archiving at BYU's Department of Education and Leadership offices.

The database was systematically spot-checked for accuracy. Time distance values were converted to minute units. Then the Access data was joined to the GIS database of student location points using the unique student identification number simultaneously assigned to each student in both the GIS and Access databases at the time of the data collection. This critical step brought all of the survey data into the GIS database making it possible for spatial inquiries through visualization and spatial analyses. These spatial analysis functionalities were essential for calculating Euclidean and Travel distances between the student home locations and the schools they attend.

There are two national exams administered to Ugandan secondary students, O-level exams and A-level exams. The study examined school performance data using O-level scores given that they are taken by more students than A-levels. The scoring for O-level exams was also more easily aggregated as O-level exams are scored on a numeric composite scale between 72 and 0 with lower scores indicating higher performance. A-level scores are reported as a combination of numeric and letter scores which are difficult aggregate into a single performance value that is comparable at the school level.

Students attending schools in the Mukono District took the O-level exams between 2001

and 2008 numbered 5,538 individuals. 801 students attending schools in the Mukono District

took the O-level exams in 2008. In 2008, the average Uganda school scored a mean O-level

score of 49.86 (see Table 11).

Table 11

2008 O-level Exam Scoring Means, Individually and Grouped by School Attributes

		Overall Mean	Female Mean	Male Mean
Uganda Average		49.86	51.37	48.58
8 Sampled Schools		37.53	39.19	35.93
School 11		32.79	34.32	31.43
School 137		33.47	34.54	32.35
School 66	High	35.31	37.00	33.98
School 151		40.05	41.39	38.33
School 252		42.57	44.42	40.62
School 39		42.75	44.14	41.31
School 28	Mid	44.61	45.11	44.10
School 304	Low	53.83	55.52	52.27
Large Schools		36.60	38.36	34.98
Small Schools		40.02	41.25	38.70
Urban Schools		36.73	38.42	35.08
Rural Schools		39.39	41.02	37.89
Government Schools		35.52	37.22	33.96
Private Schools		41.31	42.71	39.85

Note. The lower scores indicate higher performance on O-level tests. Generated from UNEB
test results database, Uganda Ministry of Education and Sports.

In order to classify the selected schools into categories, the Uganda-wide range of school test score means were divided into quartiles, that is, one quarter of all Ugandan secondary schools had a mean student score between 0 and 27. Therefore, Quartile 1 included schools with mean scores from 0 to 27. Another quarter of Uganda secondary schools had a mean student score between 28 and 36. Quartile 2 represents school with scores from 28 to 36. Likewise, quartile 3 scores ranged from 37 to 46; and quartile 4 had scores from 47 to 72.

Because sampled schools that had mean scores within quartile 1 or quartile 2 performed above the overall mean, they were classified as *High-Performing*. High-performing schools in this study included Schools 11, 137, and 66. Sampled schools with mean score with quartile 3 with were classified as *Mid-Performing*, including Schools 151, 252, 39, and 28. Only School 304 of the Mukono sampled schools was classified as *Low-Performing* as its mean score of 53.83 fell into the last quartile.

Methods of Data Analysis

Once the data were transcribed, checked and classified the spatial and statistical analyses could proceed. Three types of spatial analyses were conducted for this study. First the data spatial patterns were visualized with Standard Distance Deviation maps. Second, multiple types of distances separating each students' home and the school they attend were identified. Finally, the actual physical distances (metric distances) were compared to the student's perception of the distance (cognitive distances).

Visualizing spatial distributions with standard distance deviation maps. An important step for any spatial analysis is to visualize the distribution of data by plotting it on a map. However, plotting raw location data may hide important patterns that the viewer's eye cannot adequately recognize or quantify.

SDDs are mathematically represented as:

$$SDD = \sqrt{\frac{\sum_i (X_i - \bar{X})^2}{n} + \frac{\sum_i (Y_i - \bar{Y})^2}{n}}$$

Standard Distance Deviations (SDDs) measure the compactness of a distribution and provides a single value representing the dispersion of features around the mean center of the locations analyzed (Wang, 2006). The SDD value is a distance, so the compactness can be represented on a map by drawing a circle with the radius equal to the value.

The 2008 Ugandan pilot project (Wawro et al., 2008) collected student and school location data at two schools. Using the *Standard Distance* function found in ESRI's ArcGIS Desktop software, SDDs were calculated and plotted for both schools by student sex. The resulting maps (Figures 7 and 8) demonstrated considerable variability of catchment ranges by school type, and consequently provided some evidence for the questions being investigated in this study.

In the pilot study, the resulting catchment ranges for a rural small school (Figure 7) exhibited equally small catchments ranges for boys and girls of approximately 17 to 20 kilometers (11-13 miles). Conversely, Figure 8 shows the catchment ranges for male and female students from a larger urban school also surveyed as part of the 2008 pilot study. The larger urban school drew students from considerably further away than the small rural school as can be seen from the large catchment range of 140 kilometers (88 miles) for girls and an even larger range of 190 kilometers (118 miles) for boys.

For the 2009 study, the researcher expanded the data collection in both the number and variety of schools in order to more fully explore the possible relationships between school characteristics and the distances students travel in order to access secondary school.
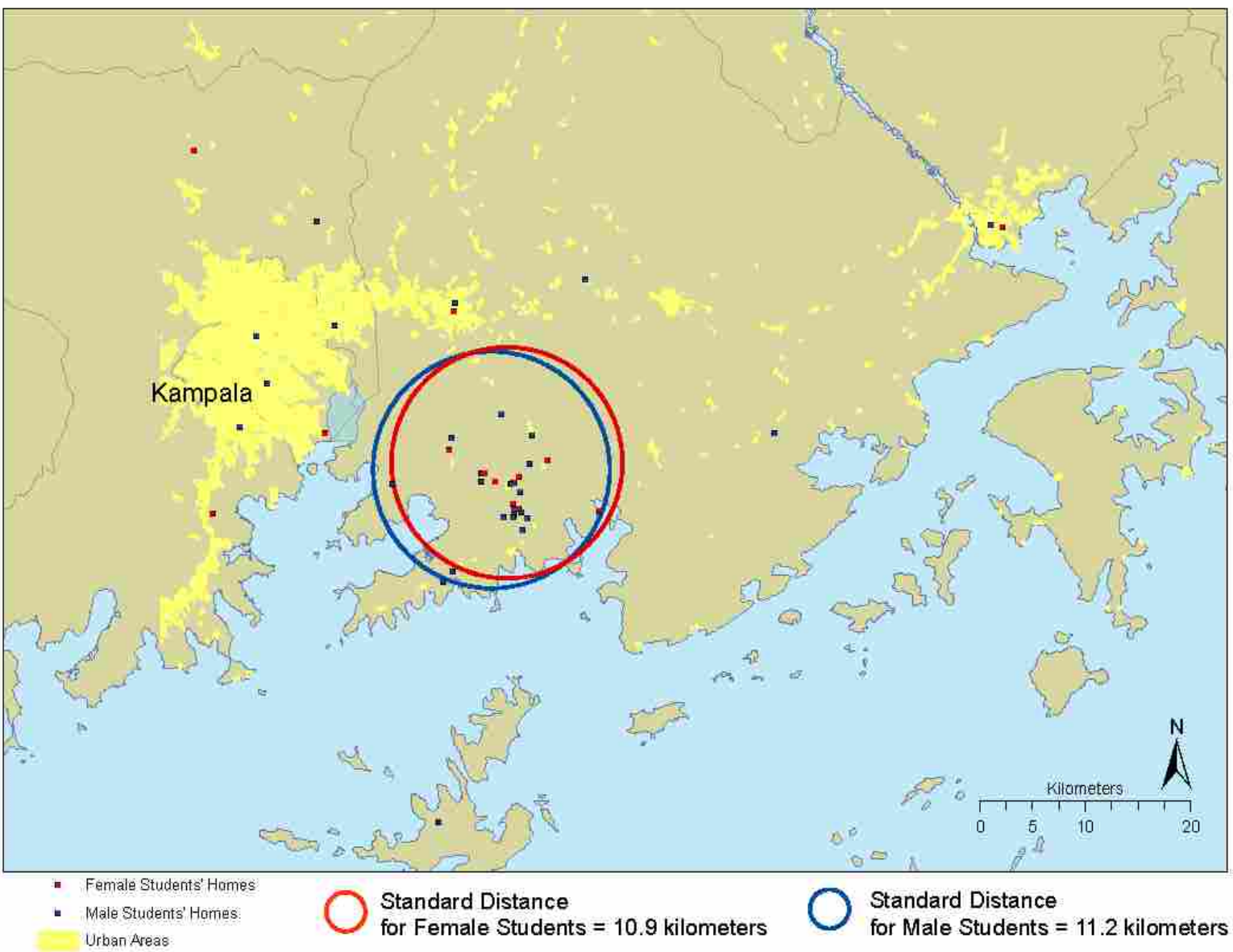
Figure 7. SDDs by Students' Sex of Small Rural Secondary School in 2008 Pilot
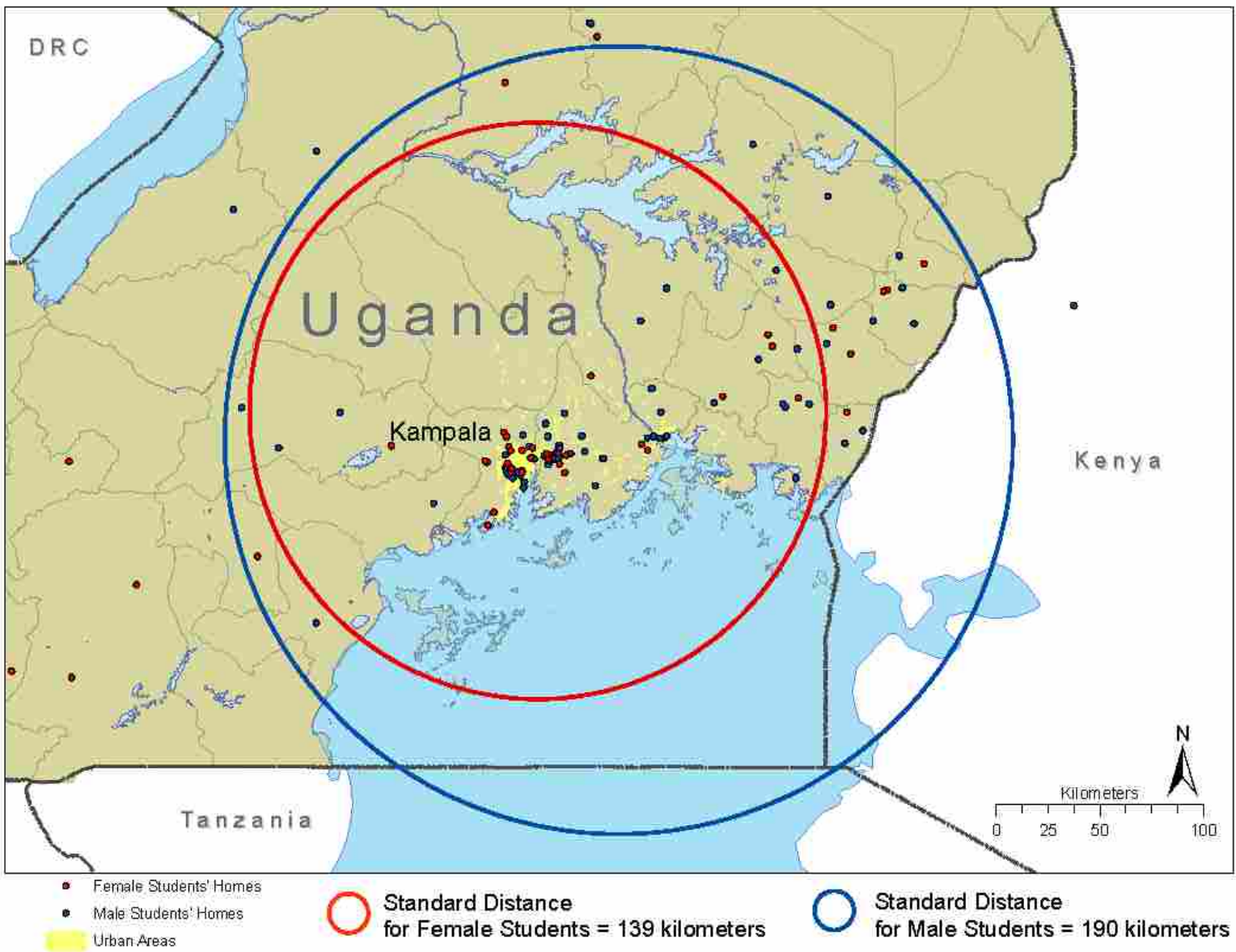
Figure 8. SDDs by Students' Sex of Large Ugandan Urban Secondary School in 2008 Pilot

Identifying metric distances. This 2009 study used the same collection and analysis process as the 2008 pilot study but expanded the sample size to eight secondary schools reflecting a wider range of school characteristics. Just as the 2008 pilot, the first step was to identify the distances separating the students' homes and the schools they attended. Time distance and cognitive distances were captured directly from the student surveys, but Euclidean and travel distances required technical calculation procedures using GIS technology.

Identifying Euclidean distance with GIS. Euclidean distances are the shortest possible distance, sometimes called straight-line, or as-the-bird-flies distances between two locations. Before Euclidean distances could be calculated, the student home locations points were separated into subset layers based on the school they attended. Likewise the eight school location points were separated into eight separate GIS data layers. Using the *Point Distance* function of ESRI's ArcGIS Desktop software package, each group of student location points were assigned as *input features* with the location of the school they attend designated as the *near features* (see Figure 9).

The output of the *Point Distance* process was a new database table with one record for each student location and a distance value describing the Euclidean distance to the school in meters. This table was then temporarily joined to the student location point GIS data and the Euclidean distance values were permanently transferred to GIS database. This process was repeated for each of the student groups and corresponding schools one at a time until every student location record contained a Euclidean distance value.
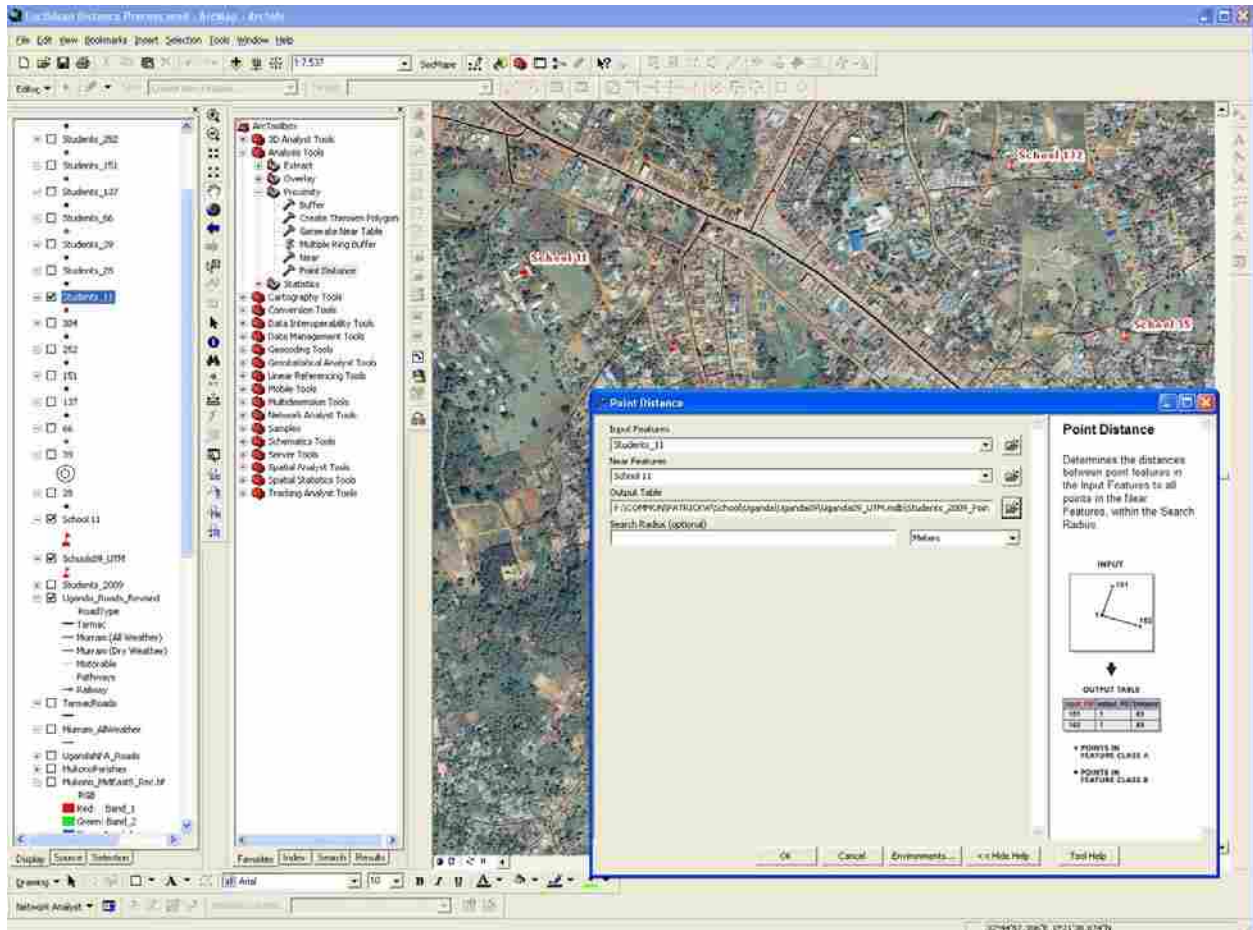
Figure 9. Using GIS for Calculating Euclidean Distances

Identifying travel distances in GIS. Students were not asked to identify their most usual

route of commute. For the purposes of this study, travel distances were assumed to be the

shortest path available to school along known transportation routes. While it may be unrealistic

to expect that each individual student actually chose the shortest path, without more precise

information, the shortest path seemed to be the most likely route most students and their families

would choose to minimize the impact of distance.

Road data was obtained in 2008 from the Uganda government showing major roads as

well as many smaller and less improved arterial, collector and roadways. This road data

provided evidence of known transportation routes throughout Uganda. This Ugandan road GIS

data had been constructed for mapping purposes only and contained many very small gaps

between the some of the road segments. Unfortunately, calculating travel distances in a GIS

environment requires continuously connected road segments. Between 35 and 40 hours were

required to clean up the road data so that the road lines were appropriately connected at

endpoints of each line segment to ensure the travel distances were accurately estimated.

Two tools in ESRI's Network Analyst extension of their ArcGIS Desktop system were

used to ascertain the metric distances students traveled to school using the shortest possible path

along known transportation routes. The first step involved converting the cleaned-up Uganda

road GIS data into a road network data layer using Networks Analyst's *Make Route Layer*

function. This network layer is a specialized type of GIS data that accommodates the inclusion

of an impedance costs and rule-based road segment connectivity. For this analysis, road segment

length (distance) was set as the impedance cost attribute.

With ArcGIS Network Analyst, network service areas around any location on a network

can be calculated. A network service area is a region that encompasses all accessible

transportation routes (that is, routes that are within a specified impedance threshold). The *Make*

Service Area Layer function of Network Analyst produced a series of nested polygons around

each school location at metric distance intervals using the route network as a framework (see

Figures 10 and 11). The boundaries of each nested polygon represent distance lines and the

shape of each polygon is influenced by the location of the underlying road and transportation

network.
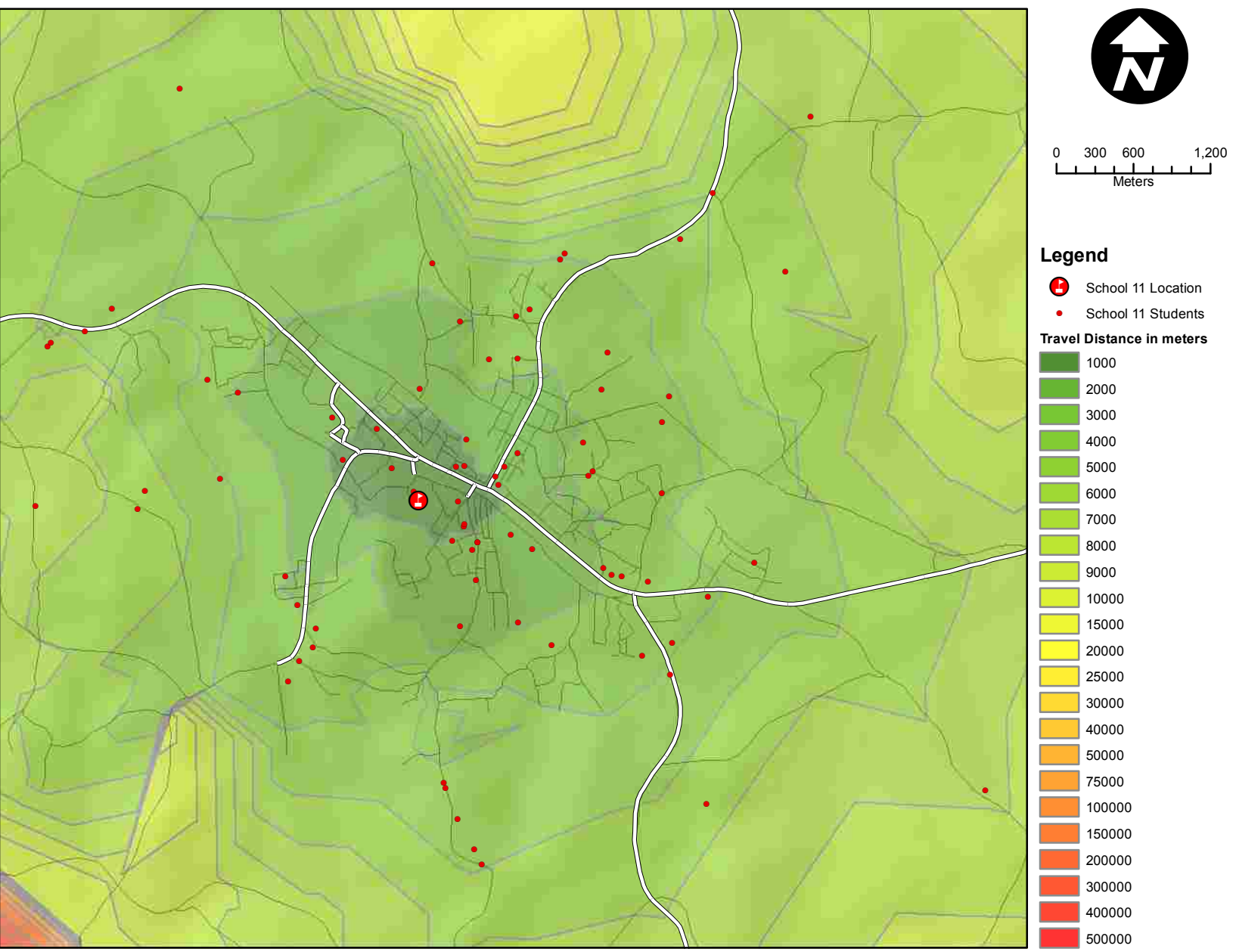
Figure 10. Travel distance calculations for School 11 using the service area function of the Network Analyst extension of ESRI's ArcGIS software.

Legend

⊕ School 11 Location

• School 11 Students

Travel Distance in meters

- 1000
- 2000
- 3000
- 4000
- 5000
- 6000
- 7000
- 8000
- 9000
- 10000
- 15000
- 20000
- 25000
- 30000
- 40000
- 50000
- 75000
- 100000
- 150000
- 200000
- 300000
- 400000
- 500000

0 300 600 1,200
Meters
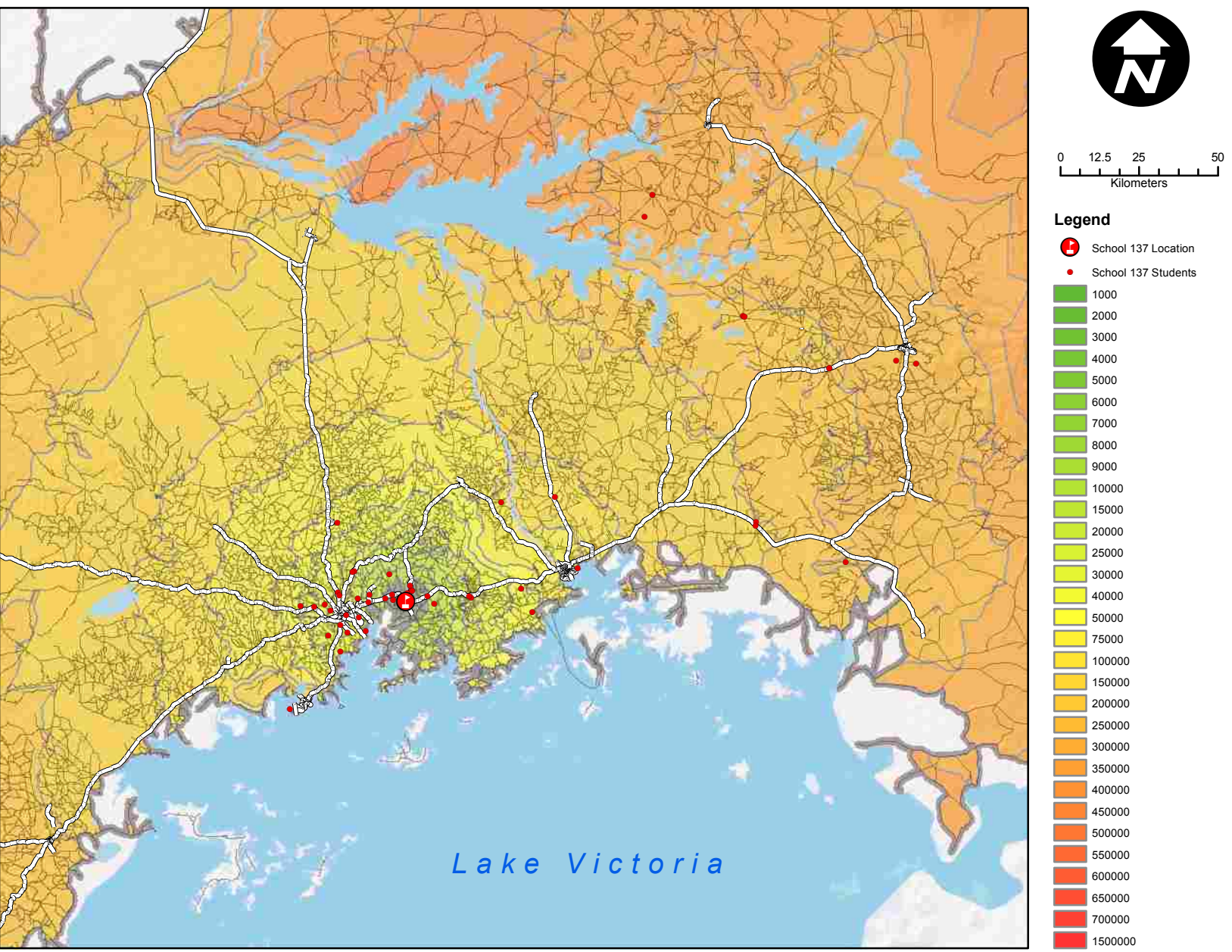
Figure 11. Travel distance calculations for School 137 using the service area function of the Network Analyst extension of ESRI's ArcGIS software.

For instance, Figure 10 shows the area immediately surrounding a school, the school location, the locations of student homes and the known transportation roadways. The darkest green shaded polygon bounded by a gray line on Figure 10 illustrates the area around the school that is reachable by traveling 1000 meters from the school along the depicted roadways. The darkest green shaded area is surrounded by a slightly lighter green polygon bounded by another gray line which represents the area that is reachable by traveling 2000 meters from the school along the roadways, and so forth.

The service area polygons of Figure 11 follows the same pattern as Figure 10 but is zoomed out to show a much larger service area. Service area polygon layers were generated for each school at intervals of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, and 1,500 kilometers. Once the service area polygons were created, all the student location points for each school that fell within each polygon were assigned the metric travel distance value of the polygon. This process was repeated for each school's service areas until every school location data point was populated with a travel distance value.

Comparing distances with statistical analyses. The research questions and hypotheses outlined at the beginning of this chapter helped to focus this research by prescribing a series of inquiries that, if answered, add considerably to our understanding of how distance (metric and cognitive) are related to school accessibility. The strategy for answering the first research question of, "*Do male or female students travel further to school in Uganda and how are school characteristics related to those distances?",* involved conducting t-tests (and an ANOVA in the case of school performance) on the null hypothesis that males and females traveled the same distance under each of the possible school characteristic scenarios. If under any conditions male

and female students are found to travel a statistically different distance, then equality of school

access could be questioned under those conditions. The yellow portion of Figure 12 highlights

the aspects of the model addressed by question one.

The second research question of, "*Do male and female students perceive the cost of

distance differently and how are school characteristics related to those perceptions?*" is more

complex than question one. The perception of distance has been shown to have a strong

relationship to participation in travel (Cadwallader, 1975; Yao & Thill, 2005); however, as the

perception of distance is undoubtedly connected to metric distances, it can be difficult to

disentangle their relationship.
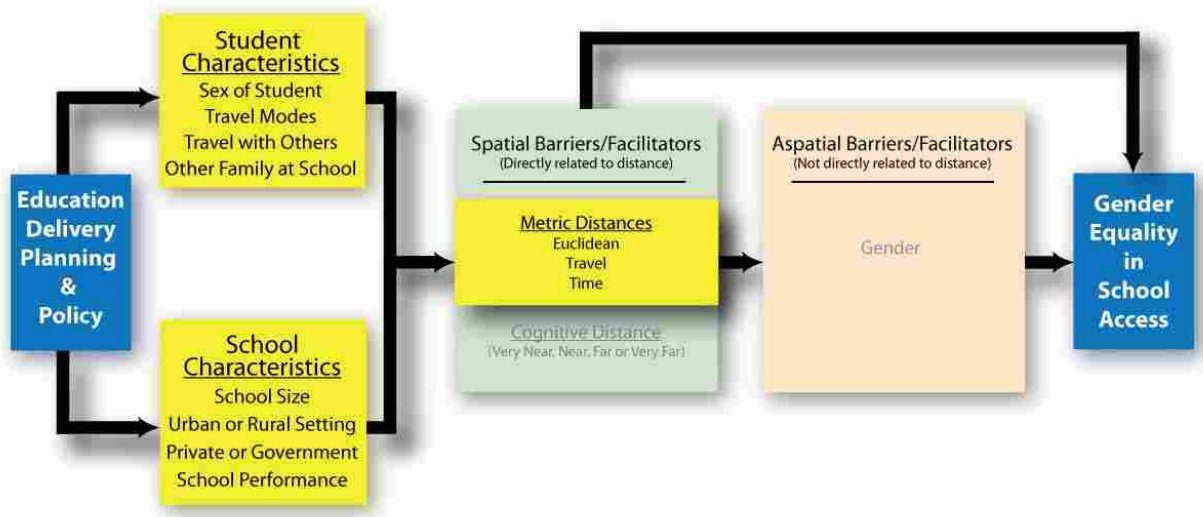
Figure 12. Student, School Characteristics and Metric Distances

This study first asked students to estimate the distance between home and school in

ordinal measurements of *very near*, *near*, *far*, or *very far*. Then these cognitive distance

measures were statistically compared to the respective metric distances using Ordinal Logistic

Regression (OLR). Yao and Thill (2005) used OLR, which is a form of linear regression, to

predict cognitive distance measures for metric distances in a case study involving 95 University

of Buffalo students. Ordinal logistic algorithms are specifically designed to perform logistic

regression analyses on ordinal response variables (McCullagh, 1980). Ordinal variables are

variables that have three or more possible levels with a natural ordering (Fraenkel & Wallen,

2009). In ORL, a model with one or more independent variables is fit using an iterative-

reweighted least squares algorithm to obtain maximum likelihood estimates (MLE) of the

parameters.

The Yao and Thill study results (2005) indicated that it was possible to predict cognitive

distance measures given an associated metric distance. The results also showed that the

relationship between cognitive and metric distances was mediated by the sex of the student. This

study used OLR to explore similar relationships between variables in the Uganda secondary

school setting. In the context of estimating the gender sensitivity of the relative accessibility of

secondary schools in Mukono District, Uganda, this exploratory study used OLR to explore the

relationship between cognitive distance measures and accessibility because it can estimate the

effect of multiple explanatory variables at one time. In short, an OLR allowed the study to

control for metric distance to see if other variables of student or school characteristics were

associated changes to students' cognitive distance assessments.

The inferential statistical method of ORL tested the following hypotheses:

Hypothesis 1. Cognitive distance measures between home village and school are

significantly related to their *Euclidean distances*,

Hypothesis 2. Cognitive distance measures between home village and school are

significantly related to their *travel distances*,

Hypothesis 3. Cognitive distance measures between home village and school are

significantly related to their *time distances*,

Hypothesis 4. Cognitive distance measures between home village and school are

significantly related to *student characteristics*, and

Hypothesis 5. Cognitive distance measures between home village and school are

significantly related to *school characteristics*.

The yellow-shaded portion of the School Accessibility Model shown in Figure 13 indicates the

larger portion of the model that can be addressed in the OLR analysis.
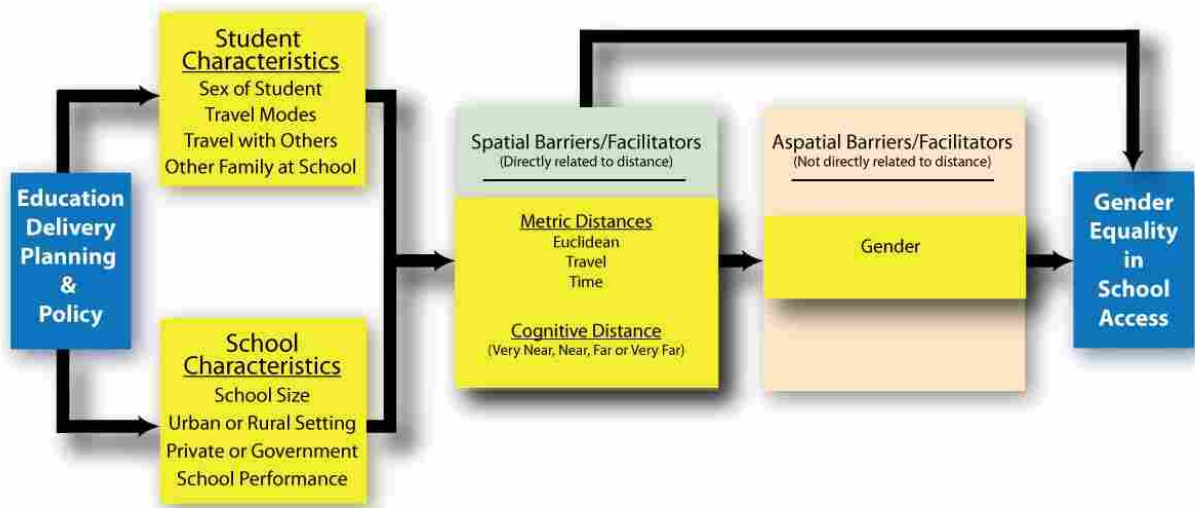
Figure 13. Student, School Characteristics, Metric Distances and Gender

In summary, this study utilized a variety of spatial analysis methods to explore the

relationships between distance, students' sex, and school accessibility. Specifically, Standard

Distance Deviation maps were used to *visualize* the differences in male and female student

spatial distributions around the schools they attend. GIS software technology was used to

identify Euclidean and travel distances that individual students had to overcome to attend their

schools. Lastly, Euclidean, travel and time distances were statistically *compared* to ordinal

values of cognitive distances to determine if male and female students perceive the same

distances differently, which would be evidence of gender inequality in school accessibility. If

these methods reveal significant differences in either the metric or cognitive distances separating

male and female students' homes and the school they attend, then those differences would

provide compelling evidence of gender inequality in secondary school access.

Chapter 4: Findings

Data were collected from 756 secondary S4 and S6 grade-level students attending eight different schools in the Mukono District of Uganda. As shown in Table 12, exactly half (378) of the sampled students were female. The sample included data from 319 day students with only 125 (39%) of the total day students being female. However, females made up a larger portion of the total boarding students sampled (253 of 437, or 58%).

Table 12

Student Sampling

	Day	Boarding	Total
Female	125	253	**378**
Male	194	184	**378**
Total	**319**	**437**	**756**

This study identified the physical (metric) distances separating the students' homes and the schools they were attending. It also recorded the students' perceptions of the magnitude of those distances (cognitive distances). A better understanding of metric and cognitive distance ranges associated with enrollment and attendance could provide important insights regarding school accessibility and the effectiveness of education delivery policies.

Metric Distances

Several types of distances were calculated for each student depicting the physical separation (referred to as metric distances) from the student's home location and the school location. These metric distances included Euclidean (direct, as-the-bird flies), travel (the shortest path available along known transportation routes), and time (the self-reported length of time the student needed to complete the commute). These distance values were aggregated by school,

school characteristics, and student characteristics to explore the possible association these characteristics may have on the distances that students travel to those schools.

At the outset of presenting these findings, and more particularly the results of the statistical analyses, it should be noted that this was an observational study, not an experiment. Consequently, inferring any causal relationships is inappropriate. Further, the schools where the students were surveyed were not randomly selected but were purposefully chosen within a single region of Uganda based on their known characteristics and their willingness to provide access. Therefore, the schools were selected as a convenience cluster sample with the cluster being the eight schools within the Mukono District of Uganda. At the larger of the two schools, the researchers collected data from the first 100 to 120 students that were made available by the school. At the other six schools surveyed, every S4 and S6 student attending school on the day of the study visit was surveyed. These sampling decisions limit the study's ability to assess, let alone guarantee, that the sample population is adequately representative of a wider Ugandan or East African population. That being said, as an exploration of possible methods, this study provides an important glimpse of possible connections between student characteristics, school characteristics and the distances students travel in developing countries.

Additionally, the standard deviation values for distance measures are considerably high. This was expected as Uganda has an extremely dispersed population and all of the schools surveyed had enrolled a considerable number of students from much larger distances than would be considered normal catchment ranges by most secondary education systems in more developed countries in other parts of the world.

Spatial distribution of distances. SDD values were calculated and plotted for all male and female student distributions around all eight schools. For easy between school comparison,

Figure 14 displays the results of the SDD calculations overlaying student location points for each of the eight schools.

The most obvious characteristic of the SDD maps is the great variation between schools. Some schools, such as School 28, have very small circles indicating a small catchment range for the school while others, like School 137, are quite large. Some schools, School 252 for example, have little variation between male and female SDD, while schools like School 137 and School 304 have substantial differences in the spread of male and female students.

Another important visual pattern worth noticing is that some schools, such as School 11 and School 304 show students spread uniformly around the school as indicated by the school location appearing centered within the SDD circles. Other school SDDs show circles skewed and centered on the school's actual location. As SDD is the measurement of geographic spread around the mean center of the student location points and not the actual school location, this can be an important visual clue that a school's enrollment includes distant enclaves of students, often travelling substantial distances to attend the school.

Each of these maps contains visual clues that have important policy implications to both local school administrators as well as education policy makers, such as national education ministries. These maps are easy to read, and do not require much instruction to understand the general principles these maps can communicate. Therefore, these SDD maps are a potentially powerful and intuitively accessible analysis tool for audiences at both the macro and micro policy levels.
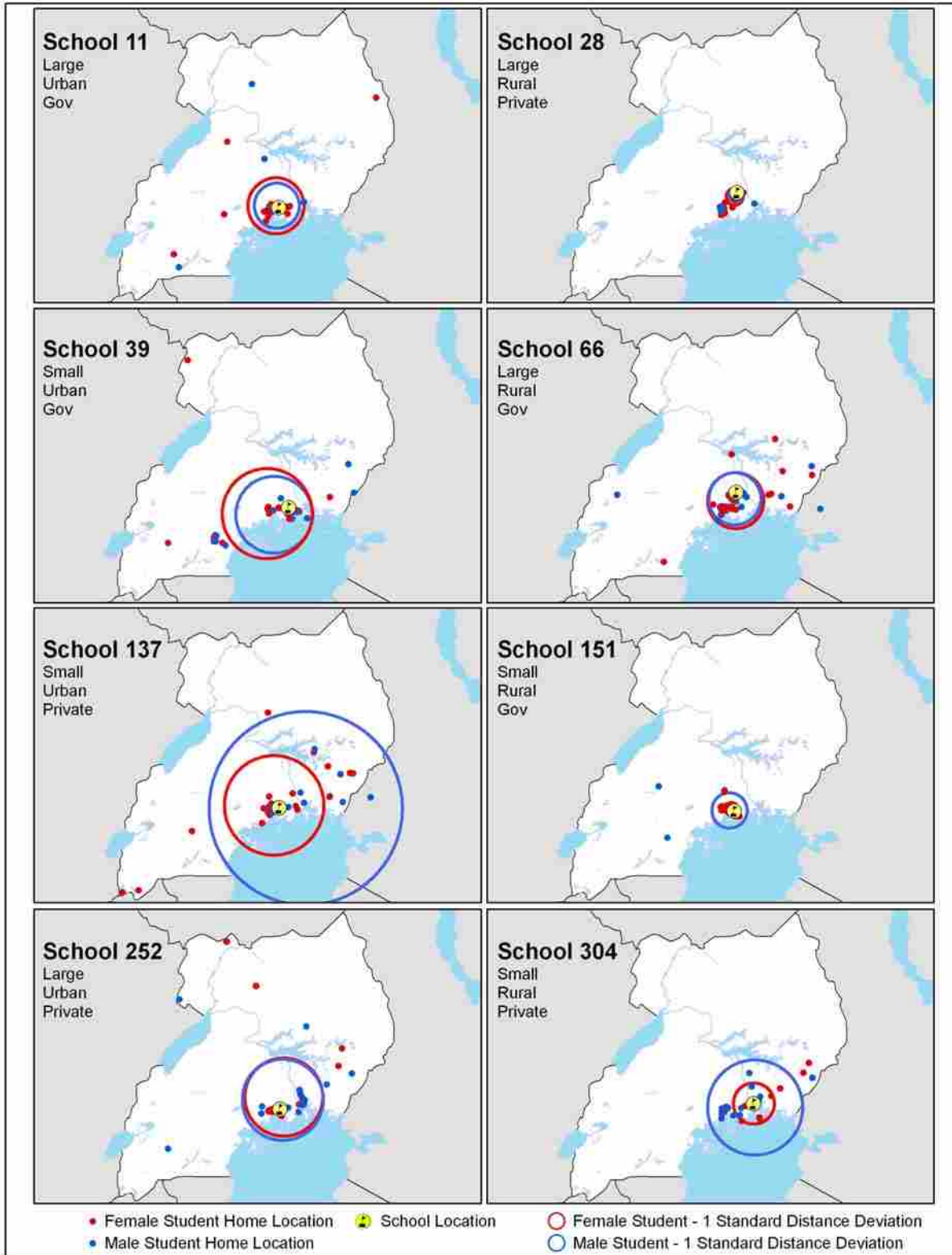
Figure 14. Standard Distance Deviations with Student and School Locations

Metric distances by student sex and school characteristics. Statistical analyses were

conducted to ascertain whether the distances that students were traveling to school were related

to a selected set of school and student characteristics, most notably the sex of the student.

Notwithstanding the known inferential limitations of the sampling methods employed, especially

the lack of multiple samples for each school characteristic type, this exploratory statistical

approach was used to check that the data was in appropriate condition for analysis.

The first condition examined was independence. As noted earlier, the schools selected

were not chosen randomly, however, all S4 and S6 secondary students were surveyed until the

sample reached a predetermined threshold of approximately 100 to 120 students. In most cases,

this sampling strategy required that every student S4 and S6 in attendance were surveyed. There

was no reason to suspect that the student's answers to the survey questions or the student's

estimation of the home location would have been significantly influenced by another student's

answer. Therefore, although the schools were chosen purposefully in order ensure a particular

school characteristic and accessibility for the researchers, at the student level there is a defensible

level of independence for student responses.

The second important condition for statistical analysis is level of normality of the metric

distance measures. Based on the Anderson-Darling normality tests p values at α levels less than

0.005, there is evidence that the Euclidean, travel and time distances data follow a normal

distribution (see Figures 15, 16, and 17).
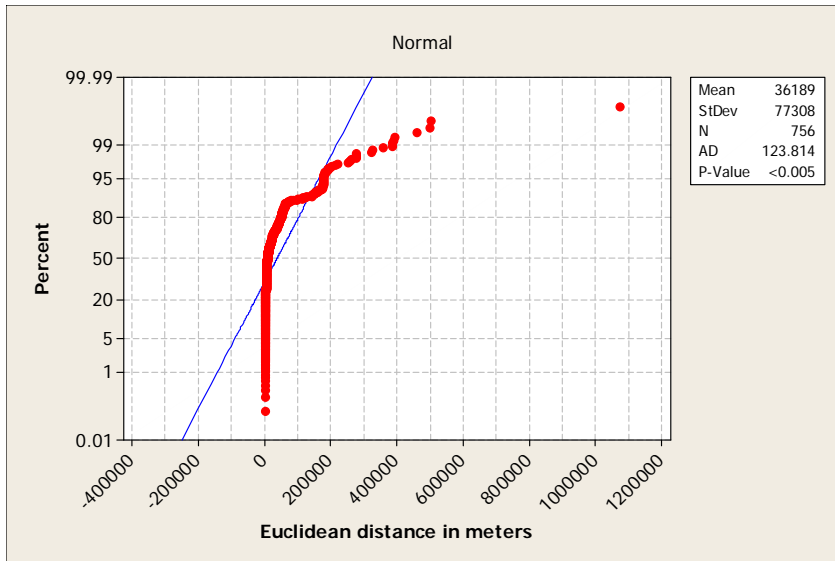
Figure 15. Anderson-Darling Normality Test of Euclidean Distance in Meters
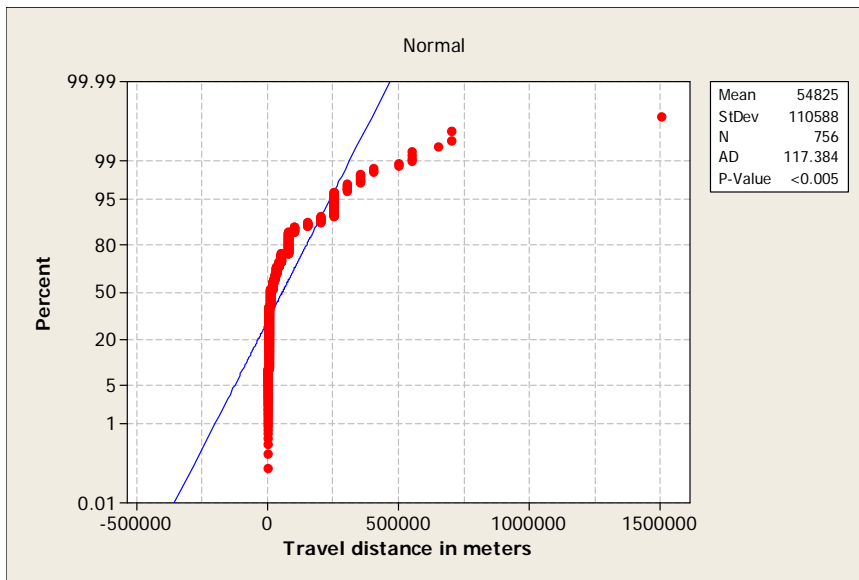
Figure 16. Anderson-Darling Normality Test of Travel Distance in Meters
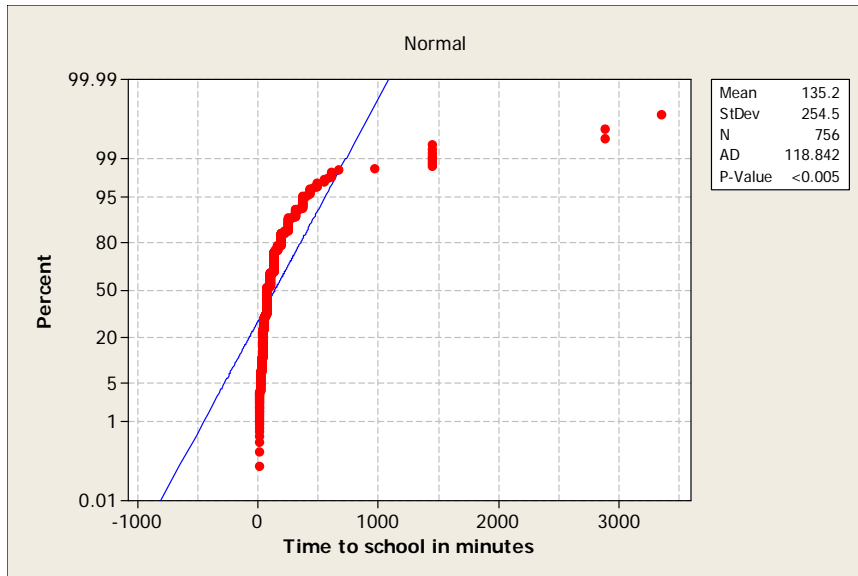
Figure 17. Anderson-Darling Normality Test of Time Distance in Minutes

At the extreme of α levels greater than 0.005 the data fall below the fitted line, but the

data overall appear to be adequately normal to confidently proceed with statistical inquiries.

The metric distance data collected showed that day students at the surveyed Mukono schools

travel a mean Euclidean distance of 2.9 kilometers to school each day. The female day students

sampled traveled slightly further than their male counterparts with mean distances of 3.3 to 2.8

kilometers respectively. However, as Table 13 illustrates, a *t*-test did not result in evidence of a

significant difference ($p = 0.324$) in the Euclidean distance day students traveled to school based

on the sex of the student. Similarly large *p* values for time and travel distances among day

students were found as well. Because of the lack of evidence for a significant difference in each

type of distance traveled by day students based on the sex of the student, statistical investigation

of day student distances was stopped and the rest of the analyses focused on boarding students.

Table 13

Euclidean, Travel and Time Distance for All Day Students by Student Sex

Euclidean Distance for All Day Students by Student Sex				
	N	Mean	SD	SE Mean
Female	125	3.3 km	4.1 km	.371 km
Male	194	2.8 km	4.0 km	.286 km
		$t = 0.99$	$p = 0.324$	DF = 317
Travel Distance for All Day Students by Student Sex				
	N	Mean	SD	SE Mean
Female	125	7.0 km	13.5 km	1.206 km
Male	194	5.4 km	8.8 km	.633 km
		$t = 1.19$	$p = 0.237$	DF = 192
Time Distance for All Day Students by Student Sex				
	N	Mean	SD	SE Mean
Female	125	59.6 min	45.9 min	4.1 min
Male	194	54.5 min	52.7 min	3.8 min
		$t = 0.92$	$p = 0.361$	DF = 289

Note. Two-tailed, two-sample *t*-tests

The collected data provides considerable evidence to suggest that that if the sampled

population of boarding students in this study is representative of all Uganda boarding students

then male boarding students in Uganda travel significantly further to school than female

boarding students. Female boarding students surveyed commuted an average of 51.4 kilometers

to school while male boarding students attended a school that was an average of 72.9 kilometers

away from their home location. The resulting *p* value of 0.027 for a two-sample *t*-test

substantiated that the distances traveled by each sex are statistically different (see Table 14). The

calculated travel distances were at times considerably larger than their corresponding Euclidean

distances implying the travel routes along known roadways did not often provide a direct path to

schools. These results were also not surprising given the uneven density and quality of the road

network throughout Uganda. The resulting *p* value of the travel distance *t*-test of 0.025 presents

solid evidence that males travel further than females along established road network pathways.

Table 14

Euclidean, Travel and Time Distance for All Boarding Students by Student Sex

Euclidean Distance for All Boarding Students by Student Sex				
	N	Mean	SD	SE Mean
Female	253	51.3 km	74.6 km	4.7 km
Male	184	72.9 km	115.6 km	8.5 km
		$t = -2.22$	$p = 0.027*$	DF = 291
Travel Distance for All Boarding Students by Student Sex				
	N	Mean	SD	SE Mean
Female	253	77.3 km	105.6 km	6.6 km
Male	184	108.4 km	164.8 km	12.1 km
		$t = -2.25$	$p = 0.025*$	DF = 289
Time Distance for All Boarding Students by Student Sex				
	N	Mean	SD	SE Mean
Female	253	187 min	259 min	16 min
Male	184	200 min	390 min	29 min
		$t = -0.37$	$p = 0.712$	DF = 297

Note. Two-tailed, two-sample *t*-tests
*$p < .05$

Females in the sample reported that they traveled an average of 187 minutes to boarding school, while male students reported an average travel time of 200 minutes. Variability was extremely high in the time distances reported, with standard deviation values nearly twice as high as the mean time distance values. The time distance differences between female and male students were not found to be statistically significant (see Table 14).

In summary, little difference was found in the distance male and female day students traveled to school as both commuted approximately 3.0 kilometers on average. However, the boarding students surveyed did present solid evidence that males travel significantly further to school than female boarding students in terms of Euclidean and travel distances. The time distances required to travel to school were not statistically different between male and female boarding students.

In other geographical settings, school characteristics have been shown to be related to the distances students are willing to travel to school (Filmer, 2004; Shrestha et al., 1986). School characteristics considered in this study were school size, school type (government or private), school setting (urban or rural), and school performance levels on national tests.

School size. The study collected data from 220 boarding students from large schools and 217 boarding students attending small schools. Boarding students from large schools traveled an average of 20.5 km further than boarding students attending small schools. The low *p* value of 0.024 shown in Table 15 demonstrates that this difference was significant.

Table 15

Euclidean Distance for Boarding Students by School Size

	N	Mean	SD	SE Mean	
Large	220	50.2 km	70.9 km	4.7 km	
Small	217	70.7 km	112.9 km	7.7 km	
		$t = -2.27$	$p = 0.024*$	DF = 362	

Note. Two-tailed, two-sample *t*-tests
*$p < .05$

When the Euclidean distance and the sex of the student is considered among boarding students attending large schools, these data do not provide sufficient evidence for a statistical difference in the mean distance between male and female students. That is, there was not sufficient statistical evidence that male students traveled further than female students enrolled at large boarding schools. Conversely, the difference between male and females was found to be significant among boarding students attending smaller schools as demonstrated by the small *p* value of 0.022 (see Table 16).

Table 16

Euclidean Distance for Boarding Students by School Size and Student Sex

Euclidean Distance for All Boarding Students at Large Schools				
	N	Mean	SD	SE Mean
Female	122	47.7 km	69.0 km	6.2 km
Male	98	53.5 km	73.5 km	7.4 km
		$t = -0.60$	$p = 0.550$	DF = 201

Euclidean Distance for All Boarding Students at Small Schools				
	N	Mean	SD	SE Mean
Female	131	54.8 km	79.6 km	6.9 km
Male	86	95.1 km	147.3 km	15.9 km
		$t = -2.32$	$p = 0.022*$	DF = 117

Note. Two-tailed, two-sample *t*-tests
*$p < .05$

Statistical analyses of the observed travel distances of boarding students at large and

small schools produced almost identical *p* values as Euclidean distance analyses, suggesting that

Euclidean distances may be an appropriate proxy for travel distances. Time distances, however,

were not found to be significantly different between males and females at either large or small

schools.

School type. Although there are a few newer government schools in Uganda, most were

established a considerably long time ago (Wawro et al., 2008). In contrast, private schools began

to proliferate in the 1990s and most private schools open today in Uganda did not exist 15 years

ago. At the outset of this research project, the researcher expected that government schools, with

their longer history of stability and more developed social, administrative, and political networks

had the ability to attract students from further away than newer less established private schools

without those implicit advantages.

As the Euclidean distance means displayed in Table 17 show, boarding students in the

study traveled more than 10 kilometers further to the four private schools surveyed than boarding

students traveled to the four government schools surveyed. However, the resulting *p* value of

0.269 demonstrates the statistical evidence was too weak to infer that this may hold true to the

larger population. Although statistically inconclusive, it was surprising to the researcher that the

surveyed government schools did not enjoy a wider range of recruitment than the private schools

surveyed.

Table 17

Euclidean Distance for Boarding Students by School Type

	N	Mean	SD	SE Mean	
Government	238	55.6 km	71.5 km	4.6 km	
Private	199	66.1 km	116.2 km	8.2 km	
		$t = -1.11$	$p = 0.269$	DF = 316	

Note. Two-tailed, two-sample *t*-tests

While the Euclidean distance means indicated that male boarding students attending

either government or private schools lived further from the school than female boarding students,

a statistical difference of the means on the basis of the student's sex was not observed at

significant levels for either government or private schools (Table 18). The travel and time

distance means were also not conclusively different between male and female boarding students

at government or private schools.

Table 18

Euclidean Distance for Boarding Students by School Type and Student Sex

Euclidean Distance for All Boarding Students at Government Schools				
	N	Mean	SD	SE Mean
Female	144	49.9 km	70.4 km	5.9 km
Male	94	64.4 km	72.8 km	7.5 km
		$t = -1.52$	$p = 0.129$	DF = 194
Euclidean Distance for All Boarding Students at Private Schools				
	N	Mean	SD	SE Mean
Female	109	53.2 km	80.1 km	7.7 km
Male	90	81.8 km	147.7 km	15.6 km
		$t = -1.64$	$p = 0.103$	DF = 131

Note. Two-tailed*,* two-sample *t*-tests

   School setting. Schools located in urban areas clearly have more accessibility to

transportation systems (roads, taxis, etc.) which may be an advantage to students who need travel

long distances to attend school. The data supports this claim as the average boarding student

surveyed attending an urban school lived 32.6 km further away than boarding students attending

a rural school. Table 19 provides evidence from a school setting *t*-test that this difference is

indeed, statistically significant, as demonstrated by the very small *p* value of 0.000.

Table 19

Euclidean Distance for Boarding Students by School Setting

	N	Mean	SD	SE Mean
Rural	183	41.5 km	54.2 km	4.0 km
Urban	254	74.1 km	113.3 km	7.1 km
		$t = -3.99$	$p = 0.000*$	DF = 385

Note. Two-tailed*,* two-sample *t*-tests
*$*p < .05$

Examining Euclidean distance with the combined the school characteristics of setting and size, illustrates that small rural schools have the smallest catchment range of any of the four categories while small urban schools attract students from the furthest distances (Figure 18). Large urban schools drew students from further away than large rural schools suggesting that while school size matters, school setting may play a larger role in relation to catchment ranges than school size.

The Euclidean distance is related to a boarding student's sex in a rural setting but that is not necessarily so in an urban setting. A *t-test* examining Euclidean distances and students' sex of students attending rural schools clearly shows that male students come from homes that are further away from school than female boarding students attending rural schools, as the *p* value of 0.024 as Table 20 indicates.
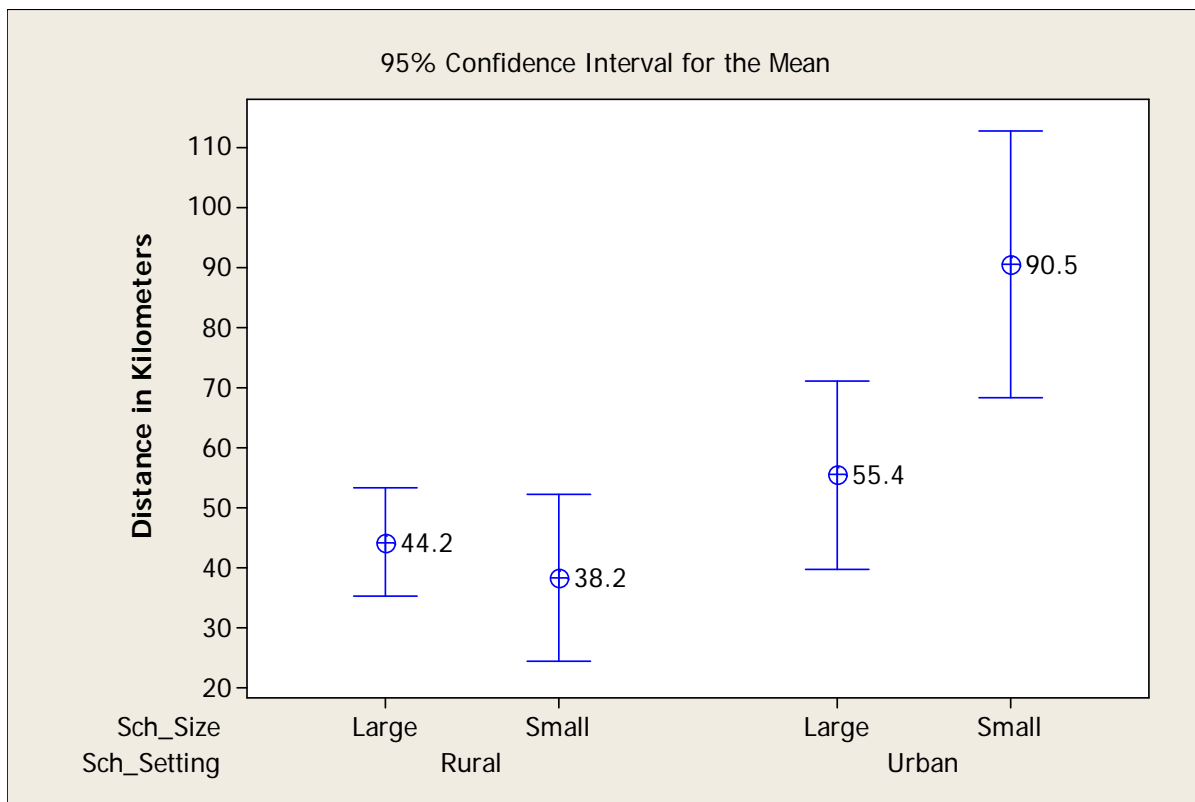
Figure 18. Interval Plot of Distance in Kilometers vs. School Size by School Setting

However, the same test for students attending urban schools resulted in a *p* value of 0.265

indicating that there was no statistical evidence that the distances were different between this

group of male and female boarding students. As was found with the other school characteristics

of setting and size, the resulting statistical significance of travel distances mirrored that of

Euclidean distances. Again, time distance was not found to be significantly different at all.

Table 20

Euclidean Distance for Boarding Students by School Setting and Student Sex

Euclidean Distance for All Boarding Students at Rural Schools				
	N	Mean	SD	SE Mean
Female	116	33.4 km	37.4 km	3.4 km
Male	67	55.4 km	73.2 km	8.9 km
		$t = -2.29$	$p = 0.024*$	DF = 86
Euclidean Distance for All Boarding Students at Urban Schools				
	N	Mean	SD	SE Mean
Female	137	66.5 km	92.8 km	7.9 km
Male	117	82.9 km	133.3 km	12.3 km
		$t = -1.12$	$p = 0.265$	DF = 202

Note. Two-tailed, two-sample *t*-tests
*$p < .05$

School performance. A one-way ANOVA comparing the Euclidean distance means of

the 437 surveyed boarding students of high, mid, and low-performing schools resulted in a *p*

value of 0.347, indicating that there is insufficient evidence to infer that the means are

substantially different between school performance groupings. Figure 19 illustrating the sample

means according to performance does reveal that the Euclidean distances of the female students

surveyed were consistently smaller than the male students surveyed with the greatest gap

exhibited at the mid-performing schools.
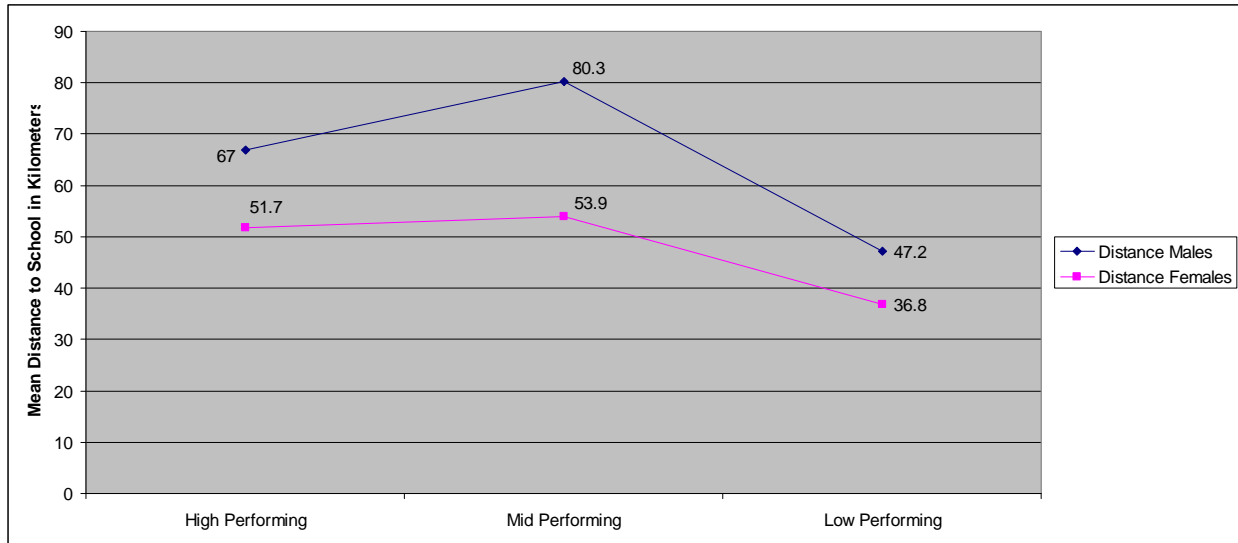
Figure 19. Euclidean Distance Means and School Performance by Student Sex

In an effort to more fully explore the observed differences of Euclidean distances
between sexes at each performance grouping, a series of *t*-tests were conducted to compare the
means for male and female boarding students at each performance level. Three of the schools
surveyed fell into the high-performing grouping with mean O-level aggregate test scores between
0 to 36 (lower scores are better). Table 21 shows that although the homes of male boarding
students are an average of 15 kilometers further from school than female boarding students, there
is not sufficient statistical evidence to infer a real difference in Euclidean distances ($p = 0.352$).

Four of the schools surveyed performed at the mid range (37-46). A more sizable gap in
Euclidean distance means suggested that males may travel a statistically larger distance than
female students. As Table 21 goes on to detail, the *t*-test and resulting *p* value of 0.029
confirmed that there is strong statistical evidence that the male do travel further to mid-
performing schools than female boarding students. This disparity between in the Euclidean

distances of male and females boarding students attending mid-performing schools could have important policy implications that are discussed in a later section.

The distance means for boarding students attending the only low-performing school (mean O-level scores of 47-72) surveyed were considerably smaller than the higher performing schools. Male boarding students continued the trend of traveling further than females among the survey sample with a moderate difference of 10.4 kilometers. As indicated in Table 21, the *t*-test resulted in a *p* value of 0.374, suggesting that there was insufficient evidence to infer that the homes of male boarding students were further away from school than females boarding students attending low-performing schools.

Table 21

Euclidean Distance for Boarding Students at High, Mid and Low-Performing Schools

Euclidean Distance for All Boarding Students at High-performing Schools				
	N	Mean	SD	SE Mean
Female	111	51.7 km	74.3 km	7.1 km
Male	89	67.0 km	140.0 km	15 km
		$t = -0.93$	$p = 0.352$	DF = 127
Euclidean Distance for All Boarding Students at Mid-performing Schools				
	N	Mean	SD	SE Mean
Female	118	54.0 km	80.1 km	7.4 km
Male	76	80.3 km	82.2 km	9.4 km
		$t = -2.20$	$p = 0.029*$	DF = 157
Euclidean Distance for All Boarding Students at Low-performing Schools				
	N	Mean	SD	SE Mean
Female	24	36.8 km	40.5 km	8.3 km
Male	18	47.2 km	33.9 km	8.0 km
		$t = -0.90$	$p = 0.374$	DF = 39

Note. Two-tailed, two-sample *t*-tests. One male student attending the low-performing school was considered to be an outlier and dropped as he travelled from a distance several times further then any other student at that school significantly altering the mean distance of males.
*$p < .05$

Summarizing the results of the exploration the relationship of school characteristics on distances traveled to school by student sex, male boarding students consistently traveled further than females among the sampled population. The small and urban schools sampled drew students from significantly further away than did large and rural schools.

Statistical analyses such as *t*-tests and ANOVAs looking at school characteristics and the distances traveled and grouping students according to their sex revealed that there was no statistical difference in the distances male and female boarding students traveled to government or private schools. Urban, large, high-performing and low-performing schools also saw little statistical differences in the distances male and females traveled to school. However, male boarding students did travel significantly longer distances than female students attending small, rural and mid-performing schools.

Relationships between Euclidean, travel and time distances. The statistical significance of Euclidean distances and travel distances were closely related. Euclidean and time distances consistently showed extremely similar associations with the other contextual variables of student and school characteristics. That is, without exception if a school's characteristic was found to be statistically related to Euclidean distances then travel distances was also related to the characteristic. Consequently, in Uganda, travel distance (which is difficult, time-consuming, and potentially expensive to generate) does not significantly improve the explanatory power of the analysis. Euclidean distance, which is much simpler to calculate than travel distances can serve as a reasonable proxy for travel distance. This means that research using distances can conserve resources for expanding sample sizes and/or geographic study area.

While Euclidean and travel distances were calculated by the researcher based on the student home and school locations, time distances were self-reported by the surveyed students.

Time distances were not found to be significantly related to any school or student characteristic. In general, their time estimates were inconsistent, suggesting that either time distances were not a significant concern to the students, or something was operating cognitively or contextually that rendered this type of distance measure unreliable. These results reinforce other studies that observed a lack of time distance awareness as Whitrow (1988) paraphrased from a 1975 report by Bell:

> P. M. Bell has reported that when teaching children in Uganda he found that, although they were not unintelligent, they had much greater difficulty than Western children of similar age in judging how long something took to happen. A two hour journey by bus being said by some to have taken only ten minutes and by others six hours! (p. 7)

In many developed countries time distance is a significant consideration to accessibility, but this study did not find evidence that any student or school characteristic was associated with time distances reported by the students. Therefore time distances, at least as reported by the students, were not a reliable measure of accessibility in Uganda.

Cognitive Distance

Cognitive distance data were obtained by asking each student to quantify how far the student felt the school was from their home at the time of enrollment and also at the time of the survey. Cognitive distances are subtly different from time distances in that time distances are the student's estimation of the time that separates home from school while cognitive distances are the student's perception of the distance from home to school. Therefore, cognitive distances undoubtedly incorporate ideas of the cost of time, but also include sheer distance, the difficulty of the travel, the monetary costs, etc.

Each student answered by circling one of four ordinal cognitive distance values of *very near*, *near*, *far*, and *very far*. For purposes of analysis, these cognitive values were converted to a numeric scale of 1-4 with *very near* assigned a value of 1, *near* a value of 2, *far* a value of 3, and *very far* assigned a value of 4. At the outset of the study, the researcher felt that comparing these cognitive distance values assessments with the corresponding metric distances could provide a better idea of the perceived cost or burden of distance. Additionally, the researcher surmised this type of comparison may shed light on the possible relationship between student's gender and their perception of the cost of distance.

Table 22 illustrates the differences in cognitive distance means by the student's sex. At the time of enrollment, the average value of cognitive distances among the 437 boarding students surveyed was 3.01 or an average cognitive distance category of *far*. That number decreased somewhat to 2.79 when asked how far the distance from home to school felt at the time of survey, which is not surprising given the known effect of increased familiarity decreasing the perception of distances (Olshavsky, MacKay, & Sentell, 1975).

Table 22

Cognitive Distance Means for Boarding Students by Student Sex

Cognitive Distance Means at Enrollment				
	N	Mean	SD	SE Mean
Females	249	2.98	0.916	0.058
Males	184	3.05	0.951	0.070
			$t = -0.77$	$p = 0.440$	DF = 385
Cognitive Distance Means at Time of Survey				
	N	Mean	SD	SE Mean
Female	244	2.77	0.97	0.062
Male	181	2.81	1.03	0.077
			$t = -0.38$	$p = 0.704$	DF = 374

Note. Two-tailed, two-sample *t*-tests

The data from Table 22 shows the surveyed male boarding students felt that they traveled slightly further Euclidean distance than the surveyed female boarding students at both the time of enrollment and the time of the survey. However, a two-sample *t*-test showed the difference in the sample means between the sexes in the sample were too small to provide evidence that there was a difference in a larger student population.

Relationships between Cognitive and Metric Distances

This study utilized an Ordinal Logistic Regression (OLR) model to investigate the relationship between metric distances from home to school and the perceived or cognitive distance of students in Uganda. In this instance, the researcher used the OLR model to test for the possibly significant relationship of explanatory variables (often referred in OLR analyses as factors) on the response variable of cognitive distance, while controlling for metric distance. By holding metric distance constant, other conditions could be explored such as school size, setting, and performance.

In addition to the various types of distance values identified, possibly relevant contextual information was collected about student and school characteristics that have been known to influence how student in other research settings perceive distances between their homes and the school they attended. For instance, the mode of travel they typically used to make the trip, whether they travelled with others, and whether other family members attended the school.

The full OLR model initially tested included three estimated intercepts for the logits of the cumulative probability of each cognitive distance response for *very near*, *near*, and *far*. There is not a need to estimate *very far* because the cumulative probability for the last response is 1. The full model also included metric distance, which is a defined on an interval scale, and

the remaining variables were all categorical and were converted to dummies variables. A

complete list of contextual explanatory variables is found in Table 23.

Table 23

Explanatory Variables Collected for Full OLR Model

Distance Variables
  Metric distance
  Cognitive distance

School Variables
  School size (small or large)
  School type (government or private)
  School setting (urban or rural)
  School performance (high, mid, or low)

Student Variables
  Student sex (female or male)
  Other family at school (yes or no)
  Family members living near school (yes or no)
  Travel with others (yes or no)
  Travel mode (walk, bicycle, motorcycle taxi, taxi, bus, friends vehicle, family vehicle, boat,
                or other)

      Cognitive and Euclidean distance. As can be seen from the results of the full OLR

analysis in Table 24, only *Euclidean distance*, *school size* and *mid-level performing schools* were

found to be related to changes in cognitive distance perceptions in the full OLR model. The

model terms were tested for possible interactions. Finding no evidence for interactions, the

model was then reduced by rerunning the analysis without each of the variables found to be

insignificant in the full model, one at a time, to account for any possible latent multicollinearity

in the results. Student sex was a central variable to the research question of this study, therefore,

it was not dropped as an explanatory variable even though it was not found to be significant in

either the full or reduced OLR models.

Table 24

OLR Results of Full Model for Euclidean Distance

Variable	Coefficient	SE Coefficient	z	p
Cognitive Distance				
Intercept - Very Near	-2.30276	1.74973	1.32	0.188
Intercept - Near	-0.38515	1.74711	0.22	0.826
Intercept – Far	1.06570	1.74777	0.61	0.542
Very Far (base category)	0			
Metric Distance	-0.00000*	0.00000	-3.96	0.000
Student Sex				
Male	0.01224	0.19087	0.06	0.949
Female (base category)	0			
School Size				
Small	-0.77064*	0.21607	-3.57	0.000
Large (base category)	0			
School Type				
Private	0.39846	0.219593	1.81	0.070
Government (base category)	0			
School Setting				
Urban	0.05550	0.223696	0.25	0.804
Rural (base category)	0			
School Performance				
Low	0.53246	0.440758	1.23	0.218
Mid	-0.59497*	0.210717	-2.70	0.007
High (base category)	0			
Family Living Near School				
Yes	0.23277	0.246063	0.95	0.344
No (base category)	0			
Family Member at School				
Yes	0.27960	0.190433	1.47	0.142
No (base category)	0			
Travel With Someone				
Alone	-0.84658	0.948439	-0.89	0.372
Family	-0.48349	0.987964	-0.49	0.625
Others	-0.86165	1.00241	-0.86	0.390
Friends (base category)	0			
Travel Mode				
Walk	1.47534	1.44806	1.02	0.308
Motorcycle taxi	1.69777	1.45840	1.16	0.244
Taxi	1.09102	1.42799	0.76	0.445
Bus	0.73216	1.90057	0.39	0.700
Friends vehicle	0.61047	1.53467	0.40	0.691
Family vehicle	0.74271	1.48962	0.50	0.618
Boat	-21.40240	19453.4	-0.00	0.999
Other	-15.83970	19453.4	-0.00	0.999
Bicycle (base category)	0			

Note. $*p < .05$

As none of the intercepts of the cognitive distance categories or the majority of other

contextual variables resulted in significant *p* values in the full ORL model, it became clear that

the full OLR model may need to be reduced to improve its ability to better depict the

relationships between the variables that were significant. Dropping the *travel mode* dummy

block of variables, *travel with someone*, *school setting*, *family members at school*, and *family*

members living near the school from the full model reduced the *p* values of the intercepts to

significant levels and *school type* joined *metric distance* and *school size* as significant variables

as illustrated by the results of the reduced OLR model in Table 25.

Table 25

OLR Results of Reduced Model for Euclidean Distance

Variable	Coefficient	SE Coefficient	z	p
Cognitive Distance				
Intercept – Very Near	-1.33008*	0.220384	-6.04	0.000
Intercept – Near	0.58619*	1.95959	2.99	0.003
Intercept – Far	2.10477*	0.2222074	9.48	0.000
Very Far (base category)	0			
Metric Distance (Euclidean) in Kilometers	-0. 0123692*	0.0016630	-7.44	0.000
Student Sex				
Male	-0.01343	0.187727	-0.07	0.943
Female (base category)	0			
School Size				
Small	-0.73178*	0.204983	-3.57	0.000
Large (base category)	0			
School Type				
Private	0.39136*	0.203392	1.92	0.054
Government (base category)	0			
School Performance				
Low	0.23469	0.372126	0.63	0.528
Mid	-0.60640*	0.204229	-2.97	0.003
High (base category)	0			

Note. *$p < .05$

Negative coefficient values of significant explanatory variables indicate that those

conditions tended to decrease the cognitive distance assessment of the students when compared

to the base condition. In other words, controlling for actual metric distance, the students

associated with explanatory variable values with negative coefficients (attending small,

government, mid-performing schools) assessed the distance to school as less far than students

associated with the other conditions in that category. Positive coefficients had the opposite

association with students overestimating the cognitive distance category in relation to the base condition. Since most of the variables were binary dummies, generally speaking the larger the coefficient, the stronger the association of the variable with the cognitive distance assessment. The specific examples that follow should help to clarify this relationship between coefficients and cognitive distances.

Merely having a negative coefficient does not necessarily provide evidence that disparity in cognitive distance perceptions exists, that coefficient must also be associated with a significant p value. In the sample, Table 25 contains a negative coefficient of -0.01343 for male boarding students suggesting that male students marginally under-assessed the cognitive distance when compared to female boarding students, when all other conditions remained the same. However, the associated p value is 0.943, suggesting there was no statistical evidence from the sample data that would support the claim that these observed differences in the assessment of the cognitive distances could be associated to the student's sex.

Conversely, school size had a relatively large coefficient value of -0.73178 and a p value of 0.0000. This larger coefficient indicates that boarding students who attended small schools felt the distance was significantly less than boarding students who attended large schools of comparable metric distances. The very low p value of 0.000 for school size is an indication that this disparity in cognitive distance perceptions between boarding students who attend large and small schools is statistically significant.

Mid-performing schools had the second largest coefficient of -0.60640 (and resulting p value of 0.003) also demonstrated a strong negative relationship with cognitive distance responses. Boarding students at mid-performing schools perceived the distance to be considerably less than boarding students from high-performing schools. Students attending low-

performing schools had a positive coefficient of 0.23469 but an insignificant *p* value of 0.528. This casts doubt on whether students attending low-performing schools actually perceived the cognitive distances to be larger than students attending high-performing schools.

School type also showed a significant relationship to cognitive distance responses with boarding students attending private schools having a coefficient of 0.39136 (*p* value of 0.54) . Private school boarding students overestimated the perceived distance when compared to government school boarding students when all other variables remained constant.

Cognitive, travel and time distances. As Table 26 shows, substituting Euclidean distances with travel distances into the OLR model produces almost identical results, suggesting that in this Ugandan sample, Euclidean and travel distances have the same relationship to cognitive distances. As Euclidean distances are much easier to obtain than travel distances, these results provide substantial evidence that in this geographic setting, Euclidean distance may be a reasonable proxy measure for travel distance.

Time distance was found to be statistically associated with cognitive distance assessments of the students, as Table 27 details. This is first time in this entire study that time distance was a significant factor. One possible explanation is that Ugandan students have a more consistent concept of the time it takes to arrive at school than they do of the actual Euclidean or travel distances involved. Perhaps a more likely explanation is the students' concept of time was more in line with their perception of distance than the actual distance separating their home and school.

Table 26

OLR Results of Reduced Model for Travel Distance

Variable	Coefficient	SE Coefficient	z	p
Cognitive Distance				
Intercept – Very Near	-1.31909*	0.220524	-5.98	0.000
Intercept – Near	0.59803*	1.956678	3.04	0.002
Intercept – Far	2.10958*	0.222270	9.47	0.000
Very Far (base category)	0			
Metric Distance (Travel) in Kilometers	-0.0000083*	0.0000011	-7.47	0.000
Student Sex				
Male	-0.0208901	0.187120	-0.11	0.911
Female (base category)	0			
School Size				
Small	-0.698817*	0.204555	-3.42	0.001
Large (base category)	0			
School Type				
Private	0.388094	0.204555	1.91	0.056
Government (base category)	0			
School Performance				
Low	0.235656	0.372294	0.63	0.527
Mid	-0.627768*	0.203954	-3.08	0.002
High (base category)	0			

Note. $*p < .05$

Table 27

OLR Results of Reduced Model for Time Distance

Variable	Coefficient	SE Coefficient	z	p
Cognitive Distance				
Intercept – Very Near	-0.990004*	0.237349	-4.17	0.000
Intercept – Near	0.934485*	0.220322	4.24	0.000
Intercept – Far	2.44882*	0.248561	9.85	0.000
Very Far (base category)	0			
Metric Distance (Time) in Minutes	-0.0059772*	0.0008676	-6.89	0.000
Student Sex				
Male	-0.216460	0.186203	-1.16	0.245
Female (base category)	0			
School Size				
Small	-0.594046*	0.204051	-2.91	0.004
Large (base category)	0			
School Type				
Private	0.324540	0.203575	1.59	0.111
Government (base category)	0			
School Performance				
Low	0.194095	0.372838	0.52	0.603
Mid	-0.666753*	0.204704	-3.26	0.001
High (base category)	0			

Note. $*p < .05$

School size and school performance categories demonstrated similar significance and associations as found in the Euclidean and travel distance OLR models. Student sex was again found to be insignificantly related to how the Uganda boarding students assessed the cognitive distance. Unlike the Euclidean distance OLR, school type was not found to be significant to how the Ugandan boarding students perceived cognitive distances.

Findings Summary

Many possible explanatory variables were investigated regarding their relationship to how far students actually travel to school (metric distances) and how far they perceive (cognitive distances) that distance to be. The most important explanatory variable examined in this study was students' sex because of its direct relevance to issues of gender equality in school accessibility. However, it was essential to examine other explanatory variables of school characteristics in conjunction with student sex in order to provide a deeper understanding of overall education delivery dynamics in relation to sex and gender. Table 28 summarizes the explanatory variables found to be significantly related to metric and cognitive distances of boarding students attending secondary schools in Uganda.

In summary of the OLR analysis results, although a consistent pattern was observed that male boarding students surveyed in Mukono, Uganda estimated the distance travelled as slightly less of a burden than the female boarding students surveyed, there was not sufficient evidence to infer that this pattern would hold for the larger population of Ugandan boarding students. However, the school's size and school performance characteristics appeared to be related to how students feel about the all three types of metric distances they travel to school, namely Euclidean, travel and time distances. Students traveling to small schools perceived the distance to school as less than students attending equally distant large schools. Students attending mid-performing

schools also perceived equal distances they travelled to school as less than students who attended low or high-performing schools.

School type was found to be statistically related to how students perceived distance in the OLR model with Euclidean distance and moderately significant in the OLR with travel distance. In both cases, students attending government schools perceived distance to school to be less than students attending private schools. School type was not found to be a significant variable in the OLR model with time distance.

Table 28

Response Variables and Statistically Significant Explanatory Variables

Response Variable	Significant Explanatory Variable
Metric Distances	
Euclidean Distance	Student Sex
	School Size
	School Setting
	School Performance
Travel Distance	Student Sex
	School Size
	School Setting
	School Performance
Time Distance	None

Cognitive Distance	Metric Distances
	  - Euclidean
	  - Travel
	  - Time

	School Size
	School Type
	School Performance

Chapter 5: Discussion

Current international policy regarding gender equality in school accessibility flows from the Universal Declaration of Human Rights which boldly declared that all students have an equal right to an accessible education (United Nations, 1948). The Education for All (EFA) initiative attempts to monitor school accessibility to assess global progress towards the goal of gender equality of school access. However, as this study demonstrates, accessibility is a complex construct with both spatial and aspatial dimensions. While each dimension is important, this study provides evidence that distance is not an ancillary factor in a long list of variables, but in fact, plays a central role in determining real and perceived school accessibility.

This chapter reflects on three core categories of findings that have particular relevance to issues of gender equality in school accessibility. Then a conclusion with expanded discussion of policy recommendation is presented.

Reflections on Core Findings

The findings discussed in this section fall into three categories: (a) a revised school accessibility model, (b) aspatial variables significantly related to the metric distances separating home and school, and (c) aspatial variables significantly related to the cognitive perception of distances separating home and school. Within each of the following three sections, brief glimpses of policy implications are presented.

Revision of the school accessibility model. Before data were collected and analyzed for this study, the researcher proposed that Khan's Accessibility Healthcare Model (Khan & Bhardwaj, 1994) could be adapted for investigating significant factors of school accessibility in the Mukono District of Uganda. This adapted model anticipated that student and school characteristics, different types of distances, and the socially-constructed notion of gender

operated as mediating influences on the effective implementation of education delivery efforts

and policy designed support and provide for schools in locations that facilitate gender equality in

school access.

The original school accessibility model placed both metric and cognitive distances in the

same box, reflecting a lack of understanding of the functional relationship between them (Figure

20). The data collected in the Mukono District of Uganda and the spatial and statistical analyses

that followed provided important insights regarding the factors that were related to school

accessibility in that setting.
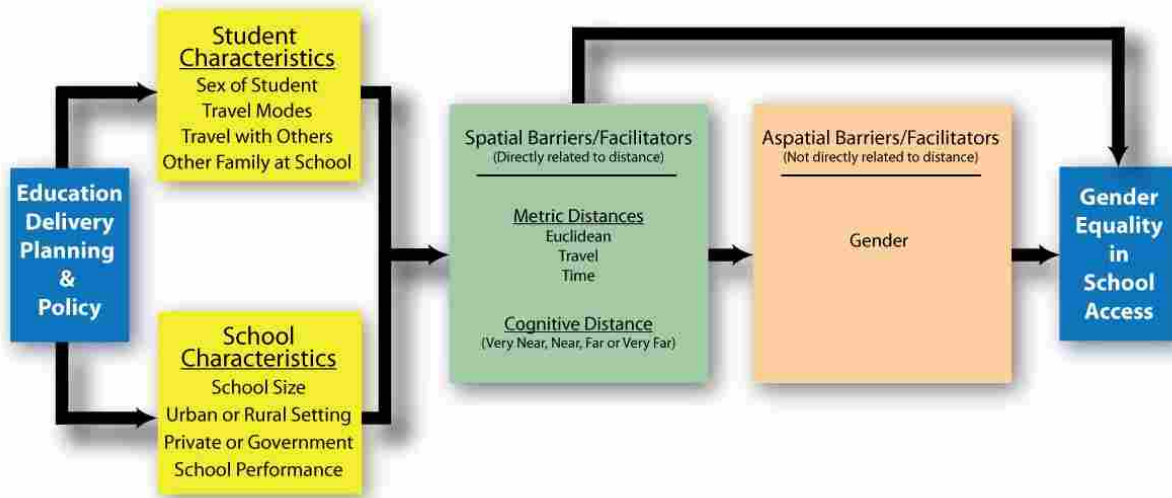
Figure 20. Original School Accessibility Model.

As a result, a revised school accessibility model was developed to reflect these insights

(Figure 21). The revised school accessibility model separates the spatial variables of metric and

cognitive distances (shown in Figure 21 as yellow boxes over the green background) into

separate spatial variables mediating of the effectiveness of education systems attempting to

deliver gender equality in school accessibility. They are mediating variables because distance,

real and perceived, is an unavoidable barrier as students seek access to school. Not only does the

revised model acknowledge that actual distances (metric) and the perception of the magnitude of those distances (cognitive) both play a central role in school accessibility, but also allows for other aspatial variables to interact with each of these spatial variable independently and at different stages of the model.
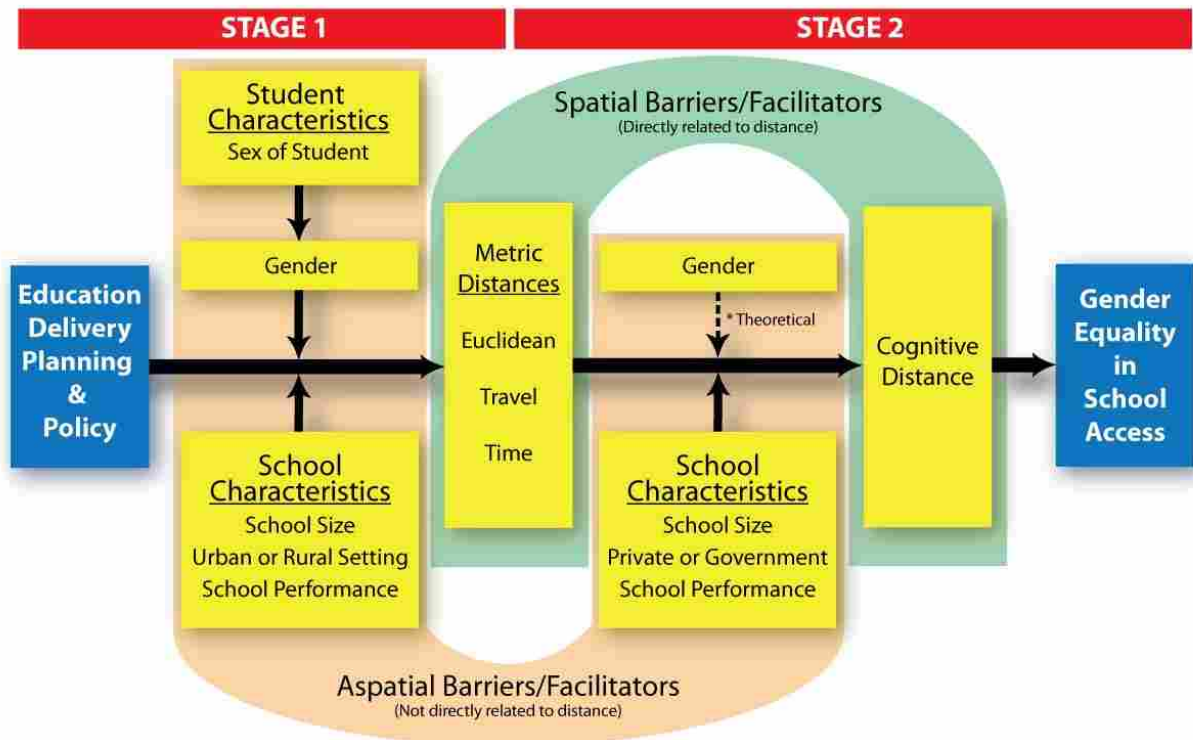
Figure 21. Revised School Accessibility Model.

The yellow boxes over the orange background in Figure 21 represent variables classified as aspatial. Aspatial variables are salient factors for school accessibility that are not inherently related to distance. There are three types of aspatial variables in the revised model including student characteristics (sex of the student), school characteristics (size, setting, type, performance), and gender. In the context of this model, gender is not considered a student characteristic used to categorize students but the residual effect of artificial and socially-

constructed expectations that society assigns to students based on their sex that may impact

school accessibility.

This revised model establishes two stages in the realization of gender equality in school

access. In stage 1, educational delivery efforts (subsidizing, managing, monitoring, building and

planning for school resources, etc) result in the provision of schools that are a given distance to

each of its students. This given distance is a metric distance and can be calculated in units of

Euclidean distance, travel distance or time. Stage 1 of the revised model illustrates the

relationship between education delivery efforts and the metric distances student must overcome

to attend school. According to the revised model, this relationship is being modified by the sex

of the student and certain school characteristics. Furthermore, the modifying role of student sex

is constantly being mediated by societal ideas of gender.

Metric distance isn't the only spatial variable at work with school accessibility. How far

away a school feels (cognitive distance) from home likely has a real relationship on the school's

perceived accessibility. In short, if the school feels too far away, a student is less likely to

choose to go there. This idea of choice substantiates Gatrell's (1983) statement that the

definition of accessibility should include both the ability to reach a place *and* the willingness or

motivation to make the journey. For example, if two schools are the same physical distance

away from a student's home, but one feels closer to the student's home, the actual distance

represents less of a perceived cost to the school that feels closer, and consequently less of a

perceived obstacle.

Because cognitive distance may likely be directly related to the willingness of a student

to make the journey, stage 2 of the model begins with the metric distance box and attempts to

account for the aspatial factors that may be related to how far the school feels (cognitive

distance) which results in some degree of gender equality in school access. Aspatial variables in stage 2 of the revised model include certain school characteristics and theoretically, gender (notice the dotted line).

Students' sex was not included in stage 2 of the revised model because of the lack of evidence that biological differences between male and female students have a significant impact on their perceptions of the magnitude of distance (Patton & Lloyd, 2009). However, gender is not based on the biological differences, only on the false expectation of differences in the capabilities between the sexes. Therefore, Ordinal Logistic Regression (OLR) analyses tested for a difference in the perceived magnitude of the distance to school between male and females. If a difference in cognitive distance could be confirmed between male and females, and if that difference was not attributed to biological differences between the sexes, than these data could present compelling evidence that gender plays a role in establishing cognitive distance perceptions. Gender-based differences in cognitive distance perceptions could unevenly impact choices in school enrollment and continued participation, thereby creating gender inequality in school access.

The revised model provides an improved framework of studying school accessibility by allowing for each of variables to be controlled for while other variables are examined. In this study, the researcher first sought to gain a basic understanding of the relative distances students were traveling to school and how they far they perceived those distances to be. Once those distances were generally understood, the researcher introduced a set of student and school characteristics to determine which characteristic, or combination of characteristics, were related to those distances, thereby improving or hindering school access.

As will be explained in more detail later in this section, the analyses only produced indirect evidence that gender mediates the moderating influence of sex on the resulting metric distances of educational planning efforts in stage 1. This model does not attempt to disentangle the relative influence of sex from impact of gender on metric distances. Consequently, while gender remains a meaningful theoretical construct distinct from sex in this research, the data uncovered no functional method of distinguishing between the moderating relationship of sex and gender on the realized metric distances between home and school.

The OLR analyses also failed to confirm that male and female students perceive the magnitude of distance differently in stage 2 of the revised model. This may mean that gender does not modify the production of cognitive distance perceptions. Alternately, the OLR instrument used to analyze these data may not be adequately sensitive to detect the presence of gender with this sample of data. Therefore, gender remains in the revised model only as a theoretical conjecture, not as an observed or demonstrated factor in this study.

Geographers such as Khan may find this model an interesting and productive approach to examining how aspatial variables can have one relationship to metric distances associated with access and another distinctively different relationship to cognitive distances perceptions. Indeed, metric distances and cognitive distances may be appropriate estimates of potential and realized accessibility, respectively, reinforcing Khan's accessibility typology (1994). For example, a student has potential access to a school if that school is within their physical range of travel, and metric distances pertain directly to the physical limitations of access observed in this study. On the other hand, cognitive distances incorporate more than just the physical distance by allowing for other possible influences on the human perception of distance that may affect the choice to enroll at a particular school. This idea of two distance-based thresholds of access, metric and

cognitive, may be a fruitful approach for explaining how realized access differs from potential

access in school accessibility.

        Significant aspatial variables and metric distances between home and school. The

data obtained in this study provide important information clarifying the actual functioning

catchment ranges of secondary schools in the Mukono District of Uganda. In addition to

establishing general catchment ranges of secondary schools in a real world setting, this study

demonstrates that certain aspatial variables in the form of school and student characteristics are

shown to be related to the magnitude of these catchment distances. This information provides an

important framework for education delivery strategy and policy discussions.

        For example, 319 day students surveyed lived an average of 3 kilometers from the school

they attended. However, some day students traveled more than 20 or 30 kilometers to school

each day. In addition, 79% of the day students surveyed reported walking as there primary mode

of travel. Clearly, attending secondary schools in developing countries such as Uganda requires

considerable daily sacrifice in travel distance and time alone, financial considerations aside, for

many students and their families.

        This finding has clear policy implications. Many day students, particularly day students

living in urban areas, have numerous secondary schools within a 3 kilometer walking distance of

their homes (Figure 22). Local school administrators can use this information regarding

overlapping catchment areas to help shape their recruitment efforts by considering all competing

schools located within 3 to 4 kilometers of their school. Comparing their own school against the

nearby competing schools would help identify their school's unique qualities that may provide a

competitive edge in recruiting future students.
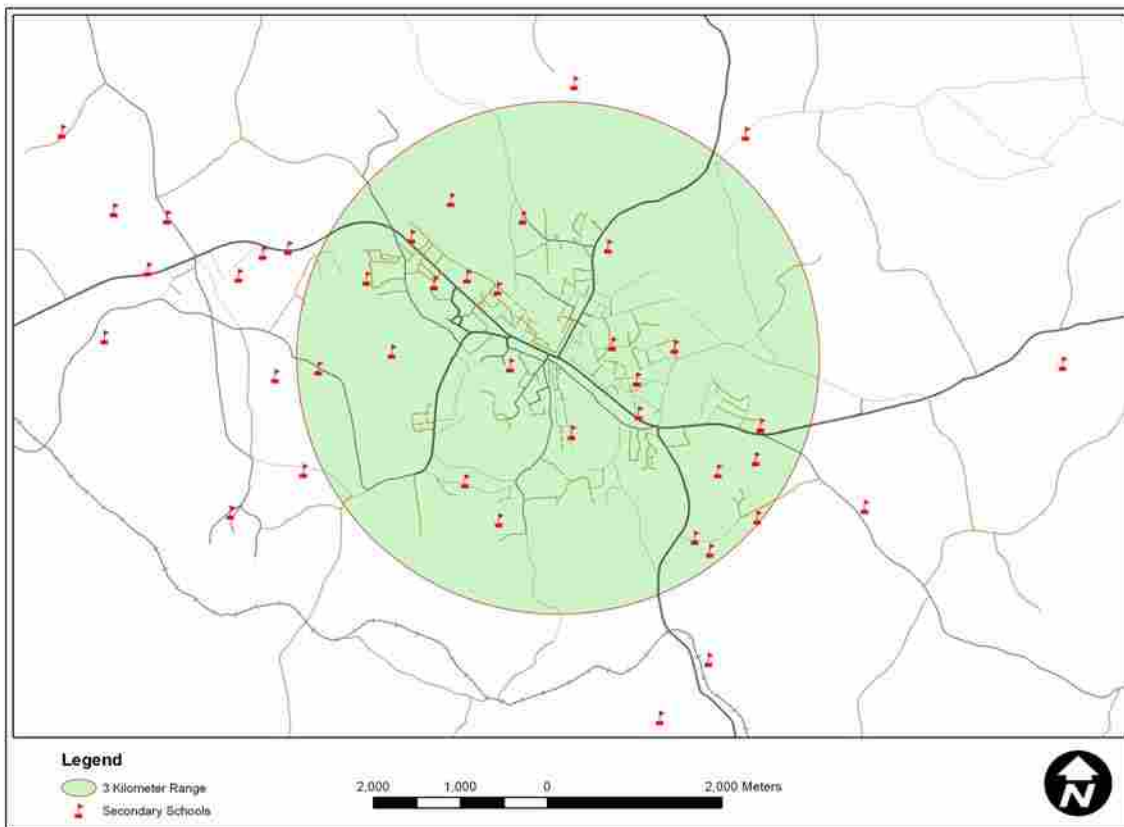
Figure 22. Secondary Schools within 3 Kilometer Range

Conversely, regional education leaders may be equally concerned with gaps in catchment areas as they are in overlapping catchment areas. For instance, rural areas with school locations further than 3 kilometers from population centers would represent a lack of catchment coverage for some day student candidates. As attending day school is typically the least expensive means of attending secondary school, day students would logically be most at risk to the cost of overcoming the distance to school. Regional educational planners who identify population areas with schools too far away may choose to incentivize the construction of small day schools in order to ensure that the population most at risk has an opportunity to attend school.

The 437 boarding students surveyed traveled much further than the day students. Boarding students reported their home locations being a mean Euclidean distance of 60 kilometers from school with the furthest living in Dar es Salaam, Tanzania, a home location 1,070 kilometers from the school they were attending. The data show that the extended commuting range of boarding secondary students provides them with many more school choices than day students enjoy, as evidenced by many of the boarding students in this study were found to literally pass by hundreds of other boarding schools that they for some reason chose not to attend.

Catchment ranges of this magnitude have important policy implications and these implications can be easily communicated and visually understood by generating Standard Distance Deviation (SDD) maps. First, the large distances many students are travelling to school are an indication of how dedicated East Africans are in attempting to better their lives through obtaining an education. And second, the huge and overlapping individual catchments areas for each school in this study show that many students are not enrolling at the closest school to their homes (Figure 23). This later observation is a powerful evidence of the uneven quality and accessibility of schools in the region.

Because many students are willing to travel so far to boarding school, regional educational leaders may choose to focus the majority of future boarding school construction assistance near regional urban centers which generally enjoy better physical access through more improved roads making urban schools easier to reach for many more distant students. Figure 23 shows that despite being located in an area with many competing secondary schools, School 137 in the study has a catchment area of 1/3 of the total area of Uganda, indicating urban schools are more accessible than rural schools.
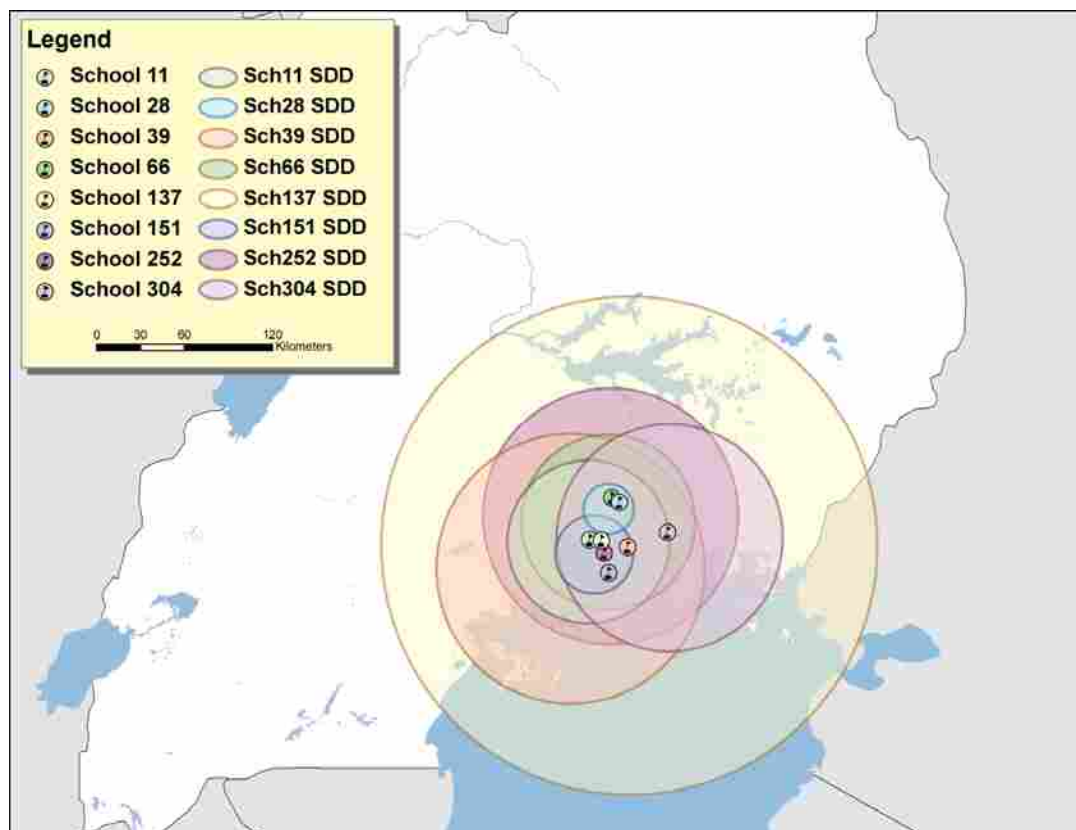
Figure 23. SDDs Depicting Overlapping Catchment Ranges of Surveyed Schools

Students' sex and metric distances. Who travels further to school, male students or

female students? The data show there were no significant differences between male and female

day students regarding the metric distances to day schools. However, the male boarding

students' average metric distance from boarding school was one third larger than the average

metric distance of female boarding students in Uganda, being 73 and 51 kilometers respectively.

This increased commuting range of male students presents males with a larger number of schools

from which to choose to attend. Therefore, male students are clearly less limited by metric

distance than female Ugandan boarding students. By definition, and practical implication, this

unequal condition in school choice based on the student's sex represents a demonstratable

condition indicating gender inequality in school accessibility (UNESCO, 2003/4).

   Other aspatial variables significant for metric distances.   Other aspatial variables

besides sex mattered as well for metric distances. School setting, school size, and school

performance were significantly associated with how far students were actually traveling.

   School setting and school size. How far away the student's homes were from school was

found to be related to the setting of the school location. On average, boarding students surveyed

in this study attending urban schools commuted 32.6 kilometers further than boarding students

attending rural schools. Finding that urban schools had larger catchment areas was not

surprising, but the magnitude of the catchment gap between urban schools and rural schools was

unexpected by the researcher.

   The size of the school also mattered. The average boarding students attending small

schools were found to be 20.5 kilometers further from home than boarding students attending

large schools. This was not anticipated by the researcher as large schools would seem to have

several recruitment advantages over small schools, including naturally larger networks of alumni

and staff to assist recruitment efforts, and generally better developed and reliable access roads.

Nevertheless, the data suggest that the large schools surveyed in this study rely more on local

recruits than on distant students. One explanation may be that large schools dominate

recruitment of the local areas surrounding the school. This conclusion is supported by the fact

that the large schools in the survey generally performed better on the O-level national exams

than the smaller schools surveyed. Perhaps, these large schools have such a recruitment

advantage that they can hand pick the best academically-performing local recruits before looking

elsewhere.

   There are important micro and macro policy implications related to these two findings.

From a school administrator perspective, the ability of urban schools to draw students from

further away than rural schools can improve urban schools' likelihood for fiscal sustainability.

Rural school administrators may be wise to focus their recruitment efforts on more localized

areas while urban school administrators could more confidently expand their recruitment areas

with the knowledge that many urban schools are drawing students from distant locations. Or,

alternatively, rural school administrators may also look to capitalize on the relative high mobility

of many Uganda students by providing transportation from the school to the nearest urban center

for their boarding students to assist them on their commute. Most boarding students only leave

school a few times a year and those times usually are predictably at the end and beginning of

terms.

As stated earlier, from a macro policy perspective, urban schools are more accessible

because they are easier to reach for more potential students than more isolated rural schools.

National educational ministries with scarce resources may use this information as rationale for

prioritizing school assistance programs toward urban schools as those resources have the

potential to reach more of the population of students, even though it may create a temporary

political concern for families not having schools built nearby.

Looking at setting and size together, the catchment ranges for small urban schools nearly

doubled the catchment range of large urban schools and more than doubled the range of rural

schools, large or small (Figure 24). While students seemed willing to travel incredible distances

to attend the small urban schools in this study, small rural schools drew boarding students from a

considerably less distance than all other schools.
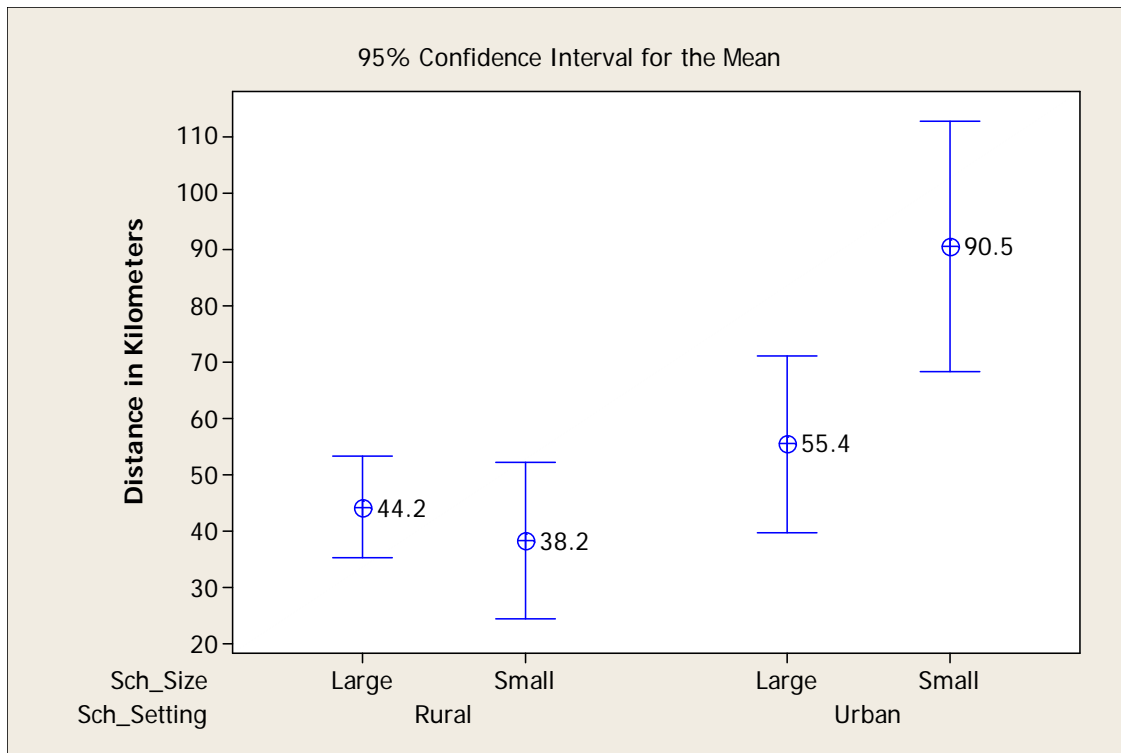
Figure 24. Interval Plot of Distance in KM vs. School Size by School Setting

This suggests that students are least likely to travel long distances for the opportunity to

attend a small rural school. In other words, it appears that students attending small rural schools

may be more limited by distance, or the cost of distance, than any other type of student surveyed.

If true, then small rural schools that are close to home may represent the only option for

secondary education for students so limited by the cost of distance. Therefore, the limited

options of small rural school boarding students may be most at risk for hindered school access on

account of distance producing unequal access.

Including students' sex in the analysis of the role of setting and size on school access

contributes even more insight to this discussion of who is most limited by the cost of distance.

Figure 25 details the mean Euclidean distances of setting, size and sex, each found to be

statistically significant predictors of metric distance.
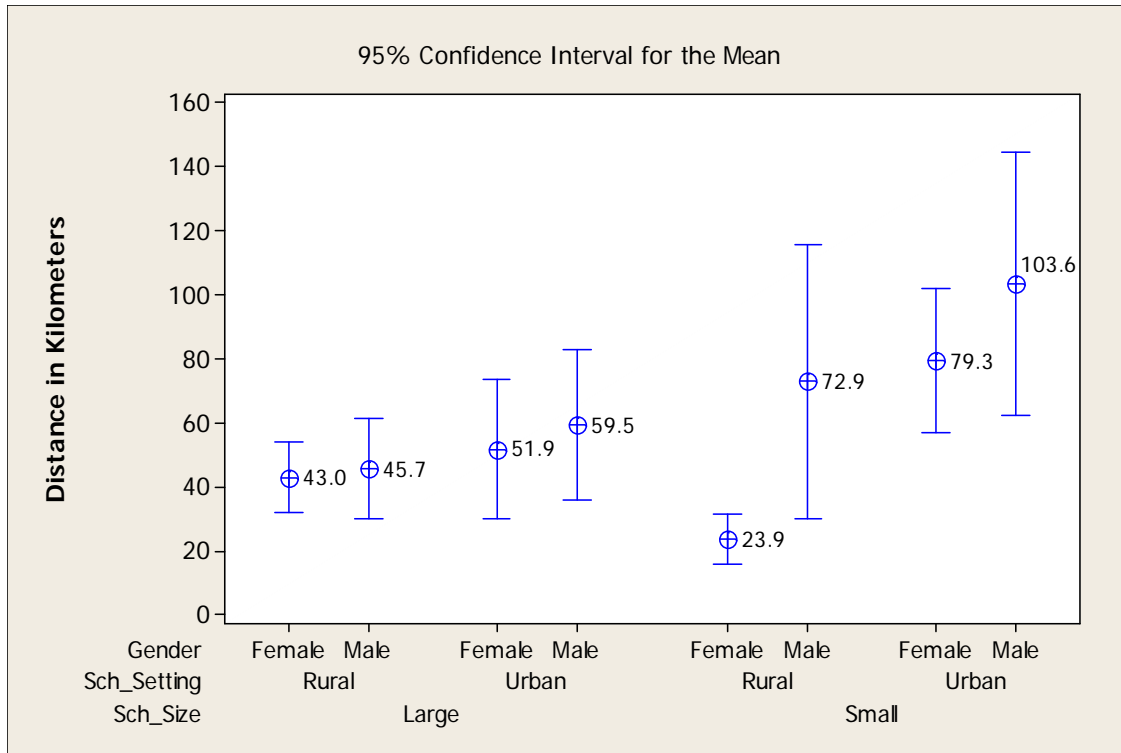
Figure 25. Interval Plot of Distance in KM vs. School Size by School Setting and Sex

The data show that the difference between the distances males and females travel is the greatest at small rural schools where the average male boarding student lives three times further from school than female boarding students. In fact, the average male boarding student attending a small rural school lives much further from home than the average boarding student at large schools, urban or rural, male or female.

However, the uniquely restrictive range of the average female boarding students at small rural schools provides the most direct evidence of gender inequality of school access. This finding supports Shrestha's (1986) explanation regarding a similar distance gap of students in Nepal. She proposed that socio-cultural norms established that education for males was essential, regardless of the circumstances but for females, education was viewed as a luxury. As such, families would not send girls too far, if they sent them at all. If rural female students are

statistically the most limited by distance, they may be the population at most risk for finding

secondary school inaccessible.

     School performance. Boarding students attending mid-performing schools had a higher

travel range than either boarding students attending high or low-performing schools. This

phenomenon may represent a geographic 'reaching up' where students and their families are

showing a willingness to shoulder more of the cost of distance to attend the best school to which

they can gain admittance. This finding may also imply that for students who can afford the costs

associated with attending a distant school, admission barriers regarding student achievement may

be more significant than distance. However, Figure 26 makes clear that male and female

students do not have equal access to mid-performing schools, particularly at small rural schools.
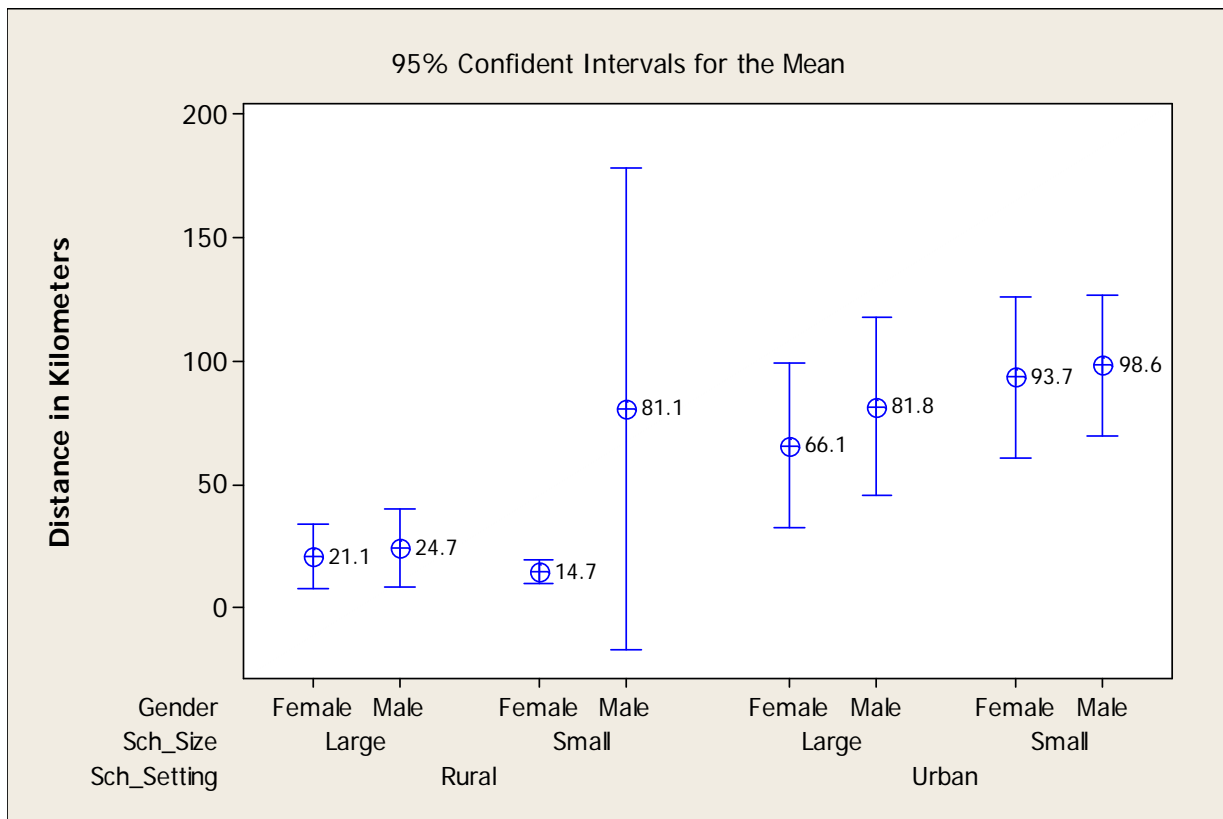

Figure 26. Interval Plot of Distance vs Setting by Size and Sex for Mid-Performing Schools

Female students attending small rural mid-performing schools live only 14.7 km away while males live an average of 81.1 km from school. This may indicate that male students are much less restricted by distance constraints if desiring to "reach up" from a low-performing school to a mid-performing school than female students.

There was no such male and female distance gap at high-performing schools. Possibly, high-performing students, male and female, are in high enough demand that well-resourced, high-performing school's merit scholarship programs even out issues of accessibility. Or perhaps, families of high-performing female students recognize that if access to a reputable high-performing secondary school is attainable, the long term economic benefits would outweigh the short-term sacrifices.

Several interesting and potentially conflicting macro and micro policy implications exist that are associated with gender and performance. Educational leaders with responsibilities of macro policy could seek to equalize the access of female students to mid-performing schools by subsidizing school fees or boarding costs, thereby lowering the cost of accessibility. However, local school administrators may favor admitting male students because they tend to perform better academically (Uganda Ministry of Education and Sports, 2009). Better school academic performance often improves enrollment demand, and enrollment demand ensures school income. School fees are an essential source of operating income for most schools in Uganda; even those receiving substantial government subsidies.

Students' sex, gender, and metric distances. This study provides substantial evidence that male boarding students travel further to school than female students. Student's sex is included in the revised model as a modifier for metric distance because it is likely that at least some of the difference in metric distances ranges can be attributed to the biological traits

associated unique to student's sex. For example, male students may travel with more speed and

stamina than female boarding students increasing their possible range of travel. Conversely,

female students' lack of speed and strength not only make the journey more strenuous but

potentially exposes female boarding students to more threats to their personal safety while they

journey to and from school.

However, it is unlikely that the considerable difference in the metric distances that male

and female boarding students travel to secondary school can be completely explained by the

biological differences of associated with sex. Differences that cannot be attributed to the sex-

based physical differences must be attributed artificial socio-cultural factors (Davidson &

Kramer Gordon, 1979; Wharton, 2005). The revised model accounts for these socio-cultural

factors of gender. In this context, gender mediates the modifying influence of sex on the

relationship between education planning and metric distances of boarding students.

If, as the literature suggests, sex only describes the biological differences and capacity,

and gender only describes socially constructed and learned differences of males and females, can

the actual male and female distance gap observed in Uganda secondary boarding students be

explained as only a difference in biological capacities to travel? A more likely conclusion is that

the significant gap in metric distances should not be attributed to biological differences alone.

Significant aspatial variables for cognitive distance. The revised school accessibility

model acknowledges that while actual metric distances are an important accessibility measure,

particularly for male and female student comparisons, cognitive distances invariably mediate the

role of metric distances in school accessibility. The mediation of metric distances by cognitive

distance assessments were observed in both negative and positive directions as some students

perceived the actual metric distances to be less then other students, while others estimate the distances to be more.

Decisions, such as the decision to attend a particular school, are based on the perception of the facts rather than facts themselves. It is reasonable to expect that if a school feels too far away, then that perception will play an important role in many families' decision on which school their child should attend.

Students' sex, gender and cognitive distance. While there is some evidence that the male brain might have a slight advantage over a female brain in processing spatial information (Patton & Lloyd, 2009), there is no known research suggesting that cognitive distance perceptions are impacted by the perceiver's sex in a biological sense. That is, males are not biologically predispositioned to estimate something as nearer or farther than their female counterparts. For this reason, sex was not included as a modifying variable in the relationship between metric and cognitive distances in the revised model.

However, the researcher hypothesized that if there was a difference in the perception of the distance from home to school between male and female students, that such a difference may be substantial evidence that those differences were a result of artificially-learned ideas of gender. The OLR analyses were designed then to test for evidence of gender (as a social construction) influencing perceptions.

The OLR analyses did not provide any statistical evidence that male and female students perceive the distances from home to school differently based on their status as a male or female. Either gender was not a factor in how students perceive the distance to school or the instrument used in this study was not sensitive enough to measure its effect. Therefore, gender is shown as a variable possibly moderating the relationship between metric distances and cognitive distances.

The dotted arrow signifies that while such a moderating relationship is possible, it was not confirmed with this analysis instrument using these data.

     Other variables significant for cognitive distance. The data from this study demonstrate that in Uganda there are some school characteristics that are related to how far away a school is perceived to be from the students' homes. When controlling for metric distance, small schools, government schools, and mid-performing schools felt closer (cognitive distance) to home for secondary boarding students in Uganda. Therefore, these types of schools felt more accessible than large schools, private schools, and low- or high-performing schools after controlling for metric distances.

     This cognitive adjustment may represent a desirability or comfort factor. Mid-performing schools drew students from further away than either low- or high-performing schools but comparably, the distances felt closer to the students. One plausible explanation is that these students are attempting to "reach up" to the highest performing school to which they can gain acceptance within their range of commutability. In those cases, the cost of distance may be more willingly accepted by families hoping the possible benefit of higher performances on the national exams will outweigh the interim costs of attending a more distant school. Similarly, government schools have a long established reputation in Uganda as more stable institutions with a better academic performance record than the average private schools. These perceived advantages of government schools may heighten the desirability of attending government schools to the point where distance feels like less of a burden than if attending a similarly distant private school. Small schools may present a less threatening environment for many students. If many students find large schools intimidating and/or more foreign to their home environments that they are used to, the distances separating home and school may be overestimated.

These observations regarding cognitive distance perceptions provide useful references for macro policy. Providing schools that feel closer (such as government schools) enhances their attractiveness to families of potential students. This attractiveness is most important to those families teetering on their resolve or ability to send their child to a particular secondary school. Accessibility incorporates both the ability to reach a place and the willingness or motivation to make the journey (Gatrell, 1983). Schools that feel closer feel more accessible. Therefore, if smaller government schools with a respectably moderate performance record are most welcoming to students because they feel closer to home, then perhaps those are the type of schools that should receive the highest priority of government support.

Conclusions

This study sought to explore how distance affects access to secondary schools in Uganda. Once a general idea of how far students were traveling to school was understood, different student and school characteristics were examined to determine which of these characteristics had the strongest relationships to those realized distances. Lastly, this study used OLR to investigate how these same characteristics may be related to how students' perceive these distances.

Six of the eight schools included in this study reported total enrollment ratios at or very near gender parity thresholds seemingly indicating that gender equality in school accessibility was being approached. The spatial analysis techniques of this data from this study explicitly show that female secondary students in Mukono District, Uganda do not enroll in schools as far from home as male boarding students. Because female boarding students have a reduced range of commutability, they have fewer schools from which to choose to attend. Therefore, secondary schools are not as accessible to female boarding students as they are to male boarding students, despite reports of equalizing enrollment ratios (UNESCO, 2002, 2009).

This reduction in choice will undoubtedly hinder some secondary female students from enrolling at higher quality schools because they are out of range. These unfortunate students would be left with choosing from only the lower quality schools that are nearer to their home or not to enroll in school at all. Because male students are less limited by distance, they are less restricted in their access. Gender equality in school access cannot be obtained under these conditions.

These insights are only possible, and measurable, using spatial analysis. GER, NER, and generic household surveys are not sensitive enough instruments to capture anything beyond enrollment or participation rates. School accessibility is much too complex to rely on these traditional, blunt instruments alone. Using tools like GIS to determine true distances in conjunction with established statistical tools such as OLR enhance our understanding of the dynamics of school accessibility well beyond what currently being captured by measurement tools like GER and NER.

This study acknowledged at its earliest stages the assumption that all schools were not equally accessible to all students. Spatial theories of distance establish that distance has an inverse relationship to accessibility (Christaller, 1966; Losch, 1954; W. Tobler, 1969). Any analysis is only as good as the data it examines. Accurate distance measures are an essential prerequisite to the possible formation of any credible discussion of the role of distance to the gender equality of school accessibility.

It would be difficult to overstate the importance of collecting accurate distance measures when considering gender equality in school accessibility - yet the most common indicators used to evaluate gender equality rely almost completely on enrollment ratios of GER and NER with no explicit calculation of distance at all. Additionally, study after study seeking to explore the

role of distance on school accessibility failed to collect accurate distance, basing their entire

analysis on vague and unreliable distance estimates obtained through household surveys.

Consequently, the first part of the revised model and the analyses this study undertook

purposefully concentrated on the exploration of how far the Uganda secondary students actually

traveled to school in real physical units of measure.

Distance is a core qualification to school accessibility. It would be irresponsible to try to

assess school accessibility without considering distance as a salient factor, although many other

studies have failed to account for it. However, as this study shows, it would be equally unwise to

consider distance the only significant factor of school accessibility. Accessibility is not uniform

across student sex, school size, type, setting, or performance level, therefore these variables are

also important for developing a clearer understanding of gender equality and school access.

For instance, there were not significant differences in the distances of female and male

boarding students attending large schools, but the homes of female boarding students attending

small schools were approximately twice as close to the school as male boarding students

attending small schools. By considering distance in conjunction with these other variables,

schools and students at risk for inequality can be identified.

How far a school feels from home may influence a family's decision whether or not to

enroll there student. The ORL analyses did not find evidence that male and female students

perceived distances to school differently based on their sex. However, some school

characteristics were related to how far the distances felt to the students. These cognitive distance

measures may represent a desirability factor toward certain school characteristics and away from

others.

The revised model represents a step forward in our understanding of gender equality in school accessibility. This model accounts for metric distances and cognitive distances as variables that mediate efforts to produce gender equality in school access. It also describes how certain student and school characteristics moderate metric and cognitive distances independently as students seek access to secondary schools in Uganda. This model and the accompanying methods of spatial and statistical analyses establish a powerful framework for future research in gender equality in school accessibility.

Policy recommendations. The data in this study show that many, perhaps the majority, of students attending secondary school in Mukono District of Uganda travel remarkably far for the opportunity to attend school. This pattern of extensive catchment ranges afford many students multiple schools from which to choose when completing their secondary education.

However, some students do not appear to have the same degree of mobility when it comes to attending school. Rural female students seem to be the most disadvantaged group in terms of mobility. Any macro policy adopted should strive to meet the needs of everyone, whether they are challenged by distance or not.

This study demonstrates that using Standard Distance Deviations is a practical means for estimating functional catchment ranges. With that information, it is possible to identify areas where there is insufficient coverage in school catchment ranges to those students who are the most limited by the cost of distance between home and school. Small rural day schools are essential to provide adequate coverage for those students most disadvantaged by distance constraints, especially for female students. This type of school is also the most challenged by local economies to remain solvent without some type of governmental aide.

More can also be done to better serve the large number of students that are not as restricted by distance. For them, small boarding school campuses could be constructed on the outskirts of regional urban centers. They should be located as close to tarmac road as possible to ensure good vehicular accessibility in all weather conditions. The data show that students will travel great distances if school is located in or near an urban setting, particularly if the school is performing at least moderately well academically. Small schools feel closer and are less expensive to construct, staff, and maintain than larger schools.

Locating schools just outside town but near a tarmac road will reduce property acquisition costs. Locating new schools near existing schools may help to build resource-sharing relationships (J. M. Hite et al., 2006) that improve services without increasing costs. Schools can share teachers, lab equipment, testing facilities, access road maintenance responsibilities and perhaps even share some transportation services to the nearest town center. Implementing both of these strategies would improve accessibility for all Ugandan children and may provide a useful template for improving gender equality in school accessibility in other developing countries.

Future study. This study surveyed students already enrolled in secondary school and focused on the students' perception of home to school distances. Future studies could similarly survey the students' parents or heads of families who are making the final decision of where to enroll their children at school. Parents may have a different perception of the distances involved as well as different constraints and concerns that the students themselves do not fully understand or acknowledge.

World-wide aerial imagery is rapidly becoming available for even many remote areas of the world. In the future, studies where precise student and school locations are essential,

utilizing aerial imagery detailed enough for subjects to identify their homes and schools would greatly improve the accuracy and ease of the location survey over the use of base maps. Even since the data for this study was collected, high resolution imagery has become available for several areas of Mukono District that would have drastically improved data collection. Higher precision location and the resulting distances would be particularly beneficial for day student inquiries where the ranges are more locally contained.

This study was delimited by to schools in the Mukono District in Uganda. This type of methodological inquiry could be expanded into different regions throughout Uganda to get a better picture of the variability of secondary student commuting ranges as well as school catchment ranges. For instance, local Mukono residents frequently commented that many Ugandans were migrating southward toward Kampala from the all parts of Uganda to escape violence and poverty in their home regions. Therefore, it would be interesting to see if the relatively large catchment ranges observed in the Mukono schools were shared by schools in other regions of Uganda.

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Appendix A

Definitions

Accessibility: The ease to which a place or service can be reached (Johnston, 2000).
    The *ability* (mobility) and the *desire* (motivation) to overcome the spatial separation
    between resource supplies and user demand (Gatrell, 1983).

Cognitive Distance: "Implicit or explicit judgments about the spatial separation of objects that
    cannot be seen directly" (Gatrell, 1983, p. 63).

EFA (Education for All): An international commitment first launched in Jomtien, Thailand in
    1990 to bring the benefits of education to all school-aged children with an initial deadline
    of 2000 and later adjusted to 2015.

Equity: "Equal access to the same public benefit, regardless of socioeconomic status,
    willingness to pay, or other criteria" (Talen, 2001, p. 470).

Euclidean Distance: "The length of the shortest possible line joining the locations of a pair of
    objects (distance 'as the crow flies'). There is only one such distance for any pair"
    (Gatrell, 1983, p. 26).

Gender: Refers to social roles, obligations and expectations society artificially assigns to
    individuals based on their sex. These artificial social constructions of gender often place
    females at a competitive disadvantage to men by restricting their life choices and
    opportunities as well as their access to community services and resources.

Gender Equality: Boys and girls would experience the same advantages or disadvantages in
    educational access, treatment and outcomes. In so far as it goes beyond questions of
    numerical balance, equality is more difficult to define and measure than parity
    (UNESCO, 2003/4, p. 44).

Gender Parity: Reaching gender parity in education implies that the same proportion of boys and
    girls, relative to their respective age groups, would enter the education system and
    participate in its different cycles (UNESCO, 2003/4, p. 44).

Gravity Model: "An assumption is that a measure of the intensity of relationships between two
    areas is proportional to the product of the populations concerned by the exchanges and
    inversely proportional to a function of the distance" (Sanders, 2007, p. 3).

GER: Gross enrollment rate. The number of students enrolled in primary, secondary and tertiary
    levels of education, regardless of age, as a percentage of the population of official school
    age for the three levels (UNESCO, 2009).

Human Development: Human development refers to the concept which views the general well-being of humans as the focus and purpose of development action; it involves the application of learning to improve the quality of life (WCEFA, 1990).

Individual Accessibility: "The geographical scope or the number of opportunities individuals can reach (individual accessibility) given the space-time attributes of their daily activities and fixed locations (home, work, etc)" (Kwan et al., 2003, p. 131).

Metric Distance: A set of points and a set of distances that relate those points (Gatrell, 1983, p. 27).

Millennium Development Goals (MGDs): Eight international development goals that 189 United Nations members and international organizations have agreed to achieve by the year 2015. They include reducing extreme poverty, reducing child mortality rates, fighting disease epidemics such as AIDS, and developing a global partnership for development.

NER: Net enrollment rate. Net enrollment rate is defined as the number of students enrolled in a level of education who are of official school age for that level, as a percentage of the population of official school age for that level.

Ordinal Logistic Regression (OLR): An ordinal logistic regression is used to perform logistic regression on an ordinal response variable. Ordinal variables are categorical variables that have three or more possible levels with a natural ordering, such as strongly disagree, disagree, neutral, agree, and strongly agree. A model with one or more predictors is fit using an iterative-reweighted least squares algorithm to obtain maximum likelihood estimates of the parameters. Parallel regression lines are assumed, and therefore, a single slope is calculated for each covariate. In situations where this assumption is not valid, nominal logistic regression, which generates separate logit functions, is more appropriate.

Sex: A classification most appropriately used to describe the biological differences between men and women.

Spatial Analysis: The study of the geographic distribution of features, their connectivity, and relative influence on each other relating to the distance that separates them. Hence, spatial analysis commonly focuses on distance and its influence to of physical and/or social processes.

Spatial Interaction: The flow of various kinds of commodities and information from one place to another (Abler et al., 1971).

Standard Distance Deviation (SDD): Also known as Standard Distance, SDD are a mathematical measurement of the degree to which features are concentrated or dispersed around the geometric mean center. SDD is a geographic equivalent of a standard deviation measurement.

Appendix B

STUDENT SURVEY

Name: _____

In what year were you born? _____   What is your current age (years)? _____

What is your gender (circle one)?   **MALE   FEMALE**

Are you a day or boarding student (circle one)?   **DAY   BOARDING**

What is your current school level (circle one)?   **S4   S6**

Have other family members been students at this school?   **YES   NO**

Do you have family relatives living near the school?   **YES   NO**

Do you, your parents or your relatives worry about school fees?   **YES   NO**

What is your <u>country</u> of birth? _____   How many years have you lived in Uganda? _____

How many points did you receive last term? _____   What were your aggregate primary leaving exam scores? _____

What is your tribe? _____   What is the first language you learned at home?_____

What other languages can you speak well? _____

Who are you staying with during the school term?   **PARENTS   RELATIVES   ALONE   BOARDING**

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===

____   ****If you are DAY student, and you do <u>NOT</u> live with your parents,** raise your hand now and wait for help.

1.   What is the name of the <u>home town or village</u> that you go back to when school is not in session?
      (where your parents live)

         Home Town/Village: _____ **District:** _____

2.   When you are at home, what is the name of the <u>nearest town or village</u> where you or your family go to buy food or other supplies for home?

         Home Town/Village: _____ **District:** _____

Circle one answer for each question below:

3.	When you and your family decided to enroll at this school, how far did you feel this school was from your home?	**Very Near**	**Somehow Near**	**Somehow Far**	**Very Far**
4.	Today, how far do you feel the school is from your home?	**Very Near**	**Somehow Near**	**Somehow Far**	**Very Far**

5.   When you travel from home to school, how do you primarily or usually travel? (Circle only ONE)

      Walk   Bicycle   Boda Boda   Taxi   Friend's vehicle   Family's vehicle   Other: _____

6.   How do you travel from home to school:

      Alone   With Family   With Others

7.   How much **time** does it take for you to come <u>DIRECTLY</u> to school from home: _____
      (for example, how many hours or minutes would it take without stopping in town)

Circle one answer for each question below:

8.	How far do you feel that Kampala is from your home?	**Very Near**	**Somehow Near**	**Somehow Far**	**Very Far**
9.	How far do you feel that Kampala is from your school location?	**Very Near**	**Somehow Near**	**Somehow Far**	**Very Far**

10.   FOR BOARDING STUDENTS ONLY:
   Since January 1st, how many times have you traveled back and forth between your home and school?   _____

   You have now completed the survey.
   Thank you for your help!!
   Webale nnyo!

NOT FOR STUDENT USE: ___ Parents
For day students not at home:

   What is the name of the <u>home town or village</u> that you go back to when school is not in session? (where your parents live)

   Home Town/Village: _____   **District:** _____

   When you are at home, what is the name of the <u>nearest town or village</u> where you or your family go to buy food or other supplies for home?

   Home Town/Village: _____   **District:** _____