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Human Capital Accumulation Through Quality Education: Evidence from Ethiopian Primary Schools On Factors affecting Learning Outcomes

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Abstract

Human capital represents one of the most important components of a nation's wealth and it is critically important for the economic growth of a nation and its overall well-being. From a business organizational standpoint, developing human capital is vital to improve and sustain organizational competitiveness. Building human capital of a nation and specifically that of organizations, in turn, requires investing on education. However, it is not always clear what investments should be prioritized to improve human capital through the pathways of education. The study explores the key factors shaping the learning outcomes in Ethiopian primary schools, as a way to look at human capital development. Data for this study is gathered by using 400 random schools from nationwide school database and through carrying out qualitative research with several cases. Using the education production function approach, the author uses regression analysis and ANOVA to find the major reasons why students did well or poorly in grade 8 Standardized Mathematics National Exams. The research found that schools' water availability, existence of science center and student-textbook ratio, school ownership type, gender, and teacher qualification can influence the performance of students in learning outcomes. Alternatively, most common assumptions, including the importance of principals' leadership training, education levels and experience, and school location in terms of urban or rural areas, were not backed up by the statistics. It emphasizes that focusing investment on infrastructure and learning resources leads to better learning outcomes. Evidence-based education patterns and well-targeted donor actions are necessary to increase the effectiveness of school programmers and achieve greater gains in human capital through investments in the education sector.

Keywords: Human Capital, Learning Outcomes, Ethiopian Primary Schoosl, Education Investment.

Introduction

Human capital represents one of the most important components of a nation's wealth and it is critically important for the economic growth of a nation and its overall well-being (Lim et al., 2018). Empirical studies suggest that early formation of human capital and its gradual accumulation encourage macro and micro level economic growth of a nation (Bareke et al., 2021). It has been widely acknowledged and documented that inadequate human capital development can undermine society's well-being by disrupting existing cohesive social orders (Bank, 2018). Therefore, human capital is by far the most critical component of the total capital stock of both developed and developing countries (Sarwar et al., 2021).

The centerpiece of the human capital conceptual treatment by the World Bank includes knowledge, skills, and health of individuals. It defines Human Capital as the knowledge, skills and health that people accumulate over their lives. The World Bank further puts forward a cross-country metric that measures the human capital across many countries, known as the Human Capital Index (HCI) (Gatti and Kraay, 2020). Central to the estimates of Human Capital Index for any country are found the following two broad dimensions of human capital measurements:

1. Knowledge acquired in early years of schooling, which is measured through expected years of schooling and international test scores, to capture both quantity and quality of education.
2. Health of individual, which is measured through child survival rates, stunting rates, and adult survival rates.

Using the estimates on proxy indicators of the two broad dimensions of health and knowledge, the Human Capital

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Index combines these indicators into a single index to capture the "expected productivity of a child born today as a future worker, relative to a benchmark of complete education and full health" (World Bank, 2020b, p. 15).

The problem statement dictates that there is a knowledge gap present in factors that affect development of human capital via education in the developing world, particularly in Ethiopia. This is the primary research problem that will be tackled in the current research. It has been widely acknowledged and documented that development of human capital via education is one of the core pathways of escaping poverty.

The purpose of this research is to understand key factors influencing the development of human capital through education the context of developing countries, with particular focus to Ethiopia.

The research is guided by the following five categories of research questions with their corresponding research objectives:

Infrastructure (I)

Research Question: How do schools with better infrastructure affect learning outcomes in Ethiopia? Specifically, the following are investigated:

- Does the lack of toilets affect exam scores?
- Does the presence of electricity affect exam scores?
- Does the presence of water sources within the school premises affect exam scores?

The Research Objective is to investigate the significance of these infrastructure-related variables in predicting average test scores of grade eight students. Using bi-variate and multi-variate analysis, the research determines the significant variables and relative weight of the factors in predicting exam results as measured by average pass rate.

Quality of Inputs (Q)

Research Question: Do schools with better quality of inputs have higher student scores? Specifically, the following are investigated:

- Does the size of a classroom (student section ratio) affect learning outcomes?
- Does pupil-teacher ratio (PTR) affect exam scores?
- Does lack of textbooks affect exam scores?
- Does the existence of science center in the school affect exam scores?
- Does the existence of pedagogical center in the school affect exam scores?
- Does the existence of library in the school affect exam scores?

The Research Objective is to find out whether the level of input variables as described above affect learning outcomes as measured by the average pass rates on the national standardized exam for grade 8 students. Using bi-variate and multi-variate analysis, the research determines the significant variables and relative weight of the factors in predicting exam results.

Equity (E)

Research Question: In terms of demographics, is there a difference in grade 8 student exam scores among various subgroups including between girls and boys, urban and rural schools, among regions of Ethiopia, and between private and public ownership status of schools?

Specifically, the research investigates the following:

- Is there a difference in learning outcomes between boys and girls?
- Is there a difference in learning outcomes between urban and rural schools?
- Does private schools' exam performance differ from their public counterparts?
- Is there a difference in test scores between public, private, and non-for-profit schools in Ethiopia?

The objective of the above is primarily to compare the mean achievements of students (based on their exam scores) between various subgroups utilizing one-way analysis of variance (ANOVA) and to analyses whether there is a significant variation of means among the different subgroups.

Teacher (T)

The following research questions and research objectives will be considered in this vector of variables.

Research Question: How do schools with better qualified teachers and environment (as expressed by high attrition rates) compare with those with less qualified teachers and with low attrition rates?

The specific research question is:

- Does a teacher's qualification affect student exam scores?

The research objective is to investigate the relationship between teacher qualifications and learning outcomes using bi-variate analysis. It also examines whether schools with high teacher attrition rates have significantly higher pass rates compared with those with lower attrition rates.

Management (M)

The research question seeks to understand whether school management capabilities affect learning outcomes of schools. Specifically, it investigates the following research questions:

- Does School master's experience affect student exam scores?
- Does School master's educational qualification affect student exam scores?
- Does School masters on leadership training affect exam scores?

The research objective is to investigate the relationship between school master qualification and the average pass rates of their respective schools. It also determines the relative weight of coefficients and their significance in predicting student exam scores and pass rates.

Literature Review

Human Capital and the Wealth of Nations

Measuring and identifying what constitutes a nation's wealth has been an important economic research theme since Smith (2002) published "An Enquiry into the Nature and Causes of the Wealth of Nations". Defying the prevailing view that the wealth of a nation constitutes mainly gold and silver, Smith argues that a nation's wealth is composed of the entire body of goods and services that it produced. Adam Smith referred to this as gross national product (Smith, 2002). Smith put forward several themes that shaped theories and practices of managing national economy and accumulating wealth enabling economic growth.

The conceptual underpinnings of human capital have developed tremendously over the past several decades, and since Adams Smith first introduced 'the radical' view of

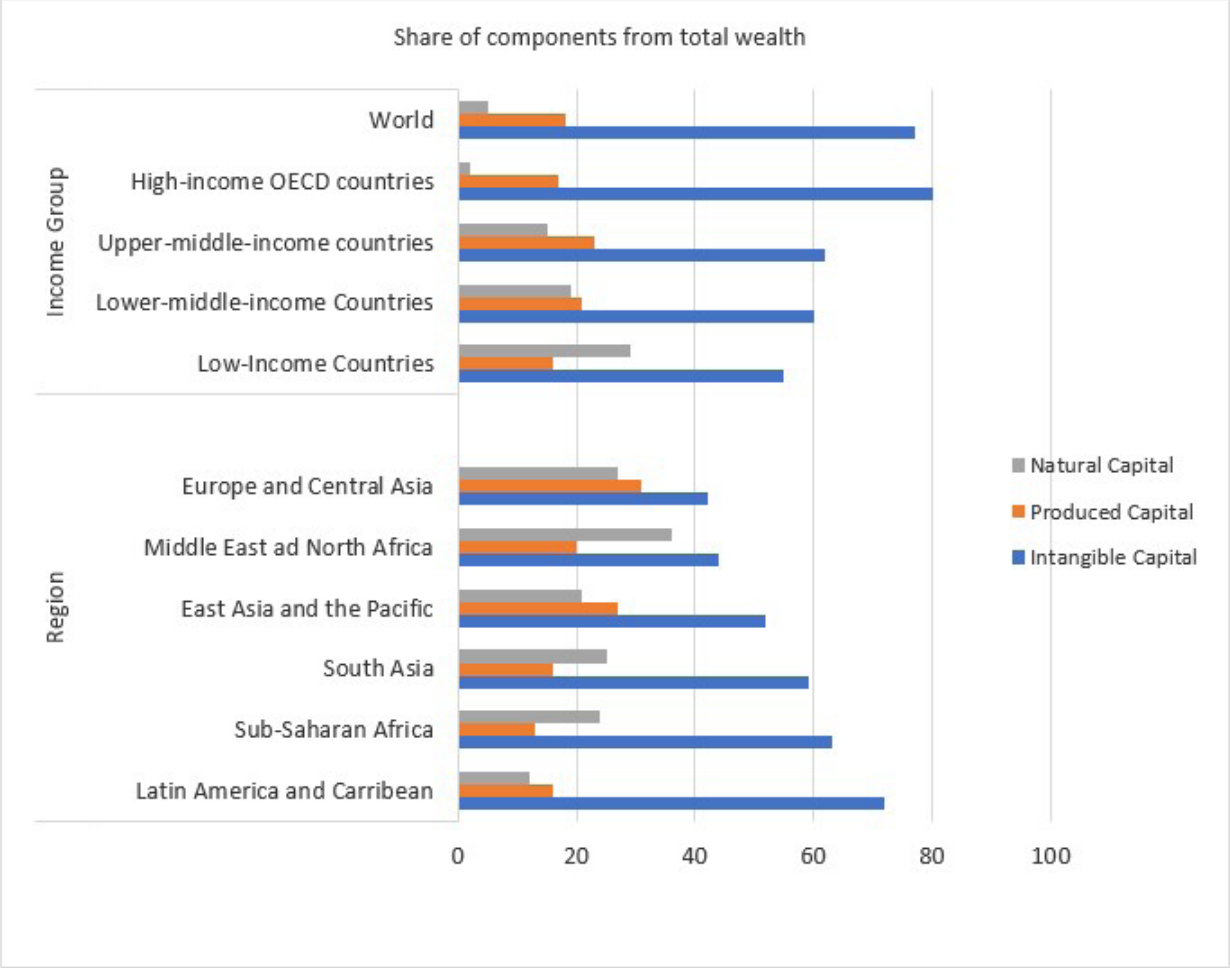

Figure 1 Wealth Component by Region and Income Group in 2000

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the concept in a book exploring the sources of the Wealth of Nations (Smith, 1776). For instance, the World Bank's 2006 assessment breaks down national wealth into three categories known as produced capital, natural capital and intangible capital (Agenda, 2006). In addition, the latter takes into account the levels of human and social capital and the quality of organisations. Above all, human capital or the pool of knowledge and expertise people have, is the key factor explaining national wealth in every region and for all income groups. In wealthy countries, housing often represents more than 80% of total wealth, making it very important to economic progress.

In estimating total wealth, the World Bank categorized the major components of national wealth as intangible capital, produced capital, and natural capital. Intangible capital encompasses raw and skilled labor, collectively termed as human capital (Corrado et al., 2022).

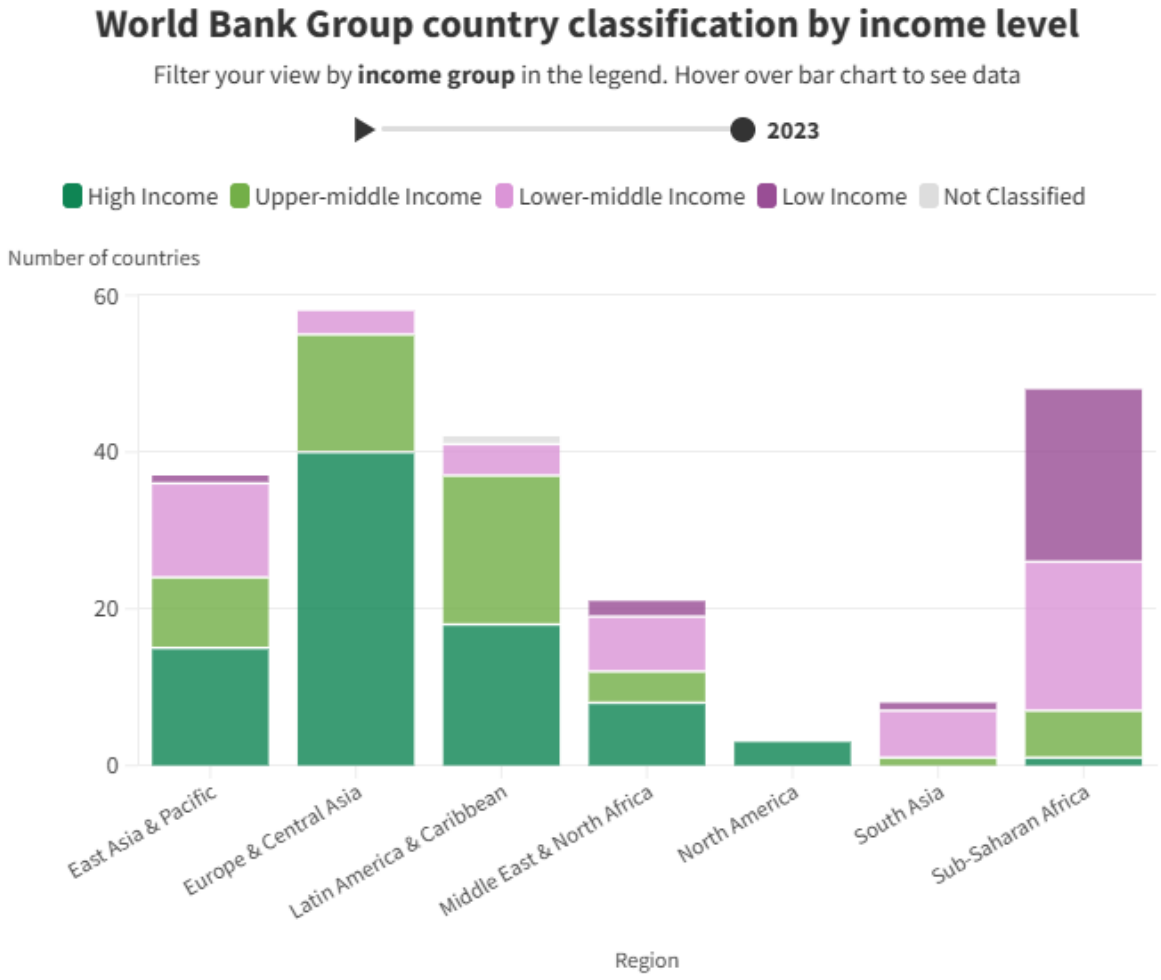

Figure 2 World Bank Group country classification by income level (2023)
Source: MetreauKathryn et al. (2024)

Human capital differs from raw labor as it includes the stock of human skills with know-how employed by the economy. Social capital and the quality of institutions are also seen as part of intangible capital (Agenda, 2006). Produced capital is the physical form of a nation's wealth traditionally considered capital. Specifically, it is the sum of buildings, machinery, equipment, and infrastructure (Agenda, 2006). Natural capital is the sum of non-renewable and renewable resources.

Conventional Method of Measuring Human Capital

Researchers suggest that human capital is the most important aspect of the total capital stock of both developed and developing countries (Bareke et al., 2023). Leaders of

many institutions have tried to define human capital and its components devising various robust methodologies for its valuation using monetary values. Across all the varied approaches and respective methodologies of discreetly monetizing human capital, one key dimension is common: schooling, educational attainment, or learning outcomes of a population are important in defining and valuating human capital (Degu and Singh, 2025).

For instance, when specifying the model of estimation for intangible capital, the World Bank (2002) considers educational attainment of the population as a key indicator for human capital. This indicator is the average number of school years for a country calculated as the number of school years per capita. This functional form also uses the Rule of Law Index as a proxy to social capital, and size of annual remittance as a gross indicator for interest from foreign human capital and assets. The model employed a Cobb-Douglas economic production function to estimate the intangible capital using the factors of human capital (school years), social capital (rule of law index), and foreign interests (remittance):

$R=AS^{\alpha s} F^{\alpha F} L^{\alpha L}$

Where, R is an intangible capital; A is a constant. S is average years of schooling; F is remittances, and L refers to the index on Rule of Law. The power coefficients αi denote the effect size (elasticity) of each of the factors on the dependent variable (the intangible capital). Measuring the contribution of the three factors (i.e., human capital, institutional strength or social capital, and human capital abroad/foreign interests) using a cross-sectional data for as many as 120 countries and employing the simple Cobb-Douglass production function resulted in the following regression outputs (Table 1)

Table 1 Factors Explaining Intangible Capital

Factors	Elasticity	R-Squared
School years per capita	0.53	0.89
Rule of law index	0.83	
Remittance per capita	0.12	

Source: World Bank (2006)

The results show that all the three elasticity coefficients estimated are significant and positive at the 5 percent alpha level. The size of the coefficients is 0.53 for school years, 0.83 for Rule of Law Index, and 0.12 for remittance. The results of the estimation indicate that a 1 percent increase in human capital, as represented by the school years variable, would increase the intangible capital by 0.53 percent. Similarly, a 1 percent increase Rule of Law Index or remittance would result in a 0.83 percent or 0.12 percent increase respectively on the residual.

Moreover, the regression result offers a deep insight that the relative effect (a unit change) on the intangible capital as a result of unit changes on each of the three factors (i.e., the marginal returns). Marginal returns are calculated using regression elasticities obtained in the Cobb-Douglas equation estimation based on the partial derivatives of the residual with each of the variables. This is proposed in the following equation:

$\partial R/\partial x=\alpha_x \ R/x$

Where αx is the elasticity of factor x, R is the mean value of the residual/Intangible capital, and x is the mean value of each of the factors. The result shows that the school years' variable that represents human capital has the largest marginal effect than other variables across all income groups of countries (Table 2).

Table 2 Variation in Intangible Capital by Income Group ($ per Capita)

	Marginal returns to schooling	**Marginal returns to rule of law**	**Marginal returns to foreign remittance**
Low-income countries	833	111	29
Lower-middle-income countries	1,721	362	27
Upper-middle-income countries	2,398	481	110
Higher-income OECD countries	16,430	2,973	306

Source: From World Bank (2006)

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The above regression result on marginal returns indicates that at the mean level of schooling, a 1-unit increase in the per capita school years (i.e., a one-year increase in schooling) results in an increase of US $838 in the monetary amount of the intangible capital in a low-income countries context (Agenda, 2006). Due to the gearing effect of infrastructure and other unobservable factors, marginal returns to schooling seem higher with increasing levels of economic growth.

However, the measurement of human capital by utilizing the proxy indicator of schooling per capita, regardless of its conceptual ease and relevance, is not without its challenges. The indirect approach of calculating human capital as part of the residual from total capital and sum of the natural and produced capital has been a subject of many academic critics. Studies have shown the serious limitations of measuring human capital indirectly from the residual (intangible capital) and only to the average number of schooling of a population. For instance, a United Nations (UN, 2012) study measuring human capital highlights the limitations of the residual approach. The report criticized the following drawbacks of the indirect approach:

1. It does not explain sources of changes of human capital overtime.
2. It is mainly a measure of intangible capital, within which human capital is encapsulated, and one could not derive human capital on its own.

Due to the weaknesses of the indirect approach, some studies (e.g., the UN (2012) guidance note on measuring human capital) propose other alternative and new approaches of ensuring Human Capital.

Modern Human Capital Measurement: A Shift to Learning Outcomes

The shift to focusing on learning outcomes and not just on educational attainment or enrolment levels, was debated intensely during the United Nations Educational, Scientific and Cultural Organization's (UNESCO, 1990) conference in 1990 held in Thailand. The conference resulted in the declaration of Education for All (EFA), where all nations and major developmental agencies committed themselves to meeting the learning needs of children and adults. The nations and donors also pledged to ensure the goals of universal primary education by 2000.

Currently, specialists in human capital measurement prefer to look at results rather than simply counting school years. This development recognizes that just being in school for a certain amount of time does not automatically give students knowledge, skills or lead to being economically active. In Ethiopia, the number of students in school has increased, but their education is still of poor quality (Diale and Sewagegn, 2021). In answer to this, international tools, including the Human Capital Index from the World Bank, have begun to measure human capital by adding learning outcomes from standard assessments (Bareke et al., 2021).

Theories on Learning Outcomes and their Critical Reviews

Behaviorist View

Learning occurs from accumulating stimulus-response associations where motivation strengthens or weakens the bond (Yang, 2023). The behaviorist view or the stimulus-response theorist advocates that knowledge is obtained through an individual's experiences and interactions with social and physical environments. Knowledge exists in the outer world and outside the human mind; therefore, it is gained through human's sense organs or empirical experiences (Marougkas et al., 2023). For example, mathematical knowledge is a set of propositions or statements verified using empirical evidence or, as Ernest (1998) calls it, some posteriori.

Cognitive View

The cognitive theorist studies the mental processes that affect human behaviors of how they make sense of the world (Wadeley et al., 1997). The word cognition is derived from the Latin word "cognuscere", meaning "to know' (Bigge, 1964); (Meade and FAACE, 2022). Theorists of cognition recommend establishing parallelism between subject matter domains and general cognitive abilities, such as reasoning, planning, problem-solving, and comprehending languages (Greeno et al., 1996). Unlike the behaviorists, cognitive theorists focus on mental functions, such as remembering and forgetting, to define learning as "a process of gaining or changing insights, outlooks, expectations, or thought patterns" (Kalina and Powell, 2009).

Conceptual framework

The overarching conceptual framework for the research is the five-vector model of factors potentially affecting development of human capital through education in Ethiopia. These are described as follows:

- Infrastructure (I): Presence of water sources, toilets, and electricity.
- Quality of Inputs (Q): Textbooks, pupil-teacher

ratio, classroom size, and educational center such as science centers, pedagogical centers, and library.

- Equity (E): Location (rural/urban, regions), school type, and gender.
- Teacher (T): Qualification
- Management (M): School master's education, experience, and training on leadership.

Global Factors Affecting Mathematics Learning Outcomes

2.12.1 Infrastructure (I)

The infrastructure dimension assesses the importance of key school infrastructure, such as availability of school water and sanitation facilities and school electricity connectivity on student learning outcomes. It has been well documented that these key school infrastructures have a profound impact on the school learning environment.

Many schools in developing countries lack adequate water and sanitation services with associated effects on student absenteeism from school, which in turn affect student learning outcomes. This is particularly concerning for adolescent girls as availability and well-functioning school sanitary and water facility is mandatory for adolescent girls to attend schooling during menstrual periods (Mathekgana et al., 2001). The impact of school infrastructure on student achievement has been researched in a developed country context as well. Insufficient and poor-quality water and sanitation facilities in the school compound have been reported as a major hindrance towards students learning achievement and skill development goals in schools across Europe and the U.K. (Haines & Rogers, 2000; Grossi et al., 2016).

Quality of Inputs (Q)

Textbooks. Several studies suggest a more consistent relationship between pupils' achievements and the availability of textbooks. For instance, a research on Sri Lanka educational system shows that availability of textbooks in schools and homes are significant determinants of test scores in mathematics and language subjects (Aturupane, Glewwe, & Wisniewski; 2013). Moreover, Van den Ham and Heinze (2018) empirical research provides evidence that textbooks have a significant and positive effect on student achievement specifically on mathematics subject. This finding is also supported by Hadar (2017) who point to a positive correlation between textbooks and student achievement in general. Törnroos (2005) and Schmidt et al. (2001) suggest that availability of mathematics textbook for students not only influences whether and how the mathematics content is taught, but it also has an effect on student achievement on test scores. These studies suggest that textbooks can leverage teachers' effort and knowledge, as is the case for other inputs, for superior achievement of student learning outcomes.

Class Size. Despite the available evidence in developed countries that smaller class size is beneficial to learning outcomes, there has been a vigorous debate about this (the effect of class sizes on student achievement) in the developing country context (Blatchford, 2003). On one side of the debate are the enthusiasts who feel strongly that smaller classes lead to better teaching and more effective learning. On the other hand, sceptics argue that the evidence for the efficacy of class size reduction is in doubt and that there are likely to be other more cost-effective strategies (school processes) for improving educational standards.

Equity Considerations in Learning Outcomes (E)

Location. Many studies point out that the gap between urban and rural schools on quality of education and academic performance in national examinations are increasingly in both developing and developed countries. In China, for instance, Zhao, Ye, Li, & Xue, S. (2017) report substantial difference in cognitive ability test scores between urban and rural students. Using the China Education Panel Survey (CEPS) collected in 2013/2014, Zhao et al. (2017) further estimate that this gap in cognitive ability exceeded 40 percent in 2014.

Gender differences in the achievement of mathematics learning outcomes are relatively the most researched topic in the academic field. Reviews of research on gender and mathematics learning typically begin with findings from the 1970s. The seminal research of Fennema and Sherman (1976) has been considered as an important initial scholarly investigation on gender issues in mathematics education. Gender differences in mathematics learning achievements continue to be studied vastly in current times with three core the objective: "(I) to understand the source of any inequalities; (ii) to improve average performance; and (iii) to improve our understanding of how students learn" (OECD, 2009, p8).

Teachers' Background (T)

Teacher qualities, as measured by their level of educational qualification, subject matter knowledge,

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experience, or certification, have been found to have a positive effect on student achievement in some contexts. For instance, using teacher related data and math and reading test scores on all North Carolina (US) students in grades 3, 4 and 5 in years 1995–2004, Clotfelter, Ladd, & Vigdor (2007) found a large and positive relationship between teacher qualities and student achievement in math and reading subjects. Clotfelter et al. concluded that a teacher's years of experience, knowledge of subject matter, and status of certification (regular licensure) have positive effects on student achievement, with larger effects noticed for math. "Taken together the various teacher credentials exhibit quite large effects on math achievement, whether compared to the effects of changes in class size or to the socio-economic characteristics of students" (p. 673). Specifically, when teacher quality is supported by other school level factors such as increased time of instruction and effective leadership, higher teacher qualities produce larger impacts on student achievements (Wedel, 2021; Abebe & Woldehanna, 2013).

School Management (M)

Clearly, quality of learning, and achievement of excellent results in national examinations depend on the quality of school administration, where principals are at the center of this process. Several studies have argued qualities of school principals determine the success of learning achievements (Dhuey & Smith, 2018; Horng, Klasik & Loeb, 2010; Grissom & Loeb, 2011). Additionally, Coelli and Green (2012) research of schools in Canada suggest that the quality of school administration is related to pupils' achievements in examinations as they report that leadership skills and years of experience of principals affected grade 12 English test scores to a large extent and overall student graduation rates to some extent. The effect size of principals on graduation rates and test scores increases with increase in the number of years of leadership experience of a principal increases.

Factors Affecting Learning Outcomes in Africa and Ethiopia

The curriculum is based on the educators' stated objectives, ensuring that the relevant standards and the expected profiles of students are achieved (Federal Democratic Republic Government of Ethiopia [FDRE], 1994, p. 12). This finding is in line with UNESCO (2000) objectives that emphasizes literacy, numeracy, and life skills to measure learning outcomes (p. 17. However, early grade mathematics competency is basically about mastering numbers (Jordan, Kaplan, Ramineni, & Locuniak, 2009; Jordan & Levine, 2009; Zevenbergen, Dole, & Wright, 2004).

Studies in Ethiopia have identified certain proxy variables to the mathematics learning competencies and academic achievements in general. The three Ethiopian National Learning Assessments (MoE, 2000, 2004, 2008b) for Grade 4 showed that mathematics achievements in Ethiopia favor males over females and rural over urban. The results for Grade 8 were also consistent with Grade 4, except for the switch in rural and urban-based mathematics achievements in the first national assessment. The latest report, the fourth National Learning Assessment, offered different findings: Being from an urban area and being male, having additional reading materials, education of the father, and have been identified as predictors of achievement (MoE, 2013). However, the reports do not clarify achievements based on gender starting from early grades or as it manifests at later stages. Moreover, though early childhood education in Ethiopia is generally limited in scope (GER in 2008 was only 4.2 percent), the opportunity is much better in urban areas (MoE, 2010). Therefore, findings favoring rural areas over urban ones in Ethiopia (e.g., the cases in the national learning assessments for Ethiopia) need further verification as it seems to underestimate differences in quality of school input between rural and urban settings.

Methodology

Research design

The methodology design applied is mixed-methods approach by mixing quantitative and qualitative strategies to discover what influences learning results in Ethiopian primary schools, acting as a sign of human capital development. According to Creswell and Creswell (2017), mixed-methods is used to give a full picture of complex topics by using data gathered in different ways. Because of this philosophy, the research considered both objective things and subjective views as useful sources of information about education and its outcomes.

Sample size

The main part of the research was the quantitative analysis using a data set from the Ethiopian Education Management Information System (EMIS). The sample group ended up being 407 schools which were selected by stratified random sampling to make sure that all regions and urban/rural levels were represented. Being well-

structured was important to address wide differences in infrastructure, management and achievements by students from one region to another. Sampling was done considering the overall school number in each region, so regions could be compared while the results stayed reliable. A random selection of schools within each strata was used to minimise selection bias.

For the research, factors at the school level were organised under five thematic areas: Infrastructure (I), Quality of Inputs (Q), Equity (E), Teacher (T) and Management (M). In order to launch these domains into operation, variables including water and sanitation, having textbooks, educational centres, pupil-teacher ratio, class size, teacher education, types of schools, student gender distribution and the qualifications of school leaders were used. The medium achievement test pass rate (PctPass2.0) and the high achievement test pass rate (PctPass3.0) served as indicators of the dependent variable.

Data analysis technique

The research evaluated the hypotheses by using bivariate correlations, stepwise multiple regression analysis and one-way analysis of variance (ANOVA). Separate regression models were applied to every vector (such as infrastructure and quality of inputs) and combined to find which factors were strongly associated with student achievement. Variance Inflation Factor (VIF) values were used to cheque for multicollinearity and Durbin-Watson statistics were used to cheque if there was any autocorrelation in the residuals. Scatterplots and Q-Q plots were used to make sure that the models were robust. All final results contained standardized coefficients, ANOVA F-statistics and an R-squared value to give exact effect sizes and explain how well the model fits.

Data collection methods

Data was gathered only using secondary information taken from EMIS which EMST acts as administrator over. Since the source gave reliable and consistent indicators measured across all sampled schools, the research could compare them fairly. Access to the dataset was allowed by the Ministry and everything was made anonymous at the school level to keep confidentiality. Raw data was organised according to a coding guide, making it suitable

Table 3 Summary of Research Question and Hypothesizes

Research question	Research objective	Hypothesis
RQ1: How do schools of better infrastructure fare with schools with weak infrastructure on learning outcomes in Ethiopian primary schools?	To determine significant variables and relative weight of infrastructure related factors in predicting exam results as measured by average pass rate and distinction rate of schools	H10: There is no significant relationship between infrastructure and learning outcomes in primary school of Ethiopia.
		H1a: There is a significant relationship of infrastructure and learning outcomes in primary school of Ethiopia.
RQ2: How does exam scores of schools with better quality of inputs compare with schools of poor quality in Ethiopian primary schools?	To investigate whether the level of input variables as described above affect learning outcomes as measured by the average pass rates and distinction rates on the national standardized exam for grade 8 students	H20: There is no significant relationship between quality of inputs and learning outcomes in primary school of Ethiopia.
		H2a: There is a significant relationship of quality of inputs and learning outcomes in primary school of Ethiopia.

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Research question	Research objective	Hypothesis
RQ3: How does grade eight students' exam scores fare among various subgroups including between girls and boys, urban and rural schools, and between private and public ownership status of schools?	To compare student achievement means of various groups and investigate whether there exists a significant variation of means among the different groups.	H30: There is no significant relationship between equity and learning outcomes in primary schools of Ethiopia.
		H3a: There is a significant relationship between equity and learning outcomes in primary schools of Ethiopia.
RQ4: How do schools with more qualified teachers and better environment (as expressed by high attrition rates) compare with schools with low level of qualified teachers and with low attrition rates?	To investigate the relationship between teacher qualifications and learning outcomes using bi-variate and multi-variate analysis.	H40: There is no significant relationship between teacher qualification and learning outcomes in primary schools in Ethiopia.
		H4a: There is a significant relationship between teacher qualification and learning outcomes in primary schools in Ethiopia.
RQ5: Does school masters' managerial capabilities have effect on school performance in terms of learning outcomes?	To investigate the relationship of school master qualification with the average pass rates of their respective schools	H5o: There is no significant relationship between school masters' managerial capability and learning outcomes of primary schools in Ethiopia.
		H5a: There is no significant relationship between school masters' managerial capability and learning outcomes of primary schools in Ethiopia.

Figure 3 Conceptual Framework for the Research

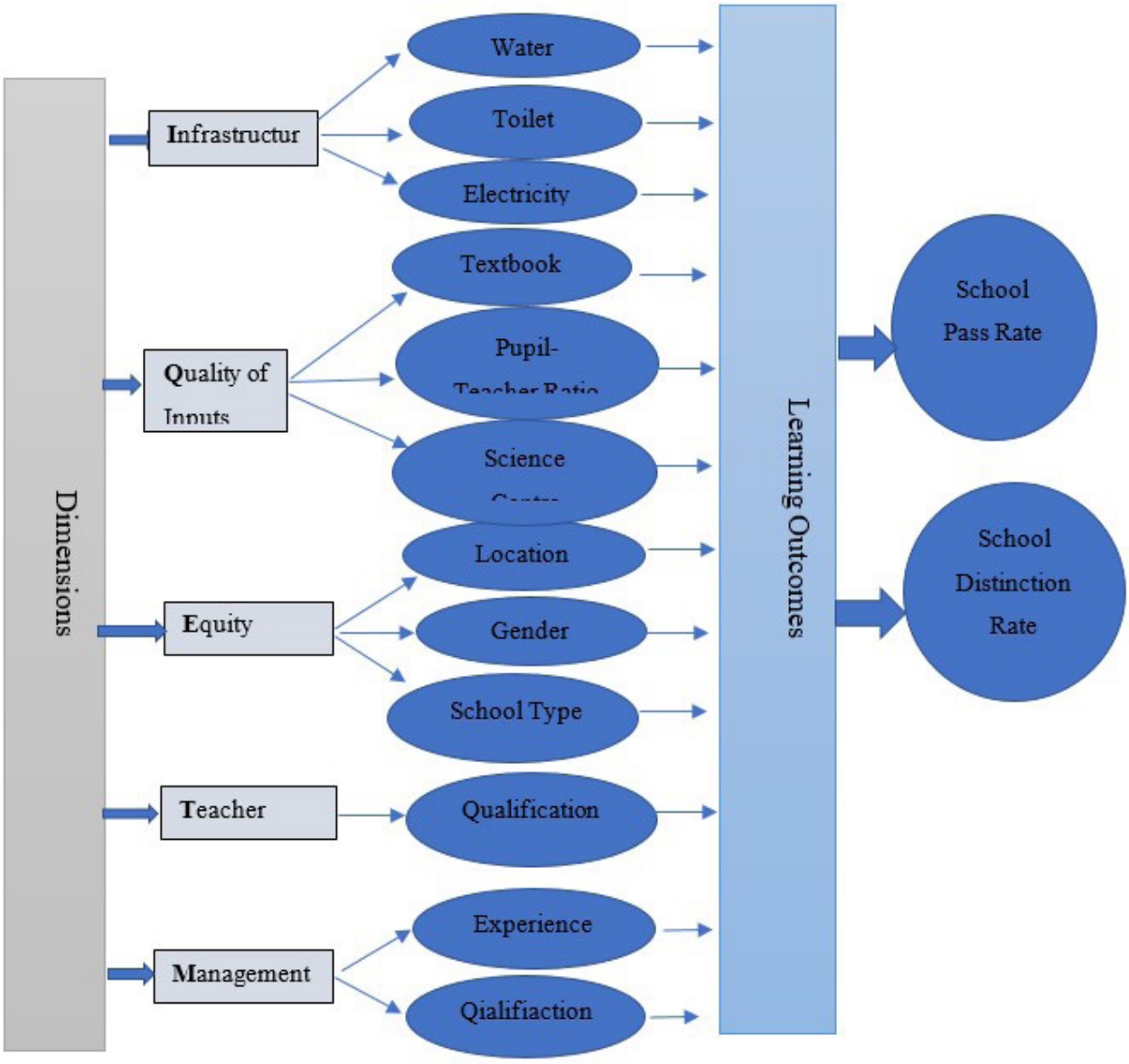

Figure 3 Conceptual Framework for the Research
Source: Author

Region	Total number of schools (with Grade 8)	Percent
Tigray	204	6.8%
Afar	32	1.1%
Amhara	490	16.2%
Oromia	1,049	34.7%
Somali	140	4.6%
SNNPR	738	24.4%
Benishangul-Gumz	75	2.5%

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Region	Total number of schools (with Grade 8)	Percent
Gambella	53	1.8%
Harari	15	0.5%
Addis Ababa	201	6.7%
Dire Dawa	23	0.8%
National	3,020	100%

Hypothesis	Variables	Statistical Analysis
Infrastructure	Electricity	Correlation and Regression
	Water	Correlation and Regression
	Toilet	Correlation and Regression
Quality of Inputs	Textbook-Pupil Ratio	Correlation and Regression
	Class size	Correlation and Regression
	Pupil-Teacher Ratio	Correlation and Regression
	Science Centre	Correlation and Regression
	Pedagogical Center	Correlation and Regression
	Library	Correlation and Regression
Equity	Gender	ANOVA and Regression
	Location	t-test, ANOVA and Regression
	School Type	t-test, ANOVA and Regression
Teacher	Qualification	Regression
Management	Qualification	Correlation and Regression
	Experience	Correlation and Regression
	Training	Correlation and Regression

for analysis and any incorrect or missing entries were left out to preserve data integrity.

Along with the numbers, a qualitative part was included by carrying out three case studies covering Public, Private and NGO (Mission-based) schools. They were chosen because one had excellent management, infrastructure and results, while the other two faced general challenges typical in rural schools. Since the COVID-19 pandemic and distance restricted in-person interviews, the interviews were conducted by phone using a semi-structured style and participants were the school executive directors. Additional information was gathered from school records, administrative papers and watching the actions of the school leaders.

By thematic coding, data from the case research were connected to the five-domain framework used in the statistical analysis (IQETM). Using a variable classification matrix and relationship table between keywords and themes made it easier to understand qualitative evidence. Due to triangulation, the qualitative phase checked, added to and explained the results from the statistical part, helping me understand the differences and similarities of different schools in handing learning-related issues.

Ethical considerations

Ethical guidelines were always followed during the research. The researcher's academic institution approved the ethical aspects of the research and all concerned groups were informed about its purpose and nature. Interview subjects did not reveal any information that could be used to identify them and they agreed to be interviewed with verbal consent. Data management was done according to established institutional and national rules for protecting data privacy.

It is to be reminded that, just as the case in other production function estimations, it is extremely difficult to list out all factors that affect learning skills. Such factors that are

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exogenous to this model are considered with in the "error term" and denoted by ε.

$y = f(I, Q, E, T, M) + \varepsilon$

The vectors of variables have several factors within them. Each of the vectors can be expressed as;

I (i1, i2, i3, …, ink); Q (q1, q2, q3, qi); E (e1, e2, e3, me); T (t1, t2, t3,., TN); and M(m1, m2, m3,…., MN).

Now that the final equation which consist of most important factors with the vectors can be expressed as a linear function that was estimated using Ordinary Least Square (OLS) method.

$$Y=\beta 0+\sum_{j=1}^{k}\beta_{ij}i_j+\sum_{j=1}^{l}\beta_{ij}q_j+\sum_{j=1}^{m}\beta_{ij}e_j+\sum_{j=1}^{n}\beta_{ij}t^j+\sum_{j=1}^{n}\beta_{ij}m_j+\varepsilon$$

The functional form for the casual relationships between the factors taken together and the outcome variable of student learning (test score) can be simplified as

$$Y = \gamma 0 + \gamma 1D1 + \gamma 2D2 + \gamma 3D3 + \ldots + \gamma nDn + \varepsilon$$

Findings

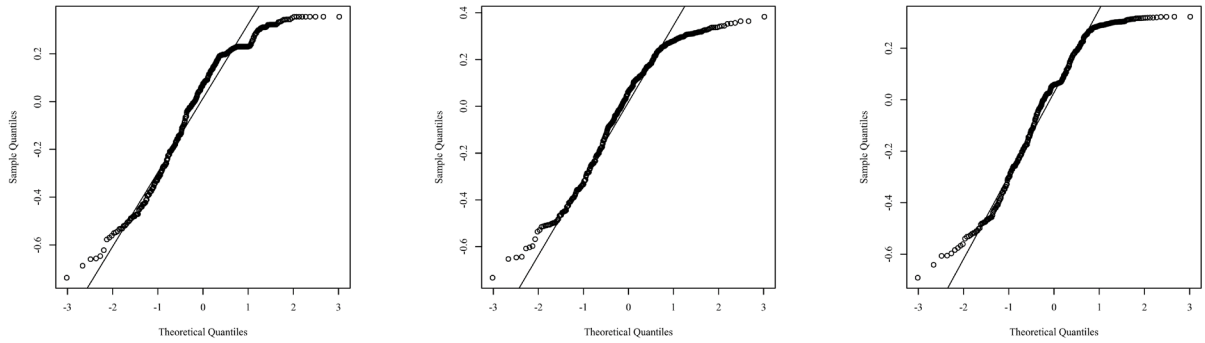
Descriptive Statistics

The original dataset included around 400 schools in Ethiopia. The actual data was collected from existing databases within the ministry of education that store census information of all schools in Ethiopia. As part of the Education Management Information System, data on

Table 4 Frequency Table for Nominal Variables

Variable	N	%
Toilets		
Yes	365	90.80
No	37	9.20
Electricity		
Yes	296	73.63
No	106	26.37
Water		
No	203	50.50
Yes	199	49.50
Location		
Urban	238	59.20
Rural	162	40.30
School type		
Government	359	89.30
Private	29	7.21
Other	14	3.48

Note. Due to rounding errors, percentages may not equal 100%.



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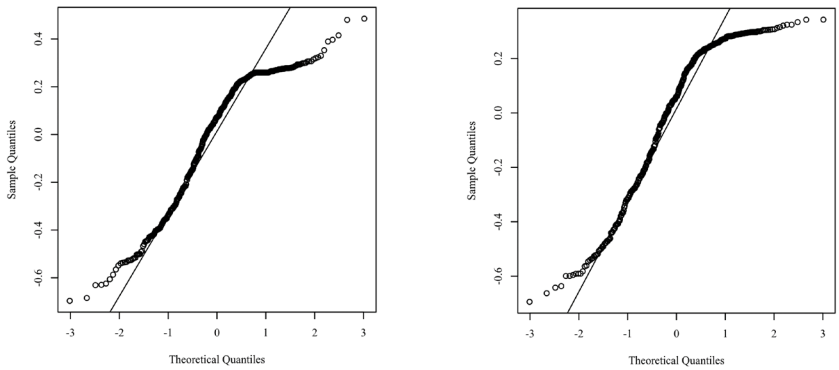

all schools is collected across many variables annually and stored in databases.

Normality

Normality was evaluated for each model using a Q-Q scatterplot. The Q-Q scatterplot compares the distribution of the residuals (the differences between observed and predicted values) with a normal distribution (a theoretical distribution which follows a bell curve). In the Q-Q scatterplot, the solid line represents the theoretical quantiles of a normal distribution. Normality can be assumed if the points form a relatively straight line. The Q-Q scatterplots for the dependent variable of proportion of students who scored above 2.0 are presented in Figure 1 while the scatterplots for the proportion of students who scored above a 3.0 are presented in Figure 2.

Since there are only minor deviations, and since the sample size is sufficiently large, we consider this assumption satisfied.

Assumptions Testing

Several procedures are used to determine whether data meets the assumptions of parametric testing including normality, linearity, homoscedasticity, independence of residuals, equal variance, and multi-collinearity. Normality is assessed using the Kolmogorov-Smirnov test. According to the Kolmogorov-Smirnov statistic, continuous data for percentage passed 2.0, passed 3.0, most of the factors have met the assumption of normality.

Linearity is assessed through a visual inspection of the Q-Q plots produced from the descriptive statistical analyses. The Q-Q plots show that the dependent variables of percentage passed 2.0 meets the assumption for linearity (see Figure 6). However, the dependent variable of percentage passed 3.0 does appear to meet the assumption for linearity on the margin (see Figure 7).

Independence of Variance

As shown in the Tables 55 and 56, the grand

Model	R		R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
Percentage Passed 2.0	1	.351	.123	.087	.222	1.63
Percentage Passed 3.0	1	.351	.123	.087	.222	1.63

Table 5: Model Summary of Regression of selected factors on PctPass2.0

Model Summary				
Model	***R***	***R Square***	***Adjusted R Square***	***Std. Error of the Estimate***
1	.364a	.132	.123	.24043
a. Predictors: (Constant), Proportion of Qualified Teachers, Science Center (1=yes; 0=no), SchoolType4 (1=Public; 2=Non-Public), Water (1=yes; 0=no)				

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regression model for PctPass2.0 produced R^2 =0 .132, F (4, 387) = 14.75, p < .001. This suggests that the model explains 13.2% of the variance in school scores on pass rates (i.e., proportion of student that passed the exam with 2.0 or above score). As seen from the ANOVA table (Table 56), the results are significance at p < 0.001.

Table 6 ANOVA for School Pass rate score with selected predictors

ANOVAa						
Model	***Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***	
1	Regression	3.411	4	.853	14.753	.000[b]
	Residual	22.371	387	.058		
	Total	25.782	391			
a. Dependent Variable: PctPass2.0						
b. Predictors: (Constant), Proportion of Qualified Teachers, Science Center(1=yes; 0=no), SchoolType4 (1=Public; 2=Other), Water(1=yes; 0=no)						

The regression model shows that all included variables are found to have the expected direction of positive influence on the schools' pass rate score, which is the proportion of student that passed the exam with 2.0 and above score. Furthermore, the model suggest that the predictor variable of School Type has the strongest contribution to the model, which is significant at B = .219, t (387) = 4.36, p < 0.001. Teacher qualification related factor has also the second largest contribution to the model with B= .138, t (387) = 2.87, p < 0.005; followed by Science center (B = .114, t (387) = 2.22, p < 0.05) and Water (B = .111, t (387) = 2.198, p < 0.05) (Table 57).

Table 7 Coefficient for Regression of selected factors on PctPass2.0

Coefficients[a]						
Model		***Unstandardized Coefficients***		***Standardized Coefficients***	***t***	***Sig.***
		B	***Std. Error***	***Beta***		
1	(Constant)	.295	.084		3.517	.000
	Water (1=yes; 0=no)	.057	.026	.111	2.198	.029
	Science Centre (1=yes; 0=no)	.073	.033	.114	2.220	.027
	SchoolType (1=Public; 2=Other)	.181	.042	.219	4.363	.000
	Proportion of Qualified Teachers	.002	.001	.138	2.874	.004
a. Dependent Variable: PctPass2.0						

The summary of the statistical analysis conducted is as follows.

- Availability of Water is a significant predictor of school scores on proportion of student that passed the exam with 2.0 and above (β = .111, t (387) = 2.18, p < 0.05)
- Existence of a science center in school is a significant predictor of school scores on proportion of student that passed the exam with 2.0 and above (β = .111, t (387) = 2.22, p < 0.05)
- SchoolType4 is a significant predictor of school scores on proportion of student that passed the exam with 2.0 and above β = .219, t (354) = 4.36, p < 0.001)
- Proportion of qualified teachers is a significant predictor of school scores on proportion of student that passed the exam with 2.0 and above (β = .138, t (387) = 2.37, p < 0.05)
- All other variables considered in this research are not found to be significant in predicting school scores on proportion of student that passed the exam with 2.0 and above at an alpha level of 0.05.

As a summary for respective research questions and hypothesis, it was found that all dimensions except management dimension, are found to have a significant influence through one or more of factors within those

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Table 8 Model Summary of Regression of selected factors on PctPass2.0

Model Summary				
Model	***R***	***R Square***	***Adjusted R Square***	***Std. Error of the Estimate***
1	.476	.228	.215	.27609
a. Predictors: (Constant), School Master Educational qualification, Water, Student-Text Ratio, PctGirlsExam, SchoolType, Science Centre.				

dimensions on determining learning outcomes of students as measured by the proportion of students that passed the national mathematics exam with a 2.0 and above score (PctPass2.0). However, none of the factors within the management dimension (i.e., school masters' training qualification on leadership, educational qualification and years of experience) were not found to be significant predictors of learning outcome as measured by the variable PctPass2.0.

Table 9 ANOVA for School Pass rate score with selected predictors

ANOVA[a]						
Model	***Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***	
1	Regression	3.411	6	1.328	17.427	.000b
	Residual	22.371	354	.066		
	Total	25.782	360			
a. Dependent Variable: PctPass2.0						
b. Predictors: (Constant), School Master Educational qualification, Water, Student-Text Ratio, PctGirlsExam, SchoolType4, Science Centre.						

Multiple regression model for PctPass3.0

A multiple regression model for schools' distinction rate score (i.e., proportion of students that passed the exam with 3.0 and above score) was also analyzed on the most relevant and significant factors found from all dimension. These factors included Water from the Infrastructure dimension, Science Centre and student-textbook ratio from the Input Quality dimensions, School Type and Proportion of girls who sat on the exam (PctGirlsExam) from the Equity dimension, and Educational qualification of school masters from Management dimension. All other factors have not been included as those factors are not significantly correlated with the PctPass3.0 or are highly correlated with one or more of the included factors, as shown in the previous section. The results of the multiple regression model are presented in Table 58 below.

Table 8 Model Summary of Regression of selected factors on PctPass2.0

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.476	.228	.215	.27609
a. Predictors: (Constant), School Master Educational qualification, Water, Student-Text Ratio, PctGirlsExam, SchoolType, Science Centre.				

As shown in the Table 58 and 59, the grand regression model for PctPass3.0 produced R^2 =0 .228, F (6, 354) = 17.43, p < .001. This suggests that the model explains 22.8 percent of the variance in school scores on distinction rates (i.e., proportion of student that passed the exam with 3.0 or above score). As seen from the ANOVA Table (Table 59), the results are significance at p < 0.001.

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Table 9 ANOVA for School Pass rate score with selected predictors

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	3.411	6	1.328	17.427	.000b
	Residual	22.371	354	.066		
	Total	25.782	360			
a. Dependent Variable: PctPass2.0						
b. Predictors: (Constant), School Master Educational qualification, Water, Student-Text Ratio, PctGirlsExam, SchoolType4, Science Centre.						

Furthermore, the regression model shows that all the included variables, except Science Centre, are found to have significantly predicted the dependent variable (PctPass3.0) with $p < 0.001$. The model also suggest that the predictor variable of School Type has the strongest contribution to the model, which is significant at $\beta = .352$, $t(354) = 7.00$, $p < 0.001$ (see Table 58). Water from infrastructure variable is also found to be the second largest contributor to the model with $\beta = .162$, $t(360) = 3.270$, $p < 0.005$; followed by PctGirlsExam ($\beta = -.106$, $t(354) = -2.09$, $p < 0.005$) and Student-Textbook ratio ($\beta =$ -. -.098, $t(354) = -2.07$, $p < 0.05$) (Table 59). Educational qualification of school masters and Science centers did not significantly predict the schools' distinction rate (PctPass3.0) at $p < 0.05$ (Table 59).

Table 11 Coefficient for Regression of selected factors on PctPass3.0

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig**
		B	Std. Error	Beta		
1	(Constant)	.100	.088		1.133	.258
	Water	.101	.031	.162	3.270	.001
	Science Centre	.050	.039	.065	1.266	.206
	Student-Textbook ratio	-.004	.002	-.098	-2.065	.040
	SchoolType	.349	.050	.352	7.009	.000
	PctGirlsExam	-.003	.001	-.106	-2.209	.028
	Educational Qualification of School Master	-.071	.040	-.087	-1.790	.074
a. Dependent Variable: PctPass3.0						

Summary of the findings on PctPass3.0

- Availability of Water is a significant predictor of school scores on proportion of student that passed the exam with 3.0 and above $\beta = .162$, $t(360) = 3.270$, $p < 0.005$)
- Student-Textbook Ratio is a significant predictor of school scores on proportion of student that passed the exam with 3.0 and above ($\beta = -.098$, $t(354) = -2.07$, $p < 0.05$)
- SchoolType is a significant predictor of school scores on proportion of student that passed the exam with 3.0 and above $\beta = .352$, $t(354) = 7.00$, $p < 0.001$)
- PctGirlsExam is a significant predictor of school scores on proportion of student that passed the exam with 3.0 and above ($\beta = -.106$, $t(354) = -2.09$, $p < 0.005$)
- Educational Qualification of School Master was not found to significantly predict PctOass3.0 at $p < 0.05$, though shown to have a negative betta coefficient.

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- Science center was not found to significantly predict PctOass3.0 at $p < 0.05$.
- All other variables considered in this research are not found to be significant in predicting school scores on proportion of student that passed the exam with 3.0 and above at an alpha level of 0.05.

Case Research analysis

For the research's research questions and their respective hypothesis, it was found that all dimensions except Teacher dimension, are found to have a significant influence through one or more of factors within those dimensions on determining learning outcomes of students as measured by the proportion of students that passed the national mathematics exam with 3.0 and above score (PctPass3.0). However, the Teacher dimension, which was measured by the proportion of teacher qualification in the school was not found to be a significant predictor of learning outcome as measured by the variable PctPass3.0.

A comparison of Donga Tunto School and High-Tech High School graphically demonstrates how better schools, resources and management influence education and back up the findings from the analysis. Donga Tunto School which is positioned in the Southern Nations, Nationalities and Peoples' Region (SNNPR), demonstrates the hurdles that under-resourced schools across Ethiopia must overcome (Hanimoglu, 2018). There is no clean water, the science center is not working and textbooks are not provided in adequate quantity at the school. The classrooms are too full, making the class sizes higher than what is recommended nationally and many teachers quit their jobs because the working environment is tough and there are limited incentives (Mdhlalose, 2023). By comparison, High-Tech High School in the capital has access to advanced science labs, plenty of library materials, excellent sanitation and a favorable student-to-teacher ratio (Ajani and Akinyele, 2014). Good teachers are sought out and most remain for a long time; the school's leaders regularly meet with students and parents to maintain the right educational approach. As a result of these different settings, student results varied greatly.

The trend found in these cases is closely in line with the scientific research which discovered that better learning results came from having water facilities, science centres and proper numbers of textbooks for each student. Looking at regression, it appeared that how much water an area had an important role in determining its exam pass rates. Since water collection is a challenge and students use the same limited sanitation, the findings show that water infrastructure problems can reduce student attention and school attendance (Sharma et al., 2024). High-Tech catering to learning by providing science laboratories and pedagogical centres also matches the results of regression, showing that these are strong indicators of passing exams. It is also significant that, in both cases, the results from the quantitative data show that school management variables are not very influential in changing the study's results as evident with its standard deviation and scatter plots respectively. Even though the principal of Donga Tunto has a master's degree in educational leadership and participated in various official training courses, learning progress in the school keeps suffering. As a result, the research's main finding stands that school masters' education and leadership were not important factors in influencing students' pass rates (6-10). It disputes standard views on leadership being effective in areas where resources are limited and stresses that effective leadership alone is not possible with insufficient educational support available.

Even so, the case studies give a personal and emotional touch to what is often just numbers. Donga Tunto School's principal said, "We are doing as much as we can with what we have. But, if students have never been in a lab, how can they learn science? Five or more students sometimes share one textbook. Because teachers rely on the right tools, their impact can be stronger. It summarises the main conflict discussed in this research: having capable teachers and effective management matters, but what affects their results is availability of resources. On the other hand, the director of High-Tech brought attention to something else: here, we want students to be curious, not only research for better grades. A learning culture exists all around the lab and library. It's very hard to accomplish this when people can't find food or shelter for their families. It becomes clear that even though resources raise test results, they also have a major impact on how the school operates and how students interact with learning which is harder to spot in the data alone.

Discussion

The results of this research help guide policies, choices about investments and programmes for growing human capital in Ethiopia and similar low-income nations. The chances of passing exams were strongly affected by clean water and sanitation in school buildings. The findings from regression models showed that students in schools with safe water on their grounds did much better in Grade

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8 than those whose schools did not have such water. This observation is true to both the way the body responds and the way it affects education (Lim et al., 2018). Those who lack water or simply must get up to go get water can often lose interest and tend to be less alert at school for the day. Lack of proper toilets mostly affects girls, especially during their teens which often means they miss more school and might not graduate. So, infrastructure does not only add to the educational experience; it should actively support their learning process (Mengesha and Singh, 2022). If policymakers want to reduce the difference in learning between city and rural students, they should guarantee access to water, sanitation and electricity in all schools, starting with poorly performing and rural schools.

Also, the research indicates that quality educational inputs are crucial. Having a small number of students per textbook, access to science centers and library facilities have found to be significant in determining student achievement. For example, schools with science centers did better which was also supported by the qualitative research of High-Tech School, where scientists note that the science labs helped students both perform well in exams and become more interested in school. Low textbook availability also went together with lower student achievement, proving again that common learning resources are among the best ways to improve school results globally (Sharma et al., 2024). It suggests that money should be spent on basic education tools rather than mainly focusing on hiring more teachers or making the administration larger.

These school management variables such as educational background, getting leadership training or years of experience of school principals did not statistically contribute to student learning. It makes sense to believe that a highly educated or seasoned school leader would help students perform well, but the data actually show something else. There, the care taken by the principal did not show results within the school since it lacked everything required for effective student learning. As a result of this approach, conventional ideas about development and leadership often fail to work well unless skills in teaching and support for students are strengthened. Even so, leadership does not have no value, just that it plays a minor role when resources are low. It thus becomes important to reassess the foundation of leadership training programmes so that they are related to local funding and performance review systems.

Equity was also examined by considering school type, gender and whether students lived in towns or rural areas. Private schools turned in better results than public and NGO-managed schools and this difference stood strong even when comparing based on important factors. Although a part of this benefit comes from who signs up for private or public schools, it still demonstrates that public school students are regularly disadvantaged because they work in environments that lack several basic resources. Even though there are still differences, they were not as severe as expected which suggests gender parity efforts in Ethiopian schools may begin to have an impact. No significant differences in the regression models are seen between places with a city and rural towns, when all other variables are considered. The evidence indicates that what matters most are the resources and conditions at school, because where the school is does not affect achievement.

Conclusion

This research, in short, reminds us that not all spending on education leads to the same educational improvements for students. Expanding access to education is important, but the research indicates that giving greater attention to quality in education, along with investing in science labs, textbooks and teacher expertise, has a much bigger positive effect on people's learning and development. However, important training on leadership or admin work is unlikely to help much if the core resources for teaching are not present. Since these findings, the field is now calling for strategies in education that are based on solid evidence instead of only on input amounts. Future research studies could examine ways to link infrastructure, teaching approaches and local governance for the overall improvement of both education and the economy in countries on a development path. For education to help achieve equity and growth, policymakers should rely on data instead of guesswork.

Limitations

There are several flaws with this study. The main source of data was the Ethiopian EMIS which covers many aspects but not how teachers and students work together, what motivates students or household issues that play a part in education. Also, since the qualitative work consisted of only three case studies over the phone, it could not cover much of the deeper context.

Future Research

In future researches, there is a strong possible to understand educational investments affect student outcomes

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over time by using longitudinal or panel data. Adding in teachers', students' and parents' experiences would give us a better picture of what happens with resources in practise. These research structures could equally be applied to studies that test changes such as providing textbooks or training teachers and help policy makers and donors invest more helpfully.

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