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Estimation of Education Production Function
A Case Study of Selected Villages in District Nowshera, Khyber Pakhtunkhwa, Pakistan

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Abstract

To assess student's academic performance (output), the education production function considers school, teacher, and student inputs. The objective of this study is to estimate an education production function for Government and Private higher secondary schools in Nowshera to analyze the drivers of educational outcome in the study area. Education is vital to development because a high-quality education system is a major component of a developing country's ability to improve individuals' skills, knowledge, and capacities, hence boosting the stock of human capital. Human capital is an important component of economic success and growing living standards. Pakistan is possibly the country in the world where educational efficiency is most crucial, because policymakers are confronted with a rapidly rising population, a poor level of education, and limited resources. It will be difficult to improve efficiency without a high-quality educational system and a thorough grasp of the factors that influence educational performance. For this purpose, a cross-sectional data and Ordinary Least Square were used to specify production function, using annual examination scores as output (DV's), while using school inputs, student characteristics, family background, and teacher characteristics are as inputs (IV's) in the private and public schools. Results of the study show that student's characteristics, teacher's characteristics, and family background except for mother education, profession, income has a positive statistically significant impact on student's academic performances. This study's findings have significant policy implications for Nowshera and Pakistan in general.

Keywords: Education Production Function, Government & Private School, Teacher and Student characteristics.

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1. Introduction

An education production function relates to school and student inputs to measure the school output. This shows that the education production process is descriptive study of human capital, while on the other hand, it is a normative investigation of optimal allocation of resources in the education sector in general (Simons, et al. 2014). Many economists including (Lucas, 1988; Mankiw et al, 1992) are of the view that education is necessary for economic growth. Furthermore, the economic research suggests that education has a positive impact on other aspects of a country's development, such as health and population growth. In accumulation to these assistances, education is also reflected to be worthy itself, as education is included in the United Nations Development Program's Human Development Index (HDI) (Choudhury, M. A. 2022).

Education plays a vital role in the country's growth since a high-quality educational system is the only way by which a developing country enlarges the skills, knowledge, and capabilities of individuals i.e., rising human capital. Human capital is an important component in economic progress, and it raises the standards of living. Realizing the importance of education, human capital has been treated as an engine of economic growth in new growth theories (Khattak and Khan, 2012). Primary and secondary schools are playing an important role in improving human capital (Pritchett and Filmer, 1999).

Researchers around the globe have studied education production function since the release of the well-known Coleman report in the 1960s (Hanushek, 1986). Many of the early studies confirmed much of the findings of the Coleman report. Hanushek (2020) conducted the most comprehensive study of this literature. Hanushek reviewed 147 studies at Primary and Secondary schools dealing with an education production function. Later, studies were conducted in education production at the university level (Dicky and Houston, 2010).

The globalization and school performance standardization have little impact on education standards in developed nations, but they have a considerable impact on developing countries and their sub-regions (Khan et al, 2016). However, it should be highlighted that the implementation of such education performance standardization, notably in the higher education sector, has been significantly delayed. These delays are mostly because of the present teaching methods and deteriorating educational quality, particularly in emerging and poor countries. According to Khan et al, (2016), setting greater demands for educational performance with poor featured human capital, might lead to a divergence between higher and secondary education.

Some of the rationale grounds for such failures include the use of contracts in educational decisions and practices. Countries have struggled to meet desired education standards and targets due to inconsistencies in policy and a lack of political will.

In the new millennium, education policies have been the focal focus and a significant part of public policy. Though, these strategies have failed to confront and overcome the barriers to education policy harmonization. The heterogeneity that has emerged from varied socio-economic conditions within a nation or region is one of the key reasons for such failure (Cascio and Schanzenbach, 2016).

Many developed countries allocate a significant portion of their scarce resources to education; as a result, education is produced efficiently. In developing countries, education is still suffering from numerous defects. Amongst them high rates of teacher non-attendance, limited quantities of basic supplies, quality of education, and high score repetition rates (Moore, 2007). The prevalence of educational inequalities between different sub-regions, as well as the bending of education standards, resulted in a loss of social welfare. The diversity in teaching modes and performance indicators among regions and sub-regions is reflected in these indicators. For Pakistan, efficiency in education is more important in the world. Policymakers are facing so many problems such as the growing population rate, low level of the educational system, and exact determinants of educational level/outputs that make it difficult to improve efficiency in education and quality of education. The educational level of a population aids in determining the quality of human resources as well as the stage of development in which a society is at (Sharma, 2022).

The concept of education production function presumes that the school selected villages (district) enhance the educational outcomes and given students' financial constraints. Therefore, there is no particular measurement of educational outcomes which perfect. Normally, inputs have been connected inside instructional and non-instructional activities within and beyond the control of school administration for the production function of education schools in selected communities. Non-school inputs include the socioeconomic status of the student and other environmental attributes impacting student productivity, such as family income, parent education, and tuition facilities, etc.

The purpose of this study is to identify the elements that influence overall educational achievement at the High Schools of Akbar Pura and Taru Jabba. These two villages are consisting of all types of schools, like Primary, Elementary, High and Secondary Schools. The goal of this research is to bring

attention to the parental characteristics, school and students' characteristics, and teacher's characteristics, which have a significant impact to achieve a high annual Examination Score. This study also emphasizes the factors that influence students' performance and provides guidance to school administrators and policymakers on how to improve students' capabilities and make tertiary level graduates competitive in professional and executive work environments both within and outside the country.

2. Literature Review

Moore (2007) estimated education production function for Botswana secondary schools to study the drivers of educational attainment in developing countries. The study used Primary data collected from schools in the district to define a Trans-log production function while utilizing standardized science and math examinations scores as an output. The study used school characteristics, students' characteristics, and family characteristics as inputs.

Khan and Kiefer (2007) analyzed the production function to recognize the effect of students, parents, teachers, and school's variables on student's academic performance measured by test score. The analysis was led in institutional background that consists of government, private and non-government organization schools comparatively. The study found that non-government schools are more efficient and effective than private and government schools.

Aslam (2003) investigated the determining factors of Student's Attainment in government and private schools using. The data was collected from the Lahore district in Pakistan. The study used ordinary least squares (OLS) to estimate the education production function. The study shows that a huge number of family backgrounds, own and school-associated factors are important determinants of student's attainment, Maths, and Reading skill. Furthermore, the study found that teachers' pay is not a significant factor of students' achievement, student absenteeism seems to be an important determinant of students' achievement and Maths scores in both government and private schools.

Brempong and Gyapong (1991) studied the factors and measured the education production function. The study used primary data and regression analysis to examine the impact of socio economic status of society in the production function of the high schools. The study found that socioeconomic characteristics have significant and positive effects on education production.

Perelman and Santin (2011) measured education efficiency of students with Parametric Stochastic distance functions. The study used primary data

from the International Student Assessment Program performed by the OECD collected in Span. The results provide an understanding of how family background of the students and school characteristics cooperate with students' outputs. Dickey and Houston (2010) estimated the education production function for Principles of Macroeconomics. The study found that measures of human capital (GPA, HOURS, and ACT (American College Testing)) to be positive and significant. The ratio of Math's to composite ACT scores was found to be a positive predictor of educational production. Student effort proved to be a positive and significant predictor of students' performance.

Awan and Zia (2015) conducted a comparative study of public and private schools in Vehari, Pakistan. The study found that family income has a significant but low effect on their children's educational performance. The student and teacher ratio has a negative and significant effect on students' performance. The study also found that facilities of the institutions cause significant and positive effect on the student's performance.

3. Theoretical Framework

Several pieces of evidence have recognized that a student's performances take place at home as well as at school. Though the way that characteristics of students, characteristics of family background, and characteristics of school interrelate with educational outputs is continuously unknown.

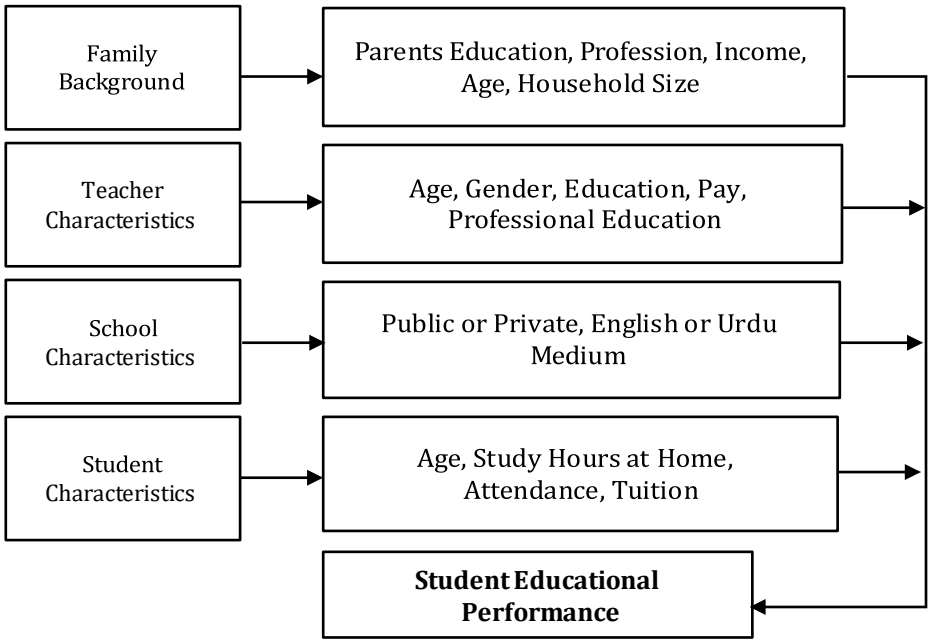

Figure 1: Antecedents of Student Educational Performance

It is a serious problem for policymakers when making decisions for the allocation of limited public resources dedicated to education. The inefficient use of school resources and resources from the family side is a common problem in developing countries like Pakistan. In developed countries like USA, UK, and Spain even in India, a lot of authors and researchers write on this problem, while in Pakistan a very limited study has been conducted on this problem. To overcome these obstacles in the way of achieving and attaining a high annual examination score. Some foreign researchers also analyzed the impact of teachers' and school characteristics, and socioeconomics' characteristics on students' achievements, which has not been used by local researchers in one research. This study is an attempt to fill this gap by applying regression analysis as a tool of analysis on impact of socio-economic characteristics, schools' as well as teachers' characteristics on students' performance.

4. Methodology

4.1. Research Approach

Quantitative research focuses on the quantification of data collection and its analysis (Bryman, 2015). To achieve the research objective the researcher adopted both qualitative and quantitative techniques. To pick the deep intention of the multiple variables related to the qualitative approach that has been proved is fruitful. All factors had included that highly correlated with an educational production function.

Therefore, the cross-sectional approach was adopted because the sampling belongs to the strata of society. The researcher conducted the survey allows to take up such data from the students that belonged to the various background. It further enhances the proper representation of many respondents (Bryman, 2015). Through a standardized questionnaire, the researcher was able to collect responses from 100 respondents in a cross-sectional survey.

4.2. Research Area

The present paper was conducted in a selected village of Nowshera city, KP. Nowshera city has been selected purposely by the researcher because it is the center of the educational sector. It is a huge area in the sense of major colleges and schools. Therefore, the researcher conducted to cope the research objective gather all significant information and data has concerned the educational production function.

4.3. Data Collection

This study is based on primary data. To collect information, two well structure questionnaires have been formulated one for teachers other for

students respectively. The data was collected from the high school's students of 10th class who were promoted from 9th to 10th class in two villages i.e., Akbar Pura and Taru Jabba. Due to time and cost constraints, data were collected from 100 sample students through a simple random sampling technique.

4.4. Sample Size and Sampling Techniques

Data collection of the sample is very crucial for every research. For this purpose, this study collected a similar representative sample of the population. It is done to analyze the 100 samples of respondents about facts and figures. Through structure questionnaire collected 100 samples from public and private schools by applying simple random sampling during the selection of respondents. During data collection, structured questionnaires were created and delivered. The questionnaire consists of two parts A & B. Part A includes Biography, gender, academic, and profession. Part B consists of information regarding the research objective.

4.5. Justification of Regression Model

A regression model was first introduced in 19th-century scientist by Sir Francis Galton to know about linear regression model is how the strange term regression came to apply. The regression model investigation is most widely accepted that applied all statistical techniques. It discussed linear and additive association between variables.

4.6. Model Specification

There are many different factors that determine students' academic or educational performance. The present study used the following model to estimate student's performance through education production function:

$EP_{ij} = f\ (F_i, T_j, S_{ij}, I_{ij}, \mu_i)$

Where,

EP_{ij} = Educational Performance of *ith* students in school *j* which shows the Percentage marks obtained by the students in their 9th class examination taken by Board of Intermediate and Secondary Education Mardan

F_i = Family background/ Parental characteristics of student *i* such as parental education, age, profession, income, household size in school *j*

T_j = Teacher characteristics such as age, gender, education, professional education, pay, experience, training, reward in school *j*

S_i = School characteristics such as school type; public or private, English, or Urdu medium

I_{ij} = Individual characteristics of student *i* such as gender, age, study hours at home, attendance, tuition etc in school *j*

μ_i = error term, assumed to be normally distributed with mean zero and constant variance.

The above functional form can be written in econometrics as below:

$$EP = \alpha+\beta_1 F+\beta_2 T+\beta_3 S+\beta_4 I+\mu$$

The above model has been estimated by using ordinary least square with usual assumptions of the model.

4.7. Data Presentation and Analysis Framework

The sum-up information and data have been categorized regarding the coded research questions. In addition, the data have been interpreted using the statistical package for social science (SPSS) software. The researcher was able to create frequency schedules, percentages, cross-tabulation, means, and standard deviation using SPSS software. This software was also useful for data analysis utilizing inferential statistics like regression. These statistical findings were used to provide quantitative data.

The results and data presentation have been interpreted by data analysis. Because the findings of both quantitative and qualitative data were agreed upon, the learning became more rational and simple. For the data quantification, the dependent variable taken as an (achievement marks) has done and denoted by (1 & 5), while the other independent variables have sub-parts denoted by like scale i.e., 1 to 5.

5. Results and Discussions

This section of the paper presents the results of the estimation of the education production function. The results are according to the theory and the expected sign of the coefficients are presented in Table 1. At any suitable significance level, the t-value and sig-values show a rejection of the null hypothesis that all coefficients are equal to zero. Explanatory variables explained around 72 percent of the model, according to regression analysis. Which means that model is a good fit.

School type was an important factor that affects student performance. The students at the private schools performed better than public schools respectively. As shown in the result, school type was positive and significantly related with student's performance. Father's education has positive and significant impact on student's performance. The result shows that student's whose father was highly educated, achieve high examination score. Father's profession was positive and significantly related with student's performance at 10%. Father's monthly income was also positive and

significant effect on student performance. As income of the father increases, student's performance also increases.

Table 1: OLS Results

Variables	Coefficients	Std. Error	t-value	p-value
(Constant)	60.990	16.946	3.599	0.001***
Gender of Respondents	6.956	1.826	3.810	0.000***
Age of Respondents	-2.420	0.907	-2.669	0.009***
School Type	11.711	1.909	6.135	0.000***
What is your father education	2.871	0.750	3.827	0.000***
What is your father profession	1.190	0.650	1.831	0.070*
What is your father monthly income	2.298	0.851	-2.702	0.008***
What is your mother education	1.203	0.977	1.231	0.222
What is your mother profession	1.055	3.625	0.291	0.772
What is your mother monthly income in thousand (PK Rs)	0.457	1.601	0.285	0.776
What was your attendance in class	1.806	1.056	1.711	0.091*
How many hours did you study at home per day	0.851	0.443	1.918	0.058**
Did you go for tuition after school hours	2.734	1.637	1.671	0.099*

Note: **, ** and *** means significance at 10%, 5% and 1% respectively*

Mother's education, profession and income were insignificant. Because of the reason that most of them were illiterate and housewives only, they did not have any job and profession respectively. Gender of respondents was positive and significant. Followed by age of the respondents was also significant and with correct sign. As the age of respondents increases their examination score is going to decrease by 2.4 percent. Student's attendance was positive and significant impact on student's academic performances at 10%. Study hours per day at home were positive and significant at 5%. More they study at home, high will be the examination score. Tuition and student's performances were positive and significantly related at 10 percent. Students who used to go for tuition, they got high examination score.

Table 2 shows the summary of the model. The model is explained 72 percent by explanatory variables.

Table 2: Summary of the Model

R Square	Adjusted R Square	F-statistic	p-value
0.716	0.672	16.309	0.000

Table 3 shows the result of teacher characteristics such as age, professional qualification, training, experience, reward, and monthly pay.

Professional qualification was positive and significantly related to student's performance. With high professional qualification, teachers were able to teach in a good way. Teacher's age was positive and significant at 5% level of significance. Training was also positive and significant at 5%. Teacher's experience was not statistically significant. Monthly pay was positive and statistically significant at 5% so as Reward was statistically significant. The results are accordance with Sharma (2022).

Table 3: OLS Results

Variables	Coefficients	Std. Error	t-value	p-value
(Constant)	66.627	6.621	10.063	0.000***
P. Qualification	2.711	0.937	2.894	0.004***
Age	0.291	0.134	2.173	0.031**
Training	4.052	1.982	2.045	0.042**
Experience	0.351	2.385	0.147	0.883
Monthly Pay	0.341	0.137	2.489	0.014***
Reward	4.450	2.307	1.929	0.055**

***Note:** *, ** and *** means significance at 10%, 5% and 1% respectively*

Table 4 shows the summary of the model. R- Square was 15 percent of the teacher's characteristics.

Table 4: Summary of the Model

R Square	Adjusted R Square	F-Statistic	P-Value
0.153	0.124	5.257	.000

6. Conclusion and Recommendations

To investigate the determinants of achieving and attaining a high examination score in the study area education production function or input-output approach was used. Teacher's characteristics, student's characteristics, and family background characteristics were used as inputs, while student's examination score (marks) in 9th class was used as output. For this purpose, primary data were collected from 100 respondents through a questionnaire. The OLS results show that teachers' characteristics i.e., age, professional qualification, training, experience, monthly pay, and reward have a positive and statistically significant impact on students' academic performances. Students' characteristics like gender, age, attendance, study hours at home, and tuition were positive and have statistically significant effects on students' performances. Parental characteristics i.e., age, qualification, profession, and income have a positive and significant impact except for the mother's qualification, profession, and income. The result of school type i.e., public, and private also shows a significant effect on students' performances.

There should be committees made up of educated people to help students whose parents are unable to provide them with guidance in their educational issues. Furthermore, this committee should assist poor pupils by offering financial assistance. The media should conduct a campaign emphasizing the importance of education and encouraging wealthy people to assist clever students whose socioeconomic status is preventing them from pursuing their educational goals. Illiterate parents should be informed about the value of education in today's world through the media and the government. They should broaden the frontiers of uneducated parents' knowledge and convince them that education is as important for them as it is for their children. Parental education is critical to a student's academic success.

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