cognizancejournal.com
Safiullah Junejo *et al*, Cognizance Journal of Multidisciplinary Studies, Vol.4, Issue.2, February 2024, pg. 232-242
(An Open Accessible, Multidisciplinary, Fully Refereed and Peer Reviewed Journal)
ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

Human Capital for Economic Development: A Study of Education Production Performance (EPP) in Khairpur

Safiullah Junejo[*1]; Maria Ayaz[2]
Faculty of Economics and Business[*1]; Faculty of Education[2]
Universitas Islam International Indonesia[*1,2]
Email: safiullah.junejo@uiii.ac.id [*1]; maria.ayaz@uiii.ac.id [2]

DOI: 10.47760/cognizance.2024.v04i02.022

Abstract:
The analysis of education production performance involves evaluating the inputs of faculty, teachers, and students to determine the academic achievement of students. This study aims to estimate the education production performance of both state and private higher secondary schools in Khairpur and identify the factors that affect instructional outcomes in the region. Education is crucial for development, as a high-quality education system is essential for increasing people's skills, knowledge, and abilities, ultimately contributing to the growth of human capital. In a developing country like Pakistan, where policymakers face challenges such as a rapidly growing population, low levels of education, and limited resources, improving educational efficiency is critical to achieving progress. A thorough understanding of the factors that contribute to instructional success is essential in this regard. To construct the model, a cross-sectional dataset was used, and a standard least squares method was employed with annual examination results as the output variable and school inputs, student characteristics, family background, and teacher characteristics as the input variables for both private and public schools. The results of the study indicate that student characteristics, teacher qualities, and family background, except for the mother's education, career, and income, have a statistically significant impact on students' academic performance. The findings of this study have significant policy implications for Khairpur and Pakistan as a whole. Improving educational outcomes will be critical in enhancing the human capital stock, which, in turn, is essential for economic growth and improving living standards. By understanding the factors that contribute to instructional success, policymakers can devise effective strategies to address the challenges faced by the education sector and improve overall educational efficiency.

Keywords: *Educational Product, Economic Development, Public and Private School, Pedagogical Characteristics, Khairpur*
JEL: *J24; I25; O15; O18*
Corresponding Author's email: safiullah.junejo@uiii.ac.id

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

1. Introduction

An education production operation could be an operation that uses faculty and student inputs to calculate faculty output. This demonstrates that the education production method could be a descriptive study of human capital. However, it is additionally a normative analysis of optimum resource allocation within the education sector (Simons et al., 2014). Several economists, like Lucas (1988) and Mankiw et al (1992), believe education is essential for economic progress. Economic analysis implies that education improves different areas of a country's development, like health and increase. Additionally, to those assistants, education is seen as valuable in and of itself since it is enclosed within the United Nations Development Program's Human Development Index (HDI) (Choudhury, 2022).

Education is vital to the nation's prosperity since a high-quality academic system is the sole methodology for a growing country to expand citizens' skills, knowledge, and capacities, i.e., increasing human capital. Human capital is essential to economic success since it enhances living standards. Recognizing the importance of education, new growth models have enclosed human capital as a driver of economic progress (Khattak and Khan, 2012). Primary and secondary faculties play an essential role in human capital development (Pritchett and Filmer, 1999).

Since the publication of the well-known Coleman report in the Nineteen Sixties, researchers worldwide have been finding out how education production operates (Hanushek, 1986). Several of the first analyses valid several of the Coleman report's conclusions. Hanushek (2020) completed the initial intensive review of the literature. Hanushek examined 147 papers from elementary and secondary faculties addressing an academic production operation. Later, investigations in literary production at the university level were done (Dicky and Houston, 2010).

Globalization and college performance standardization have a stripped-down impact on education standards in rich countries; however, they significantly influence developing countries and their sub-regions (Khan et al., 2016). However, it should be noted that the implementation of such education performance standards has been considerably delayed, significantly within the teaching sector. These delays primarily result from current teaching techniques and worsening academic quality, particularly in developing nations. Setting magnified criteria for intellectual accomplishment with low-featured human capital, consistent with (Khan et al., 2016), might end in a divergence between higher and pedagogy. Using contracts in academic decisions and practices is one of the logical causes of such failures. Thanks to policy inconsistencies and an absence of political can, countries have not reached the desired education standards and objectives.

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

Education policies are a concentration and a crucial facet of public policy within the new century. These ways, however, have not addressed and overcome the challenges to education policy harmonization. One of the first causes for such failure is the heterogeneousness that has resulted from variable socioeconomic things inside a rustic space (Cascio and Schanzenbach, 2016).

Many industrialized nations devote a substantial proportion of their restricted resources to education, producing economic education. Education in developing countries continues to be troubled with flaws. High rates of educator non-attendance, inadequate numbers of essential academic quality, and high score repeat rates square measure among them (Moore, 2007). These metrics indicate the variations in teaching modalities and performance indicators across regions and sub-regions. The prevalence of academic disparities between sub-regions, similarly because of the lowering of academic standards, resulted in an exceeding loss of financial aid. Policymakers face many challenges, like the increasing population rate, the low educational system level, and the precise drivers of academic level/outputs, that make it tough to reinforce academic potency and quality. Education potency is a lot more essential in the Islamic Republic of Pakistan than in any other place in the world. The educational level of a population influences the standard of human resources and the stage of development of a society (Sharma, 2022).

Given students' monetary fund restrictions, the notion of education production assumes that the school's chosen villages (districts) improve academic performance. As a result, there is no excellent assessment of academic results. In most cases, inputs for the assembly operation of education faculties in specific communities are joined inside the tutorial and non-instructional activities within and out of doors the jurisdiction of faculty administration. Non-school inputs embrace the student's socioeconomic scenario and different environmental factors that influence student productivity, like family financial gain, parent education, and tuition facilities.

This analysis aims to find the factors that impact overall academic attainment at Higher Secondary School Babarloi and High School Ghari Mori. These two communities are home to a range of schools, together with primary, elementary, high, and secondary schools. This study aims to bring attention ought to be paid to family factors, faculty and student characteristics, and teacher characteristics, all of which have a considerable influence on achieving a high yearly Examination Score. This study additionally focuses on the factors that influence students' performance. It offers recommendations to high school directors and policymakers on improving students' capabilities and creating tertiary-level graduates competitive in skilled and govt work environments inside and outside the country.

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

2. Literature Review

Moore (2007) approximated the education production for African country secondary colleges to research the factors that influence academic accomplishment in underdeveloped nations. The analysis used college factors, student characteristics, and family variables as inputs. The study used primary knowledge non-inheritable from district colleges to style a Trans-log production performance, with standardized science and math check results serving as an output.

Khan and Kiefer (2007) used the assembly performed to determine the impact of scholars, parents, instructors, and college characteristics on tutorial success as indicated by check scores. The investigation was conducted in an institutional context that enclosed government, private, and non-government organization colleges as compared. In keeping with the report, non-government colleges are more economical and practical than personal and public colleges.

Aslam (2003) publicly and personally explored student accomplishment determinants in colleges. The data was gathered in Pakistan's Lahore space. The education production performance was calculable victimization standard method of least squares (OLS) within the analysis. In keeping with the investigation, an outsized variety of family origins and personal and school-related characteristics are significant drivers of student accomplishment, Math, and Reading skills. Moreover, the analysis discovered that though teacher wage is not a serious influence on student accomplishment, student absence appears to be a crucial regulator of student accomplishment and math scores in both public and private colleges.

Brempong and Gyapong (1991) investigated the variables and calculated the education production performance. The analysis examined the influence of society's socioeconomic situation on the assembly performance of high college victimization prior knowledge and multivariate analysis. The investigation discovered that socioeconomic factors substantially and favourably impact academic output.

Perelman and Santin (2011) used constant random distance functions to assess students' academic effectiveness. The analysis relied on actual knowledge from the OECD's International Student Assessment Program, which was gathered in the European nation. The findings offer a lightweight insight into how kids' home backgrounds and college factors affect their outputs.

Dickey and Houston (2010) computed the education production performance for Principles of economic science. The analysis discovered that human capital metrics (GPA, HOURS, and ACT (American Faculty Testing)) were favourable and essential. The magnitude relation of maths to ACT composite scores was an honest predictor of academic output. Student effort was shown to be a severe predictor of student accomplishment.

Vehari, Pakistan, Awan, and Zia (2015) did a comparative analysis of public and personal colleges. In keeping with the study, family cash encompasses a sizable, minimal impact on their

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

children's academic success. The student-teacher magnitude relation includes a negative and sizable impact on student accomplishment. The analysis additionally discovered that the amenities of the establishments have a substantial and favourable influence on the performance of the scholars.

3. Theoretical Framework

The link between education and economic development has long been established, with education being seen as a key factor in human capital development. Human capital theory, developed by Becker (1964) and Mincer (1958), posits that education and training are investments in human capital that increase individual productivity and enhance economic growth. Additionally, the concept of education production function, first introduced by Arrow (1973), suggests that the production of education is a multi-dimensional process that involves various inputs, such as teacher quality, curriculum design, and school resources, which collectively determine the quality and quantity of educational outputs, such as student performance.

In the context of developing countries, education is viewed as a critical tool for achieving economic growth and reducing poverty. However, the quality of education in many developing countries is often poor, with low levels of student achievement and high dropout rates. As a result, there is a need to understand the factors that contribute to education production performance in these contexts.

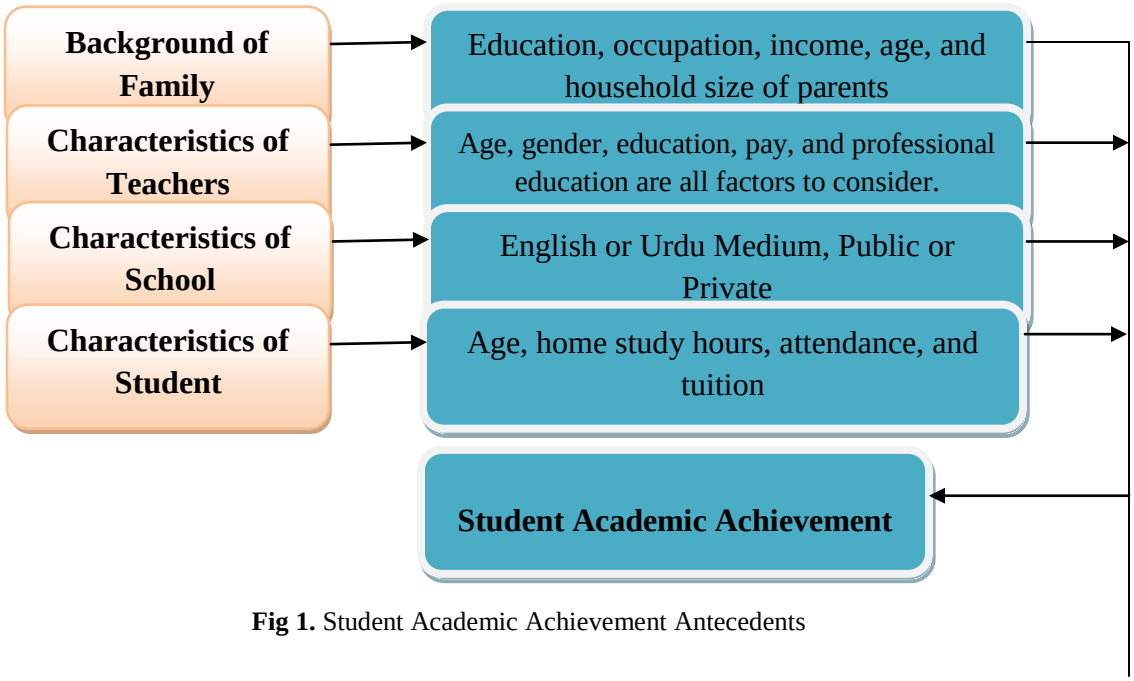

Fig 1. Student Academic Achievement Antecedents

It is a significant issue for politicians once they decide how to restrict public resources committed to education. In impoverished nations like the Islamic Republic of Pakistan, inefficient utilization of college resources and family resources may be a widespread issue. To beat these impediments to the deed and earn an honest yearly examination result. Several writers and lecturers compose this subject in industrial nations like the USA, UK, and Spain, as in Bharat, but many studies are undertaken in the Islamic Republic of Pakistan. This analysis tries to deal with this gap by victimization multivariate analysis as a way of analyzing the influence of socioeconomic variables, faculty options, and educator qualities on student performance. Some international researchers also examined the impact of instructors' and schools' options, yet as socioeconomic factors, on students' success, which native researchers in one study did not do.

4. Methodology

To decide on the deep purpose of the numerous factors associated with the tested qualitative technique. Quantitative analysis involves quantifying knowledge gathering and analysis (Bryman, 2015). The research worker used qualitative and quantitative methodologies to achieve the study goal. All of the characteristics were considerably related to an academic production operation. As a result, the cross-sectional strategy was used since the sample is stratified. The survey done by the research worker allows for gathering such knowledge from students from varied backgrounds. It improves the correct depiction of the many responses (Bryman, 2015).

The research worker was ready to gather answers from one hundred respondents during a cross-sectional study employing a standardized form. The current study was applied in a chosen hamlet of Khairpir District, Sindh, Pakistan. The research worker purposefully selected Khairpur City since it is the centre of the academic sector. In terms of necessary establishments and faculties, it is a vast space. As a result, to satisfy the study purpose, the research worker gathered all relevant data and knowledge relating to the academic production operation.

4.1 Data Collection Techniques

This analysis depends on original knowledge, and well-structured questionnaires, one for instructors and one for college students, are developed to collect data. The data was gathered from high school students within the tenth grade World Health Organization who were promoted from the ninth to the tenth grade in 2 villages: Akbar Pura and Taru Jabba. Knowledge was nonheritable from one hundred sample students employing a basic sampling approach because of time and monetary fund restrictions.

The assembling of sample knowledge is essential for any investigation. It has been done to assess the facts and numbers from one hundred samples of respondents. This analysis gathered a comparable sample distribution of the population for this objective. By mistreating

cognizancejournal.com
Safiullah Junejo *et al*, Cognizance Journal of Multidisciplinary Studies, Vol.4, Issue.2, February 2024, pg. 232-242
(An Open Accessible, Multidisciplinary, Fully Refereed and Peer Reviewed Journal)
ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

straightforward sampling for the choice of respondents, a structural form was accustomed to collecting one hundred samples from public and personal faculties. The form is split into two sections, A and B. Half A includes the subsequent sections: life history, gender, academic, and occupation. Half B contains data regarding the analysis purpose. Structured questionnaires were designed and distributed throughout the knowledge assortment.

4.2. Econometric Analysis

The regression model inquiry is the most extensively used applied mathematics approach. It examined the linear and additive relationships between variables. Sir scientist, a 19th-century human, was the primary to make a regression model regarding regression toward the mean models; that is, however the weird word regression came to use.

4.2.1 Model Specification

There are square measures that influence pupils' educational or instructional actions. The subsequent model was used during this analysis to gauge student performance mistreatment in the education production function:

$$EPij = f(F_i, T_j, S_{ij}, I_{ij}, \varepsilon_i) \qquad (1)$$

Where:

EP_{ij} is the Educational Performance of ith pupils in school j that represents the proportion of marks gained by students in their ninth category check administered by the Board of Intermediate and Education Sukkur. F_i represents the Family background/Parental characteristics of the coed, like parental education, age, career, income, and residential size at school *j*. T_j indicates Teacher qualities such as age, gender, education, skilled education, compensation, experience, training, and faculty rewards *j*. S_i shows college options, like whether the college is public or personal and if it is English or Urdu medium. I_{ij} Individual student characteristics *I* like gender, age, course of instruction hours, attendance, tuition, then on at school *j*. *e* shows an error term thought to be ordinarily distributed with a mean of zero and a variance of 1.

In economics, the said proper type could also be explicit as follows:

$$EP = \alpha + \beta_1 F + \beta_2 T + \beta_3 S + \beta_4 I + e \qquad (2)$$

The higher than model was calculable mistreatment standard statistical method mistreatment the model's traditional assumptions.

4.2.2 Data Analysis

The summarized facts and knowledge are classified and supported by the coded analysis queries. Moreover, the information analyzed mistreated the applied mathematics package for scientific discipline (SPSS). Mistreatment SPSS package, the research worker was ready to generate frequency schedules, percentages, cross-tabulation, means, and variance. This program was also

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

helpful for analyzing mistreatment inferential statistics like regression. These applied mathematics results were used to come up with quantitative data.

Data analysis was accustomed to perceiving the outcomes and knowledge presentation. Because of the approval of the quantitative and qualitative knowledge results, the training became a lot of affordable and accessible. For knowledge quantification, the variable has been done and indicated by (1 & 5), whereas the opposite freelance variables have sub-parts sense by constant scale, i.e., 1 to 5.

5. Results and Discussions

The findings of the estimate of the education production performance area unit were bestowed during this portion of the article. Table one also shows the theoretical conclusions because of the coefficients' foreseen sign. The t-value and sig-value mirror a rejection of the null hypothesis that every coefficient area unit is adequately zero at any acceptable significance level. Consistent with multivariate analysis, instructive factors explained around 72% of the model. That model is, therefore, a superb match.

The kind of college had a significant impact on student action. Students from personal faculties outperformed those from public faculties. Consistent with the findings, faculty sort was entirely and considerably associated with student performance. The education of the daddy has a favorable and substantial influence on the performance of the kids. The results reveal that students with a knowing father move on exams. At 10%, the father's occupation was completely and considerably connected to student action. The monthly financial gain of the daddy contains a favourable and substantial influence on student performance. Because the father's wealth rises, thus will the student's performance.

Table 01: OLS Results

Variables	Coefficients	Std. Error	t-value	P-value
(Constant)	61.090	17.046	3.699	0.001*
Respondent's Gender	6.966	1.926	3.910	0.000*
Respondent's Age	-2.520	1.007	-2.769	0.009*
Type of School	12.011	2.009	6.235	0.000*
Father's Education	3.071	0.850	4.027	0.000*
Father's Profession	1.390	0.750	1.931	0.070***
Father's Monthly Income Thousand (Pk Rs)	2.498	0.951	-2.802	0.008*
Mother's Education	1.503	1.077	1.231	0.222
Mother's Profession	1.255	3.725	0.391	0.772

Mother's Monthly Income in Thousands (PK Rs)	0.557	1.701	0.385	0.776
Attendance in Class	2.206	1.156	1.811	0.091***
Hours did you study at home per day	2.051	0.543	2.018	0.058**
You go for tuition after school hours	2.834	1.737	1.871	0.099***

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

Mother's education, occupation, and earnings were negligible. They had no work or profession since most were illiterate and entirely housewives. The gender of the responders was positive and essential. The respondents' age was likewise necessary and with the correct sign. The look-score of responders decreases by 4% as they mature. Students attending had a tenth favourable and substantial influence on educational action. At 5%, the reception was complimentary and essential for the daily study hours. Many of them study reception and the upper they take a look at results are. Tuition and student action were 100% absolutely and considerably connected. Students that attended tuition received pleasant to take a look at scores.

The model is summarized in Table 2. Explanatory factors explain 75%of the model.

Table 02: Summarized Model

R^2	Adjusted R^2	F-Statistic	p-Value
0.756	0.692	17.009	0.000

Table 3 indicates the outcomes of instructor characteristics such as age, professional qualification, training, experience, reward, and monthly salary. Professional qualification was associated with student performance in a good and substantial way. Teachers with excellent professional qualifications were able to educate effectively. At the 5% significance level, the teacher's age was positive and significant. At 5%, training was similarly beneficial and substantial. The experience of the teacher was not statistically significant. At 5%, monthly compensation was positive and statistically significant, and the reward was also statistically significant. Sharma's predictions were correct (2022).

Table 03: OLS Results

Variables	Coefficients	Std. Error	t-value	p-value
(Constant)	67.027	6.721	10.263	0.000*
P. Qualification	3.011	1.037	2.994	0.004*
Age	0.591	0.234	2.273	0.031**
Training	4.152	2.082	2.345	0.042**
Experience	0.551	2.685	0.177	0.883

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

Monthly Pay	0.441	0.137	2.489	0.014*
Reward	4.460	2.317	1.969	0.055**

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

The model is summarized in Table 4. R- Square accounted for 16% of the teacher's attributes.

Table 04: Summarized Model

R^2	Adjusted R^2	F-Statistic	p-Value
0.165	0.142	5.267	.000

6. Conclusion and Recommendations

The education production operation or input-output methodology was utilized to (research to investigate) the factors of deed and gaining a high take a look at score within the research region. Teacher traits, student characteristics, and family background factors were inputs, with the student's ninth-grade examination result (marks) as output. A form was wont to get prior knowledge from a hundred respondents for this purpose. In keeping with the OLS findings, instructors' attributes, like age, skilled qualification, training, experience, regular monthly payment, and reward, have a good and statistically significant influence on students' educational actions. Gender, age, attendance, study hours, reception, and tuition were all positive and statistically essential factors in students' success. Aside from the mother's qualifications, profession, and income, parental attributes like age, qualification, occupation, and financial gain have a positive and substantial influence. The result of college kind, i.e., public vs. personal, conjointly negatively impacts students' performance.

Parental education is crucial for a child's educational performance. Educated people should create committees to help pupils whose oldsters area unit cannot offer them instructional help. Moreover, this committee ought to facilitate impoverished students by assisting them. The media ought to run a campaign promoting the worth of education and urging affluent people to assist bright students whose monetary circumstances hinder them from following their instructional ambitions. The media and, therefore the government ought to educate illiterate oldsters concerning the importance of education in today's society. They ought to extend the understanding of illiterate oldsters and persuade them that education is as important for them because it is for their kids.

ISSN: 0976-7797
Impact Factor: 4.843
Index Copernicus Value (ICV) = 77.57

References

1. Arrow, K. (1973). Higher education as a filter. *Journal of Public Economics*, 2(3), 193-216.
2. Aslam, M. (2003). The Determinants of Student Achievement in Government and Private Schools in Pakistan. *The Pakistan Development Review*. https://doi.org/10.30541/v42i4iipp.841-876
3. Awan, A. G., & Zia, A. (2015). Comparative Analysis of Public and Private Educational Institutions: A case study of District Vehari-Pakistan. *Journal of Education and Practice*, *6*(16), 122–130. http://files.eric.ed.gov/fulltext/EJ1079988.pdf
4. Becker, G. S. (1964). Human capital. New York, NY: Columbia University Press.
5. Cascio, E., & Schanzenbach, D. W. (2016). First in the Class? Age and the Education Production Function. *Education Finance and Policy*, *11*(3), 225–250. https://doi.org/10.1162/edfp_a_00191
6. Chizmar, J. F., & Zak, T. A. (1984). Canonical estimation of joint educational production functions. *Economics of Education Review*, *3*(1), 37–43. https://doi.org/10.1016/0272-7757(84)90006-2
7. Das, J., Dercon, S., Habyarimana, J., Krishnan, P., Muralidharan, K., & Sundararaman, V. (2011). School Inputs, Household Substitution, and Test Scores. *American Economic Journal: Applied Economics*, *5*(2), 29–57. https://doi.org/10.1257/app.5.2.29
8. Dickey, S., & Houston, RG (2010). Estimation of the Education Production Function for Principles of Macroeconomics. *Perspectives on Economic Education Research* , 6 (1), 72.
9. Glewwe, P., & Lambert, S. (2010). Education Production Functions: Evidence from Developing Countries. In . https://doi.org/10.1016/b978-0-08-044894-7.01232-x
10. Gyimah-Brempong, K., & Gyapong, A. O. (1991). Characteristics of education production functions: An application of canonical regression analysis. *Economics of Education Review*, *10*(1), 7–17. https://doi.org/10.1016/0272-7757(91)90035-n
11. Hanushek, E. A. (1986). The economics of schooling: Production and efficiency in public schools. Journal of economic literature, 24(3), 1141-1177.
12. Hanushek, E. A. (2020). Education production functions. *In The economics of education* (pp. 161-170). Academic Press.
13. Holmes, J. (2003). Measuring the determinants of school completion in Pakistan: analysis of censoring and selection bias. *Economics of Education Review*, *22*(3), 249–264. https://doi.org/10.1016/s0272-7757(02)00024-9
14. Khan, S. R., & Kiefer, D. (2007). Educational production functions for rural Pakistan: A comparative institutional analysis. *Education Economics*, 15(3), 327-342.
15. Khatiwada, D., & Yadav, P. K. (2022). Technical Efficiency of Ginger Production in Ilam District of Nepal: A Stochastic Production Frontier Approach. *Advances in Agriculture*, *2022*, 1–8. https://doi.org/10.1155/2022/3007624
16. Khattak, N. U. R. (2012). The contribution of education to economic growth: evidence from Pakistan.
17. Mankiw, N. G., Romer, D. H., & Weil, D. N. (1992). A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, *107*(2), 407–437. https://doi.org/10.2307/2118477
18. Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy*, 66(4), 281-302.
19. Misanew, A., & Tadesse, M. (2014). Determinants of Student and Staff Satisfaction with Services at Dilla University, Ethiopia: Application of Single and Multilevel Logistic Regression Analyses. *Social Indicators Research*, *119*(3), 1571–1587. https://doi.org/10.1007/s11205-013-0561-y
20. Moore, N. T. (2011). An Education Production Function for Botswanan Secondary Schools.
21. Perelman, S., & Santín, D. (2011). Measuring educational efficiency at student level with parametric stochastic distance functions: an application to Spanish PISA results. *Education Economics*, *19*(1), 29–49. https://doi.org/10.1080/09645290802470475
22. Pritchett, L., & Filmer, D. (1999). What education production functions really show: a positive theory of education expenditures. *Economics of Education Review*, *18*(2), 223–239. https://doi.org/10.1016/s0272-7757(98)00034-x
23. Sharma, A. K. (2021). Neoliberal etiology and educational failure: A critical exploration. *Curriculum Inquiry*, *51*(5), 542–561. https://doi.org/10.1080/03626784.2021.1964905
24. Shen, T., & Konstantopoulos, S. (2022). Are class size and teacher characteristics associated with cognitive outcomes in early grades?. *School Effectiveness and School Improvement*, 33(3), 333-359.
25. Simons, S., Bartelings, H., Hamon, K. G., Kempf, A., Döring, R., & Temming, A. (2014). Integrating stochastic age-structured population dynamics into complex fisheries economic models for management evaluations: the North Sea saithe fishery as a case study. *Ices Journal of Marine Science*, *71*(7), 1638–1652. https://doi.org/10.1093/icesjms/fsu049

