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Technical Efficiency of Teacher Education in the Secondary Level of Bangladesh

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Abstract

Secondary level teacher education program plays a vital role in the teachers' professional development in Bangladesh. Since the teachers execute their training outcomes in their working places, the technical efficiency/ inefficiency of teacher education programs are relevant in consideration with the quality education. The objective of the paper is to identify such factors/variables and measures the efficiencies of the teacher's education program using primary data that have been collected following well-structured questionnaires under a two-stage random sampling methodology. As the respondents, 625 students, 125 teachers, and 40 head teachers have interviewed following observation schedules and checklists. Although both the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) are widely used in these areas, SFA is quite acceptable to the Statistician due to its advantageous properties. As such SFA model have been used considering both the error variables (hours of time students use email/Facebook/ internet in a day, Father/ Mother / Both, spend of time with their child, hours of time students play in the school per day, Percentage of class, teachers used teaching materials, the members of the SMC come to school for students monitoring) and the inefficiency effect variables (Sex of the students, students get admission in the coaching center, the grade of the students (class 5), grade of the students (class 8), teachers used teaching materials in the classroom, teachers used teaching method for students problem-solving and teachers completed the syllabus within the school year). The average technical efficiency measures as 70% for the output variables, 'written exam results of class nine students' with the maximum technical efficiency, 72%. Finally, the inefficiency parameters confirm the effectiveness of the teacher education program, as

well as the teaching-learning activities of the secondary education level and that, could be an important message for the educationists and/or concerning authorities.

Keyword: Technical Efficiency, Teacher Education, Secondary Level, Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA).

AMS Classification: 97C80.

1. Introduction

Education is the backbone of a nation and it is a very important factor to ensure the development of a country (David Melita Ole Katitia-2015). Teachers' quality is always cited as the most significant efficiency of teacher preparation programs and this paper discusses the aspects of Teacher education factors that influence student achievement. Teacher education means the program of education, research or training of persons for equipping them to teach at any level of education like pre-primary, primary, secondary and higher secondary stages of formal educational institutions as well as non-formal education, part-time education, adult education and so on (According to Singh. *et al.*, (2005)). The importance of quality education at the secondary level is an essential tool for the accelerated economic development of any developing country like Bangladesh. How to ensure inclusive and quality education for all and promote lifelong learning has been included in the Sustainable Development Goals (SDGs-4), 2030. Wider access to good quality secondary education is a critical element in attaining the goals of political stability, human development, and a nation's economic competitiveness. Following the primary stage, secondary education is an important turning step between primary and tertiary levels and it is critical to equip youngsters with relevant skills and knowledge for their future life. The student of the secondary level is scattered over different disciplines according to their choices and abilities. It is also the key consideration of the knowledge that is acquired at the primary level but it is crucial to prepare the young future generation for further studies and the labor market. Secondary education is also critical for the world's economic development because it enables massive and long-term investment in human capital. In recent times, secondary education has been a growing understanding that the wider access to proper quality secondary education is a critical element in achieving the goals of political stability, human resource development, and a nation's economic competitiveness. Baran, *et al.* (2017). The paper was to

examine pre-service teachers' perceptions of the support their teacher education programs provide for developing their technological pedagogical content knowledge (TPACK). The strategies investigated in the synthesis of qualitative evidence (SQD) model included: using teacher educators as role models; reflecting on the role of technology in education; learning how to use technology by design; collaboration with peers; scaffolding authentic technology experiences; and providing continuous feedback. The linear regression analysis revealed a positive relationship between teacher education strategies and pre-service teachers' TPACK. Reflection and teacher educators' role models were the most frequently used teacher education strategies in teacher education programs included in this paper. Results provided recommendations for further research on the connection between teacher education strategies and the development of preservice teachers' TPACK in teacher education programs.

The teacher education program is diagnosed nationally and internationally aspects through Technical Efficiency (TE). Chakraborty (2009) has measured the efficiency of public education using a stochastic frontier model that estimates an educational production function and an inefficiency effect function that controls the socio-economic and environmental factors simultaneously following Battese and Coelli model of 1995. Although the quality of teacher education is hard to define precisely due to difficulties in measurement, generally it refers to the "knowledge base and analytical skills that are the focal point of the classroom situation of schools" (Hanushek and Luque, 2002). Mahmudi Hadi 2014 was assessed the TE level of management at Private and Public Junior High School and to examine input-output variables that cause the lack of TE of management at Private and Public Junior High School following DEA method. On basis of the average academic achievement, They found Private Junior High School more efficient than Public Junior High School. Training program works as a reinforcement that brings a significant change in teachers, revising the rules and systems, establishing the far-reaching vision, and works to change the attitude and behavior of teachers were reported by Kazmi, Pervez, Mumtaz in 2011. It is obvious from some studies [Swmupwa (2008); Islam, Azharu (2000); Fare's et al. (1993); Ingvarsonet al., 2007; Gray et al.,1986; Jesson et al., 1987; Aigneret al.,1977; Chakraborty, at el.,1999)] that teacher training makes teachers more time befitting and logical. Teachers of this century not only play a significant role in

learners' achievement of knowledge and skills but also do their duties for their self-development have been depicted by the research followed by Kakkar in 2001.

Following this literature, we have been intended to conduct such research to measures the technical efficiency/inefficiency of the teacher education program that could be a matter of facts for the policymaker of Bangladesh for the secondary level of education.

2. Data and methodology

The study area of teacher education program in secondary level in Rajshahi district with the consideration of rural secondary school, urban secondary schools and semi-urban secondary schools. The primary data from 625 students, 125 teachers, and 40 headteachers have collected by direct interview from the selected institutions. The data were collected through the research tools from the selected schools on basis of the questionnaire following different instruments from different stakeholders like head teachers, trained and non-trained teachers and students. The present study has also taken the written exam on English and Math for collecting dependable data. Bsed on a well prepared questionnaires, the data in this study have been collected using two stage sampling. Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) are widely used in this areas (Ingvarson et al., 2007; Proceeding C., 2013; Gray et al.,1986; Jesson et al., 1987;Aigner et al.,1977; meeusen & van den Broeck, 1977; Franta and Konecny, 2009). SFA is recently developed technique that can capture both deterministic and probabilistic part of the model. In this respect, SFA is quite acceptable to the Statistician to estimate the TE. In this research, we have considered SAF as a data analysis tool.

The TE in the individuals are formulated as

$$TE_i = \frac{(\text{Oberved output for a given set of inputs})}{(\text{Maximum attainable output at the same level of inputs})} = \frac{y_i}{y^*_i} \tag{1}$$

where, y_i denotes observed output of ith farm for given input level and technology, y^*_i denotes the maximum attainable or production frontier output of ith farm at the same input level and technology. Aigner *et al.* (1977) and Meeusen

et al. (1977) independently proposed stochastic frontier production function model which can therefore be written as;

$$y_i = f(x_i, \beta).\exp(v_i - u) \quad \text{i= 1, 2, 3,…,N} \tag{2}$$

where, y_i is the scalar output of the ith farm; $\boldsymbol{x_i}$ is a vector of quantity of input applied to ith farm, β is a vector of parameters and f (.) is a suitable production function, v_i is a random error associated with random events and it is assumed to be independently and identically distributed as $N(o,\sigma^2)$ random variable and u_i is technical inefficiency of the ith respondent. The possible production yi is bounded by the stochastic quantity $f(x_i, \beta).\exp(v_i)$. Mathematically, it can be expressed as

$$TE_i = \frac{y_i}{\{f(x_i, \beta).\exp(v_i)\}} = \frac{\{f(x_i, \beta).\exp(v_i - u_i\}}{\{f(x_i, \beta).\exp(v_i)\}} = \exp(-u_i) \tag{3}$$

where, y_i achieves its maximum feasible value of $f(x_i, \beta).\exp(v_i)$ if, and only if TE_i =1. Otherwise TE_i <1 provides a measure of the shortfall of observed output from maximum feasible output in an environment characterized by $\exp(v_i)$, which is allowed to vary across producers.

Estimation of the stochastic production frontier requires a particular functional form of the production function. Most frequently used forms being Cobb-Douglas and trans-log functions. The general functional forms of Cobb-Douglas and trans-log model can be expressed as

Cobb-Douglas Model:

$$Ln(y_i) = \beta_0 + \sum_{j=1}^{n} \beta_j In(x_{ij)} + \varepsilon_i \tag{4}$$

Trans-log Model:

$$Ln(y_i) = \beta_0 + \sum_{j=1}^{n} \beta_j In(x_{ij)} + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \beta_{jk} In(x_{ji}) In(x_{ki}) + \varepsilon_i \tag{5}$$

where, i denotes respondent or producer; i= 1, 2, 3 … N, yi denotes the output of ith farm, $x_{ij}'s$ and $x_{ki}'s$ are explanatory variables; j, k = 1, 2, 3 … n, β_0, $\beta_j's$, $\beta_{jk}'s$ are unknown parameters, $\beta_{jk} = \beta_{kj}$ for all j, k and $\varepsilon_i = u_i - v_i$ is the error term and it is asymmetric. The Cobb-Douglas function is a special case of trans-log function. When the effect of interaction terms including square terms are equal to zero, i.e. β_{jk} =0, for all j, k. Then, trans-log function becomes identical to the Cobb-Douglas function.

2.1 Production function and the models

Although the teachers give the maximum effort to the students there is no proper mechanism to assess the teacher's education productivity for the student's development. Conventionally, it is assume that for the production of teacher education in different places use some input factors (efficient variables) that are associated with instructional and non-instructional activities within and outside the control of the school management. The trained teachers training input factors that are associated with achievement scores (written marks of English and Math) of students measures as the students efficient activities, i.e., how many hours of students use email/Facebook/ internet in a day, how many hours of Father/ Mother / Both, spend with the students, How many hours students play in the school per day, what percentage of class, teachers are used teaching materials and how many times, the members of the SMC come to school for students monitoring. The inefficient activities of students that is teacher education activities influencing the teacher educational productivity such as students going to coaching center, grade of students, teachers use different teaching methods, teachers complete the syllabus within school year. The inefficient factors are often measured by geographic location (e.g., rural vs. urban), the nest assessed value teacher education and below TE.

Stochastic production frontier was developed and extended by Aigner, Lovell, and Schmidt (1977), Meeusenad van den Broeck (1977), and Jodrow *et al.* (1982). The basic idea behind the stochastic fronter model is the error term is composed of two parts:(i) the systematic component (i.e., a traditional random error) that captures the effect of measurement error, other statistical noise, and random shocks; and (ii) The one sided component that captures the effects of inefficiency. Several

extensions of the stochastic frontier model have been proposed over the years (Battese and Coelli, 1992; 1995; Kumbhakar, 1997; Kumbhakar and Lovell, 2001, 2002a, 2002b). In the stochastic frontier model, a non-negative error term representing technical inefficiency is subtracted from the traditional random error in the classical linear model. The general formulation of the model is:

$$y_i = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \ldots\ldots\ldots . + \beta_k x_{ik} + \varepsilon_i \qquad (6)$$

where, y_i is output and the x_j are inputs. It is postulated that $\varepsilon_i = v_i - u_i$ and $v_i \sim \mathrm{N}(0,\sigma_v{}^2)$ and $u_i \sim \left|\mathrm{N}(0,\sigma_u{}^2)\right|$, $u_i \geq 0$ and u_i and v_i are assume to be independent. The error term (ε_i) is the difference between the standard white-noise disturbance (v_i)**,** and the one-sided component (u_i). The term v_i allows for randomness acroos firms and captures the effect of measurement error, other statistical noise, and random shocks outside the firm's control. The components u_i captures the effect of inefficiency (Forsund *et al*. 1980). Most of the earlier stochastic production frontier studies estimated only the mean technical inefficiency of teacher education institutions because the residual for individual observations could not be decomposed into the two components. Jondrow *et al.* (1982) solved the problem by defining the functional form of the distribution of the one-sided inefficiency component and deriving the conditional distribution of [$u_i / v_i - u_i$] for two popular distribution cases (i.e., the half normal and exponential) to estimate firm-specific technical inefficiency.

Following Battee and Coelli (1992), the random variables u_{it} s are non-negative unobserved random variables associated with the TE of production function of model (2) and it is defined as $u_{it} = \{\exp[-\eta(t-T)]\}u_i$; i=1, 2, 3, 4, 5; t=1, where $\mathrm{u_{it}} \sim \mathrm{N}^{+}(\mu,\sigma^{2})$ and η is a parameter to be estimated. Under this specification inefficiencies in periods prior to T depends on the parameter η. If η is positive then $\exp\{-\eta(t-T)\} = \exp\{\eta(T-t)\}$ is always greater than 1, and increase with the distance of the period t and the last period T. If η is positive, then it implies technical inefficiencies decrease over time and if η is negative, then the technical inefficiencies increase over time. The general interest in this model is texting the

null hypothesis that the technical inefficiency effect are not present in the model, which is expressed as $H_o = \gamma = 0$, where $\gamma = \frac{\sigma_u^{\ 2}}{\sigma_v^{\ 2} + \sigma_u^{\ 2}}$.

2.2 Technical efficiency/inefficiency model

In this study, written exam score of English is considered as output or dependent variables. Two types of input variables are explained for investigating the impact and TE of teacher's education such as variables in the error component model and variables in the inefficiency effect model. The Cobb-Douglas production function of secondary teacher education program is

$$\text{Model-01: } Y_{ij} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + V_i - U_i \quad (7)$$

$$U_{ij} = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + \delta_6 z_6 + + \beta_7 z_7 + \varepsilon_{ij} \quad (8)$$

In the above models,

x_1: how many hours your use email/Facebook/ internet in a day? ; x_2: Father/ Mother / Both, how many hours they spend with you; x_3: How many hours you play in the school per day? ; x_4: in what percentage of class, teachers are used teaching materials? ; x_5: How many times, the members of the SMC come to school for students monitoring?

z_1: Sex of the students; z_2: Are got admission in the coaching center?

z_3: Grade of the students (class 5); z_4: Grade of the students (class 8)

z_5: Which methods, teachers used in the class?; z_6: Which methods, teachers used for students problem-solving in the class? and z_7: Are teachers completed the syllabus within school year?

The technical inefficiency of the secondary level teacher education program (if any) can be tested by the statistic λ =-2[InL(H0) – InL(H1)] = -2[LR(OLS) – LR (MLE)] with appropriate degrees of freedom.

3. Empirical Results

The estimated parameters of the Error Frontier Model (ECM) and Inefficiency Effect Model (IEM) of the written marks in English against the assigned independent variables and the inefficient effects are enlisted in the Tables 3.1-3.5.

Table 3.1: The parameters for the hypothesis H_0: $\lambda = \delta_0 = 0$.

Model	Coefficient	Standard Error	t-ratio
ECM			
β_0	2.2524**	0.0508	44.3358
β_1	-0.0058	0.0324	-0.1786
β_2	-0.0032	0.0067	-0.4742
β_3	-0.0375	0.0255	-1.4739
β_4	0.0011	0.0007	1.5673
β_5	0.0012	0.0058	0.2108
IEM			
δ_0	-26.2644	33.8728	-0.7754
Variance parameter			
σ^2	10.3716	13.1273	0.7901
γ (Gamma)	0.9884**	0.0141	70.2066
LogLik = -442.589; TE=73%; Test Statistic = 59.483 ($\chi^2_{0.05}$= 5.991), df=2 c			

** indicates significance at 0.01 probability level

Table 3.2: The parameters for the hypothesis $H_0 : \gamma = \delta_1 = \delta_2 = 0$.

Model	Coefficient	Standard Error	t-ratio
ECM			
β_0	2.1905**	0.0691	31.680
β_1	0.0251	0.0351	0.7149
β_2	-0.0046	0.0065	-0.713
β_3	-0.0076	0.0264	-0.286
β_4	0.0016*	0.0008	2.307
β_5	0.0046	0.0056	0.811
IEM			
δ_0	0.6199	1.3380	0.463
δ_1	-1.9363	2.6003	-0.745
δ_2	-1.9363	2.6003	-0.745
Variance parameter			
σ^2	2.3648	2.9559	0.800
γ (Gamma)	0.9507**	0.0590	16.100
LogLik = -427.088; TE=72%; Test Statistic = 90.484 ($\chi^2_{0.05}$= 7.779), df= 4			

significance: ** at 0.01 and * at 0.05 level

Table 3.3: The parameters for the hypothesis $H_0 : \gamma = \delta_2 = \delta_3 = 0$.

Model	Coefficient	Standard Error	t-ratio
ECM			
β_0	2.21697**	0.0711	31.185
β_1	0.0239	0.0343	0.695
β_2	-0.0052	0.0065	-0.796
β_3	-0.0056	0.0266	-0.211
β_4	0.0014*	0.0007	2.026
β_5	0.0044	0.0056	0.780
IEM			
δ_0	2.2950*	1.0692	2.147
δ_2	-2.5776	2.3485	-1.100
δ_3	-0.3709	0.2933	-1.264
Variance parameter			
σ^2	1.6425	1.4339	1.145
γ (Gamma)	0.9316**	0.0568	16.404
LogLik = - 425.697; TE=72%; Test Statistic = 93.268 ($\chi^2_{0.05}$= 9.488), df= 4			

significance: ** at 0.01 and * at 0.05 level

Table 3.4: The parameters for the hypothesis $H_0 : \gamma = \delta_2 = \delta_3 = \delta_4 = 0$.

Model	Coefficient	Standard Error	t-ratio
ECM			
β_0	0.2227**	0.0691	3.2184
β_1	0.0262	0.0360	0.7281
β_2	-0.0059	0.0067	-0.8867
β_3	-0.0065	0.0262	-0.2481
β_4	0.0014*	0.0008	0.2019
β_5	0.0045	0.0057	0.7872
IEM			
δ_0	0.1448	0.9196	0.1574
δ_2	-0.2269	0.1622	-0.1399
δ_3	-0.4662	0.3016	-0.1546
δ_4	0.3234	0.1832	0.1765
Variance parameter			
σ^2	0.1419	0.9816	0.1446
γ (Gamma)	0.9219 **	0.0527	17.4947
LogLik = - 424.75; TE=72%; Test Statistic = 96.025 ($\chi^2_{0.05}$= 9.488), df=4			

significance: ** at 0.01 and * at 0.05 level

Table 3.5: The parameters for the hypothesis $H_0 : \gamma = \delta_2 = ... = \delta_5 = 0$.

Model	Coefficient	Standard Error	t-ratio
ECM			
β_0	2.2298**	0.0662	33.6990
β_1	0.0178	0.0362	0.4919
β_2	-0.0057	0.0065	-0.8735
β_3	-0.0014	0.0267	-0.0517
β_4	0.0012*	0.0007	1.7597
β_5	0.0033	0.0056	0.5859
IEM			
δ_0	2.0637*	1.0929	1.8882
δ_2	-2.3701	1.5690	-1.5106
δ_3	-0.4957	0.3067	-1.6164
δ_4	0.4086*	0.2609	1.5662
δ_5	-0.4082	0.3263	-1.2511
Variance parameter			
σ^2	1.4412*	0.9355	1.5406
γ (Gamma)	0.9223**	0.0503	18.3437
LogLik = - 421.987; TE=72%; Test Statistic = 100.687 ($\chi^2_{0.05}$= 12.592), df=6			

significance: ** at 0.01 and * at 0.05 level

4. Conclusion

The teacher education program is an important indicator to ensure effective teaching learning in educational institutions. The secondary level teachers play a vital role as (rules of) a manager, facilitators, evaluator, guide as well as a counselor, and also they have the competencies of personal, professional, social. Several null hypotheses of the inefficient variables (such as $H_o : \gamma = \delta_0 = 0$; H_o: $\gamma = \delta_1 = \delta_2 = 0$; H_o: $\gamma = \delta_2 = \delta_3 = 0$; H_o: $\gamma = \delta_2 = \delta_3 = \delta_4 = 0$; and H_o: $\gamma = \delta_2 = ... = \delta_5 = 0$) have tested and all are found to be rejected having the TE in different null hypotheses individually greater than 70% with average TE, 72%. As such, the teacher education program could be considered as effective tools that

have been observed in this study for the English performance of the respondents. Finally, the training may help the teachers to develop themselves with an acceptable desired perspective about the academic stream and understanding of its nature, purpose, and philosophy about the purpose and teaching-learning mechanism of the subjects.

Suggestion: The more training, the more competencies of teachers. The head of the colleges/schools need to monitor the classroom situation as their managerial duty to enhance quality education. The present research may be helpful to confirm the effectiveness of the teacher education program to the secondary education monitors and the concerning authorities.

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