Addressing the Issue on Teacher Shortage: Bridging the Gap on Public School Teachers and LEPT Passers

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ABSTRACT

This paper seeks to contribute to an evidence-based discussion of this question by developing predictive models that translate the number of licensed teachers into actual hiring trends of the Department of Education (DepEd). Using longitudinal data from School Year 2010–2011 to School Year 2022–2023, the study uses the GAIMME modeling framework and the Trendline Function of Microsoft Excel to formulate the following models: (1) to predict the number of public-school teachers to be hired over; (2) time to estimate the number of Board Licensure Examination for Professional Teachers (LEPT) passers at the elementary and secondary levels; and (3) to calculate the hiring of teachers per given year as a function of LEPT passers. A variety of models (linear, logarithmic, exponential and polynomial functions) were compared according to coefficient of determination (R^2), sum of square errors (SSE) and simplicity. The best model to predict the number of employed teachers was relatively different, revealed by the logarithmic model, while linear and logarithmic models could approximate to forecast LEPT passers. Power functions were found to be the best for predicting teacher employment from LEPT output. These models can offer policymakers actionable insights and demonstrate the value of incorporating predictive analytics into workforce planning. The models should be updated frequently and disaggregated by region to enhance predictive validity. Although data limitations were presented, the research shows promise of a basic use of Excel-based mathematical modeling as a decision support tool for teacher deployment and its potential to contribute to reaching quality education as part of SDG 4.

Keywords: Teacher shortage, public school teachers, LEPT passers, mathematical modeling

INTRODUCTION

The Philippine basic education system is facing a chronic and multi-dimensional shortage of teachers with direct implications for the quality and equity of learning achievements across the country (EDCOM II, 2023; PBEd, 2023). Despite the nation's long history of commitment to making education accessible, numerous public schools, especially in far-flung, conflict-ridden, and marginal communities, still lack an adequate number of qualified teachers. This mismatch between teacher demand and supply undermines efforts to uphold learners' rights to quality teaching, and it is a key source of overloading classrooms, burnout among teachers, and learning deficits (EDCOM II, 2023; Castro, 2023). Addressing this fundamental issue requires not only short-term policy responses but also long-term data-driven planning and well-informed projections.

Recent research by the Second Congressional Commission on Education (EDCOM II) highlights this problem. The 2023 report of EDCOM II showed that the public-school teacher shortage is not just one of quantities but stems from structural inefficiencies with regards to recruitment, deployment, and retention (EDCOM II, 2023). The study emphasized the necessity to streamline teacher recruitment processes and strengthen congruence of the country's teacher licensure system with the reality of school-level staffing needs (EDCOM II, 2023). Citing for emphasis, the Philippine Business for Education (PBEd) has consistently pointed out the declining performance of teacher education graduates in the Board Licensure Examination for Professional Teachers (LEPT), noting that low passing rates have not only a bearing on the quality of teachers but on national teacher workforce planning as well (PBEd, 2023; Abao et al., 2023).

A critical issue identified by both PBEd and EDCOM II is the glaring gap between LEPT passers and actual public school hires (PBEd, 2023; EDCOM II, 2023). While tens of thousands of candidates pass the LEPT annually, only a fraction is ultimately absorbed into the Department of Education (DepEd) workforce, highlighting a significant inefficiency in the transition from licensure to employment (Abao et al., 2023). Some contributory factors to this gap include regional disparities, budget constraints, and even complicated hiring procedures (EDCOM II, 2023; Castro, 2023). Consequently, teachers switch to non-teaching positions or seek opportunities overseas. Moreover, other teachers teach subjects not on the scope, or beyond their specializations, with over 60% of teachers teaching outside their field of specialization (EDCOM II, 2023).

Additionally, there are quality issues underlying teacher preparation. EDCOM II and PBEd have stressed the imperative of reforms in pre-service education, noting that several teacher education institutions (TEIs) are turning out graduates lacking pedagogical content knowledge and classroom readiness necessary for 21st-century learners (PBEd, 2023; EDCOM II, 2023). These deficits in teacher readiness, combined with less-than-ideal LEPT passing rates, form a vicious cycle: the education system cannot produce and maintain high-quality teachers, while students bear the brunt of inept instruction (Abao et al., 2023; Acosta & Acosta, 2016). Therefore, solving teacher shortage is not merely a matter of raising the number of teachers but of having the system in place to prepare and hold onto qualified professionals who can address the needs of contemporary classrooms (EDCOM II, 2023; PBEd, 2023).

Furthermore, the national level budgeting has not always been responsive to genuine needs for employment. The creation of plantilla positions of public-school teachers is typically fixed by budgetary constraints rather than realistic projections of teacher demand (EDCOM II, 2023; Castro, 2023). This contributes to the vacancy arrears, even if a pool of surplus LEPT passers exists. Moreover, provincial hiring processes, although decentralized, are typically skewed in terms of efficiency and transparency, resulting in prolonged vacancies and underemployment of qualified candidates (EDCOM II, 2023).

Addressing these issues is in direct support of the United Nations Sustainable Development Goals (UN SDGs), with a focus on SDG 4, which is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2015). An educated and well-distributed teaching professional workforce is one of the cornerstones to realizing SDG 4. Further, this initiative also supports SDG 8 decent work by promoting formal work for licensed professionals, and SDG 10 reduction of inequalities, particularly in marginalized and geographically remote areas (United Nations, 2015). A mathematical model may be beneficial to predict LEPT passers in the succeeding years and mapping consistencies in hiring public-school teachers (Abao et al., 2023; Delos Angeles, 2020). This will provide a data-driven methodology to provide insights to national leveled problems, which augments the gaps in the delivery of quality education (Abao et al., 2023).

This article is grounded in human capital theory (Becker, 1993) which posits that education and skill development increases the productivity and value of individuals. Teachers are linearly educated, licensed, and recruited as an investment of people that can determine a nation’s learning achievement. Finally, the paper also applied a systems thinking perspective (Senge, 2006), conceptualizing the teacher shortage, not simply as a fundamental issue of supply and demand, but as an interconnected issue encompassing recruitment policies, licensure pathways, institutional capacity, and policy conditions. These frameworks also inform the modeling of relationships between LEPT passers and teacher hiring, thus providing perspective not just on numeric gaps but systemic gaps and corresponding implications for underrepresentation.

In line with these contexts, the present paper seeks to explore the critical teacher shortage in Philippine public schools through mathematical modeling. Specifically, the research aims to determine predictive models that forecast: (1) the number of public-school teachers to be hired by DepEd in future school years; (2) the number of LEPT passers for elementary and secondary levels in future years; and (3) the performance of a model connecting LEPT passers with the actual number of hired teachers. In the process, this paper seeks to move not only within the field of educational data analytics but also national initiatives, and international commitments, to a responsive, resilient, and equitable education system.

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Statement of the Problem

Generally, the paper aims to determine a mathematical model to predict the possible number of public-school teachers hired by the Department of Education (DepEd) with respect to the number of Board Licensure Examination for Professional Teachers (LEPT) passers for elementary and secondary level.

Specifically, the paper sought answers to the following questions.

1. What is the mathematical model to predict the number of public-school teachers hired by the Department of Education (DepEd) in the succeeding school years?

2. What is the mathematical model to predict the Board Licensure Examination for Professional Teachers (LEPT) passers for the succeeding years according to:

   2.1. elementary level; and

   2.2. secondary level?

3. Is there a robust mathematical model that predicts the number of public-school teachers hired by the Department of Education (DepEd) given the number of Board Licensure Examination for Professional Teachers (LEPT) passers?

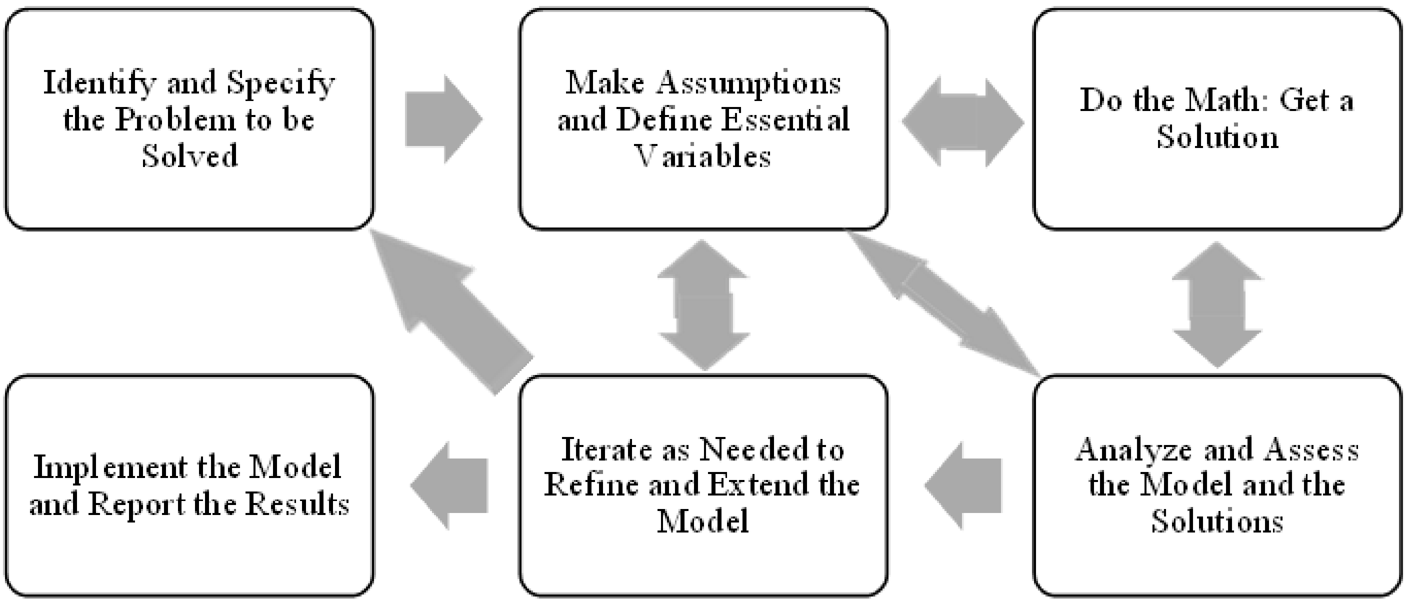
METHODOLOGY

The subsequent portion of this section shows the detailed procedure on the modeling process of the number of public-school teachers hired by the Department of Education (DepEd) with respect to the number of Board Licensure Examination for Professional Teachers (LEPT) passers for elementary and secondary level and the empirical valid data source.

Modeling Processes

To effectively predict the number of public-school teachers employed by the Department of Education (DepEd) and the number of Board Licensure Examination for Professional Teachers (LEPT) passers for elementary and secondary level, including the model utilizing the LEPT passers as predictors of number of public-school teachers, a robust modeling procedure must be conducted by the researcher. Figure 1 shows a detailed process on how the researcher developed the mathematical models in line with the specified variables.

Figure 1. GAIMME Mathematical Modeling Processes



Mathematical modeling, according to the Guidelines for Assessment and Instruction in Mathematical Modeling Education (GAIMME) model, includes selecting a realistic problem, formulating the model including assumptions and variables, solution with mathematical methods, analysis and evaluation of the mathematical model, iteration and refinement of the model, and implementation with reporting results (Garfunkel & Montgomery, 2019).

Identify and Specify the Problem to be Solved

In this stage, one should be interested to exactly specify the problem the model will try to solve. The study aims to establish a mathematical model that will forecast the number of public-school teachers hired by the Department of Education (DepEd) through the number of Board Licensure Examination for Professional Teachers (LEPT) passers. It likewise intends to formulate a prediction model for number of LEPT passers in the elementary and secondary levels in the subsequent years. Addressing these problems, the study ultimately aims to contribute to the workforce planning and policy development in the public education sector, offering empirical knowledge on the teacher supply-side dynamics.

Make Assumptions and Define Essential Variables

At this point, the modeler highlights important variables and asserts some claims about the world which makes the real-world system easier to understand. In the construction of models, simplicity and focus are the keys towards formulating certain assumptions. While simplicity and focus are foundational to the GAIMME modeling framework, the assumptions underlying these models require critical examination. First, it is presumed that DepEd's hiring procedures, as defined by current issuances (DepEd, 2024), remain consistent; however, we acknowledge that shifts in national administration or budget reallocations could temporarily disrupt hiring velocity. Second, the LEPT is assumed to be administered annually without major disturbances. Finally, external inputs, such as passing and employment rates, are held at a constant rate. While holding these rates constant simplifies the complex reality of fluctuating university curricula and economic conditions, it is a necessary mathematical constraint to isolate and baseline the primary relationship between LEPT outputs and teacher hiring. By holding these variables constant, the model provides a clear, initial forecast, though future iterations should incorporate dynamic variables to account for macroeconomic fluctuations. The key variables determined were the number of LEPT passers per level, the number of teachers hired by DepEd and the academic year. These parameters are the foundation for further mathematical relations, which are to be established in subsequent sections.

Do the Math: Get a Solution

This level corresponds to the use of relevant mathematical tools to identify potential model-solutions to the problem. Initially, the Trendline Function in Microsoft Excel was utilized to establish baseline mathematical models (e.g., Linear, Polynomial, Exponential, Logarithmic) for the historical dataset. To address the inherent limitations of basic trendline functions and to strengthen methodological rigor, these baseline outputs serve as a foundation for further validation. Future phases of this research will cross-validate these findings using advanced statistical programming environments, such as Python or R, and explore predictive machine learning algorithms to confirm the robustness and generalizability of the chosen predictive models. Trendline Function was also applied for forecasting in terms of (1) number of LEPT passers for elementary and secondary levels through time, and (2) number of public-school teachers hired as a function of LEPT passers. This is similar to the mathematical modeling conducted by Pascua (2024).

Analyze and Assess the Model and the Solutions

In this phase, the results are explained, checked and the applicability of the solutions to the real-world problem is determined. Once the models are created, one will judge the fitting trend line from the other with their R^2 score, and their residuals, if needed. The higher the value of R^2, the better the model will explain the variation observed in the data. Moreover, the Sum of Squares of Errors (SSE) was calculated per generated model to determine the appropriate fitting of the model. It is considered that when the SSE is lower, an appropriate fitting of the model may be observed. In addition, to avoid overfitting, the modeler also considered the number of parameters in the model. To make sure that the model is still contextual and will predict future value, a reasonable number of parameters were considered. The models were evaluated for plausibility and predictive power, and practical relevance, against observed experience. The goal is that the models not only fit/feel good statistically, but also that they yield sensible and interpretable results in terms of DepEd hiring trends and LEPT scores.

Iterate as Needed to Refine and Extend the Model

If the first model is inadequate, the model is reviewed or expanded through an iterative process. The development of the model will be inherently iterative. If the initial trendline models did not look like they are capturing something important in our data or if the prediction results look unstable or oscillating, the models were further refined. This might require investigating different types of trendlines in Excel, potential inclusion of factors, revisiting underlying assumptions, or breaking the data into smaller subsets to come to more homogeneous setting. Repeating this process iteratively refines the models to make them increasingly valid, stable, and useful in practice.

Implement the Model and Report the Results

The last phase is to show the model, discuss its restrictions, and ruminate the impact on the design problem. When good fitting models were developed, the last math models will be published officially, together with such visualizations as scatterplots with fitted lines to trends. Implications of the models on hiring of public teachers and LEPT results were covered in detail in subsequent portions. Critical to this iterative development process are the analysis that were documented to illustrate the process and directions in which models and constituent methods improved over the course of the study. Generally, the study offers not only its final models, but illuminates the establishment of relationships, opening this process to public learning, reflecting the dynamic cycle of modeling as suggested by the GAIMME framework.

Data Source and Validity

To serve as the basis for the mathematical model, the researcher obtained the data for the number of elementary and secondary public-school teachers in the 2023 Philippine Statistics Authority Yearbook, while the number of Board Licensure Examination for Professional Teachers (LEPT) passers was derived from the Philippine Business for Education (PBEd) repository of educational data through a Google Sheets file under a public sharing domain.

Table 1. Number of Elementary Teachers in Public Schools per School Year and the Number of LEPT Passers Nationwide

School Year	Elementary Teachers	LEPT Passers
2010-2011	361,564	11,811
2011-2012	363,955	15,265
2012-2013	377,831	37,690
2013-2014	401,913	28,989
2014-2015	417,848	35,858
2015-2016	448,966	32,878
2016-2017	450,134	34,810
2017-2018	462,299	26,323

2018-2019	484,406	31,519
2019-2020	497,200	48,093
2020-2021	508,412	-*
2021-2022	510,770	4,883
2022-2023	511,866	67,185

*Note: Due to the COVID-19 pandemic, no LEPT was conducted for the year 2020.

Table 1 displays the longitudinal data from School Year (SY) 2010–2011 to SY 2022–2023 which shows intricate patterns in the relationship between the number of elementary teachers in the Philippines and the number of Board Licensure Examination for Professional Teachers (LEPT) passers. The number of elementary teachers has been continuously on the rise since 2010 (361,564 in SY 2010–2011 and 511,866 in SY 2022–2023), indicating the long-term investment in the workforce of public education. However, the performance of LEPT passers tends to be more erratic, with greater fluctuations up and down, evident in, rank-and-file, a remarkable increase in SY 2012–2013 (37,690 passers) and the highest peak of the LEPT were registered in SY 2022–2023 (67,185 passers), while SY 2021–2022 exhibit a huge dip (4,883 passers), probably an after-effect of the effects of COVID-19 pandemic and disruption in licensure examinations and teacher education programs. When contrasted with the increasing number of teachers over time due to continuing recruitment, the inordinate size of passer for some years leads to inquiries on recruitment strategies, dependence on non-licensed teachers or provisionally licensed teachers, and policy considerations that could engage hiring-on-probation for short-term staffing needs. The high number of passers for LEPT in 2022–2023 may indicate policy interventions, examination backlog in previous years, or improvements in teacher education and the examination system.

Table 2. Number of Secondary Teachers in Public Schools per School Year and the Number of LEPT Passers Nationwide

School Year	Secondary Teachers	LEPT Passers
2010-2011	146,269	11,057
2011-2012	150,516	14,323
2012-2013	169,743	19,413
2013-2014	201,651	28,195
2014-2015	219,710	26,382
2015-2016	243,321	34,739
2016-2017	237,083	33,272
2017-2018	246,095	45,169
2018-2019	268,527	55,009
2019-2020	277,393	50,129
2020-2021	284,481	-*

2021-2022	290,409	6,796
2022-2023	291,135	61,429

*Note: Due to the COVID-19 pandemic, no LEPT was conducted for the year 2020.

Table 2 exhibits the trend of secondary teachers in the Philippines which have significantly and consistently increased from School Year (SY) 2010–2011 to SY 2022–2023: its population doubled from 146,269 to 291,135 in the span of thirteen years. The upswinging trend of the data obtained do not only manifest the country's response towards meeting enhance basic education needs, particularly the full implementation of the K to 12 curriculum, but also the Department of Education's (DepEd) drive to uplift the status of the secondary education sector. Of particular interest, even in the face of the unprecedented disruptions posed by the COVID-19 pandemic, the steady increase in size of the secondary teacher workforce over time is indicative that DepEd decided to continue its hiring of teachers even in the context of crisis and is indicative of institutional resilience and commitment to educational continuity in a time of widespread uncertainty.

This analysis describes overall LEPT passers in SY 2012–2023 of which while it also increased as a whole, exhibited greater variance, such as the drastic drop in SY 2021–2022 (6,796 passers) followed by an all-time-high surge of passers in SY 2022–2023 (61,429 passers). The wave seems to have been a result of temporary constraints on licensure exam passage and review program access and logistics during the pandemic. The surge following the pandemic possibly shows the well-functioning of licensure operations but could also point to reforms or policy changes that promoted a faster path of qualified teachers.

RESULTS

This portion presents the mathematical models that may be used to predict the number of public-school teachers and the LEPT passers across the century, for both elementary and secondary teachers. Moreover, a mathematical model is also determined to predict the number of public-school teachers considering the number of LEPT passers for the particular year, for both elementary and secondary levels.

Number of Public-School Teachers Prediction

Table 3. Consolidated Mathematical Models for Elementary Public-School Teacher Prediction

Type of Model	Equation	SSE	R^2	Parameters
Linear	$y = 14234x + 218198$	1,188,201,824	0.9688	2
Exponential	$y = 262741e^{0.0326x}$	1,823,293,831	0.9529	2
Logarithmic	$y = 220031\ln(x) - 157783$	752,005,953	0.9802	2
Power	$y = 110360x^{0.5062}$	852,521,124	0.9777	2
Quadratic	$y = -527.72x^2 + 31121x + 90488$	630,657,637	0.9834	3
Cubic	$y = -119.96x^3 + 5230.3x^2 - 58008x + 533855$	334,337,206	0.9912	4
Quartic	$y = 9.9693x^4 - 758x^3 + 20191x^2 - 210089x + 10^6$	126,998,991,290	0.9917	5
Quintic	$y = -7.9505x^5 + 646.01x^4 - 20753x^3 + 328669x^2 - 3000000x + 8000000$	734,277,824,343,338	0.9948	6

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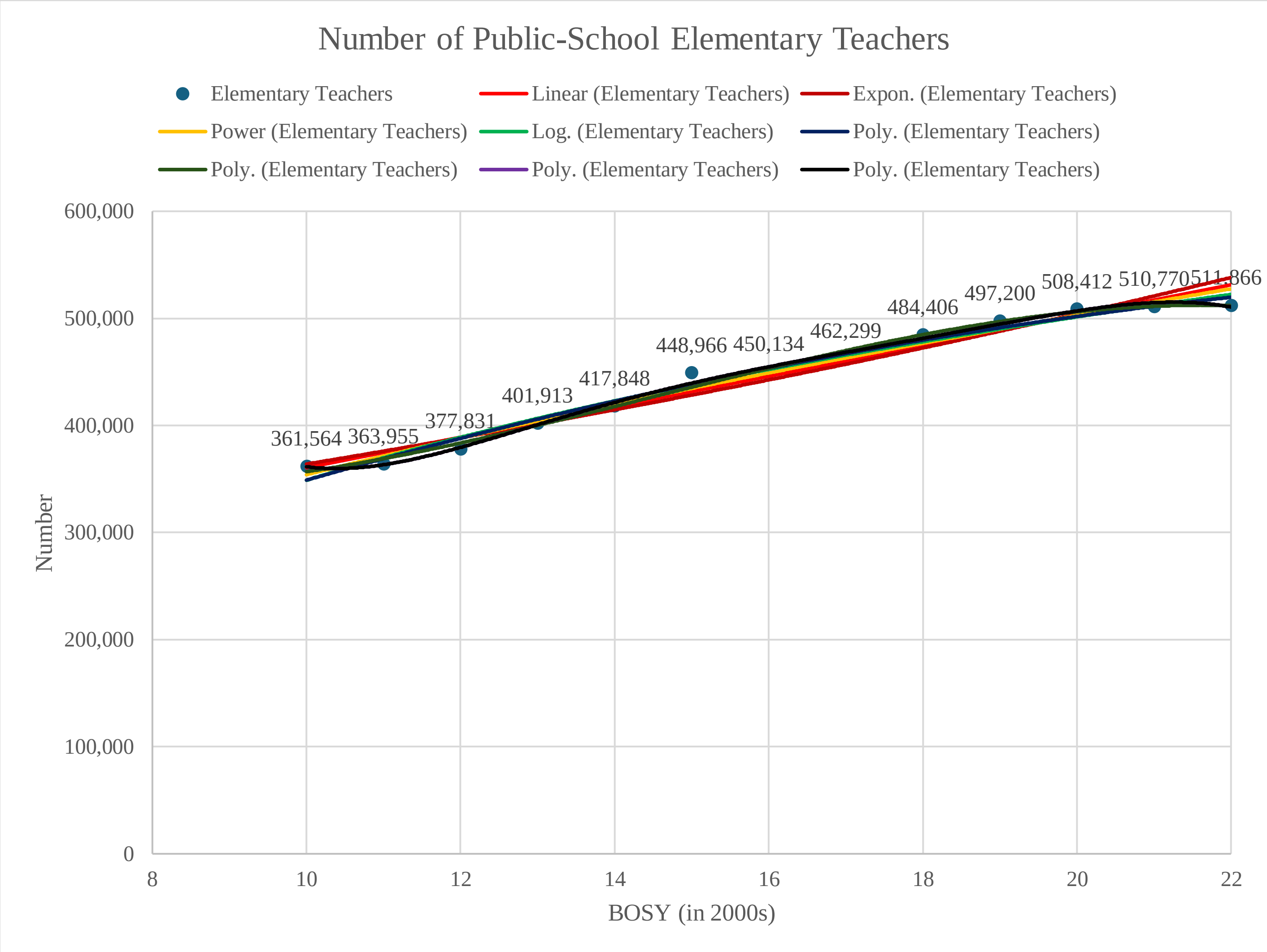
It is vitally important to choose the right mathematical model to forecast the number of elementary public-school teachers for an effective educational planning, as revealed in Table 3. The objective of this study was to assess alternative models in terms of predictive success, simplicity and policy relevance, and to therefore account for indicators of fit such as the sum of squared errors (SSE) and coefficient of determination (R^2), number of parameters, and practical applicability, as explained below.

While the linear model shows a high statistical correlation ($R^2 = 0.9688$), its massive prediction error (an SSE exceeding 1 billion) means it cannot reliably be used by policymakers to predict real-world teacher hiring over the long term. Conversely, highly complex models (like the cubic or quintic functions) closely match historical data but suffer from 'overfitting', meaning they are far too sensitive to past anomalies to accurately forecast future trends. In practical policy terms, the logarithmic model proves the most effective. It perfectly illustrates a reality educational planners frequently face, while teacher hiring might experience rapid initial growth, it eventually slows down and plateaus due to real-world constraints such as national budget caps, limited school infrastructure, and systemic absorption limits.

However, in terms of the SSE, R^2, number of parameters, and practicality of the policy implications, the logarithmic model is the best for prediction of the number of elementary public-school teachers in the future. It represents a good balance between predictive relevance and simplicity, showing the lowest SSE and highest R^2, when compared to the simpler models. Its applicability to educational planning, its capacity to take into consideration the likely settling of teacher growth over time, makes it the best model to forecast long-term forecasts. Moreover, the concern of decay will not be of major impact because the limit for the value of x can be stretched only up to 99, implying that the model may help policymakers up to the year 2099.

Figure 2. Scatterplot and the Trendline Graphs for the Elementary Public-School Teachers



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Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

The scatterplot and polynomial trendlines for the number of elementary public-school teachers are shown in Figure 2. The non-linear positive trend indicated by the data, could justify fitting the data using polynomial models with different powers. Among the fitted models—quadratic (dark blue), cubic (dark green), quartic (violet), and quintic (black)—higher-order polynomials provide for more precise visual fits to the data, notably around the local peaks and troughs. However, though the quintic model closely fits the data, it might be the case that the data are simply random, with no actual structure. By contrast, the patterns of the quadratic and cubic models have smoother curves, and they are more likely to be consistent with continuum changes in teacher human capital development. However, this contradicts the most appropriate model which is the logarithmic model. Although it is not the function with the highest fit with the actual data, the model offers simplicity and ease in understanding for future considerations. The model also appears visually like other graphs, indicating that this is not fully deviated with the other models available. This illustrates the importance of finding the right balance between model complexity and interpretability, especially in policy contexts.

Table 4. Consolidated Mathematical Models for Secondary Public-School Teacher Prediction

Type of Model	**Equation**	**SSE**	**R^2**	**Parameters**
Linear	$y = 12941x + 25740$	1,860,448,127	0.9425	2
Exponential	$y = 87385e^{0.0596x}$	3,593,259,783	0.8965	2
Logarithmic	$y = 201951\ln(x) - 321317$	910,158,831	0.9719	2
Power	$y = 17222x^{0.9396}$	1,884,114,425	0.9449	2
Quadratic	$y = -788.04x^2 + 38158x - 164965$	617,135,620	0.9809	3
Cubic	$y = -15.633x^3 - 37.645x^2 + 26543x - 107185$	612,171,062	0.9811	4
Quartic	$y = 11.452x^4 - 748.54x^3 + 17148x^2 - 148150x + 541515$	3,087,991,786,670	0.9819	5
Quintic	$y = -12.602x^5 + 1019.6x^4 - 32442x^3 + 506104x^2 - 4000000x + 10000000$	207,994,584,112,756	0.9908	6

From the tested models found in Table 4, a compelling balance between accuracy and simplicity is achieved for the logarithmic model ($R^2 = 0.9719$; SSE = 910,158,831; 2 parameters). It has the largest R^2 and smallest SSE of all the two-parameter models and statistically robust and simple to explain. This is particularly useful for policymakers, where precision and simplicity are necessities.

From a statistical perspective, the logarithmic model is quite superior to both the linear and exponential models. It features the least prediction error (minimum SSE) and an increased proportion of variance explained (maximal R^2) than all other two-parameter models. This indicates that it catches trend well without overfitting, which is crucial for reliable long-term prediction. Moreover, reality assumptions were clear in the logarithmic model. It depicts rapid early growth that tapers off the longer the time frame, a common dynamic in public systems such as teacher recruitment. Growth eventually plateaus as hiring catches up with increasing demand, limited budget, training space and other restrictions simultaneously come into play.

Simplicity is also one of its main strong sides. It is transparent and interpretable to non-technical audiences with just two parameters in the model. Policymakers can rely on its forecasts when making decisions about staffing, budgets or training programs. More complex models, such as the quadratic and cubic models, however, do fit better, but add parameters and may result in overfitting and can be less transparent. Quartic

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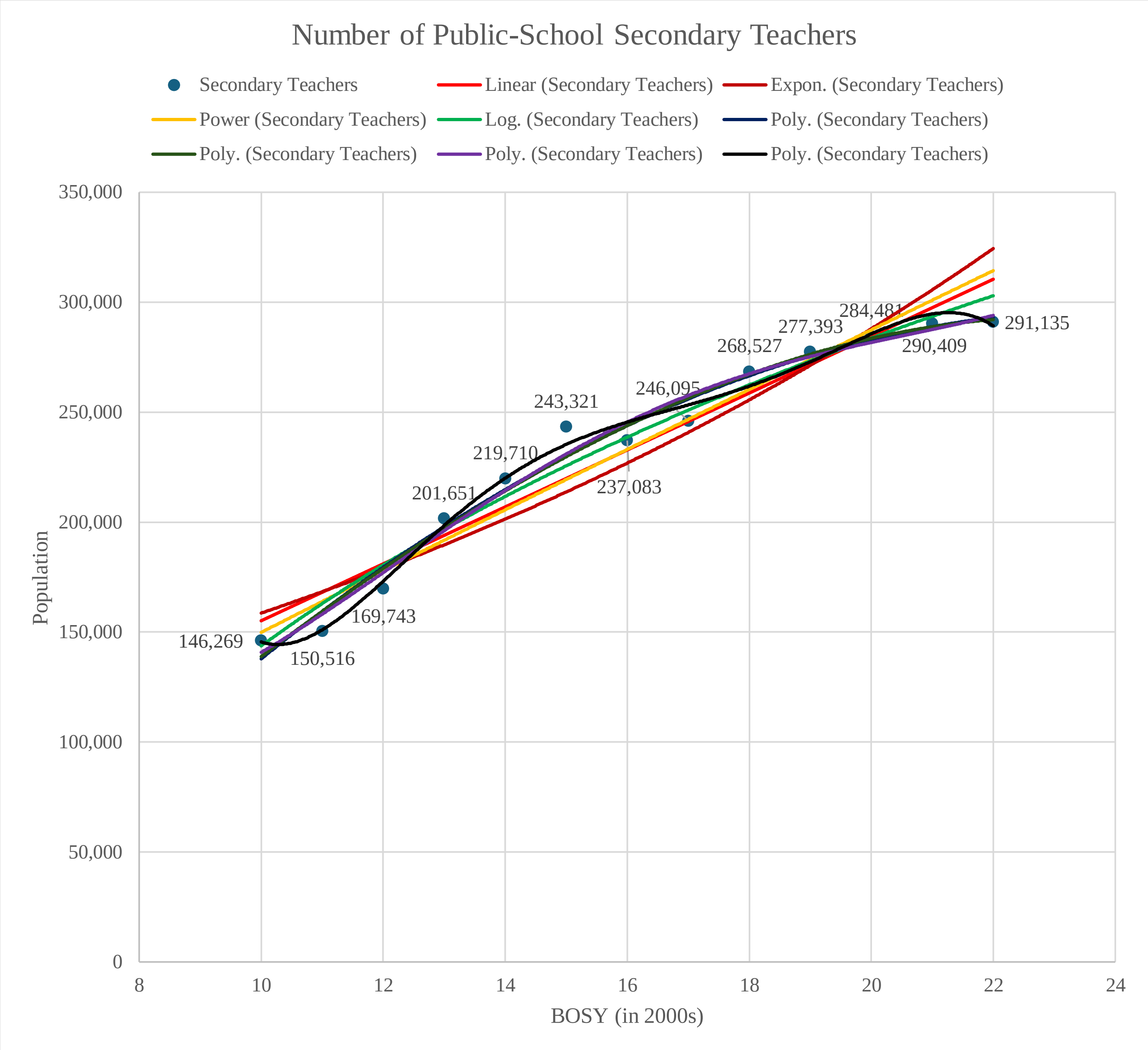
and quintic, with the highest R^2, 0.9819 and 0.9908, respectively, exhibit however high SSE values and thus provide the least stable and overfitted models. Their complexity renders them impractical to be used for forecasting and decision-making. More straightforward models such as linear fit and exponential fit that are easier to manipulate and interpret have less predictive power (R^2 smaller than 0.95), which weakens the extent of the value of use for capturing the fine distinctions of teacher workers dynamics.

For planning of education, the logarithmic model is the most appropriate model. It possesses strong statistical performance, real-world relevance, and interpretability, all three of which are necessary to become a trusted vehicle for data-driven policy.

Figure 3. Scatterplot and the Trendline Graphs for the Elementary Public-School Teachers



Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

The scatterplot and trendline graphs for elementary public-school teachers looks the same as it does, in Figure 3, but probably reflects a different grouping or timeframe. Once again, lines of polynomial fits of increasing power are drawn. Both quintic and quartic models appear to visually fit the data points but make oscillations that could largely distort the trend. The cubic model, which is flexible enough to capture the curvature in the data, without imposing the erratic swings of higher polynomials. However, the logarithmic model seems to be

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the best choice for this graph as the graph of a logarithmic function closely fits the actual observations. Moreover, the range of the years from 2025 to 2099 (with x = 25, 26, …, 99) will not lead the function into its irrelevant decay, making it suitable on the context of its prediction through time.

Number of LEPT Passers Prediction

Table 5. Consolidated Mathematical Models for Elementary LEPT Passers Prediction

Type of Model	Equation	SSE	R^2	Parameters
Linear	$y = 3369.7x – 17483$	733,836,647.2	0.674	2
Exponential	$y = 6158.2e^{0.1055x}$	649,161,550.2	0.7177	2
Logarithmic	$y = 49582 \ln(x) – 99877$	803,376,398.1	0.6431	2
Power	$y = 387.99x^{1.621}$	708,071,675.6	0.69	2
Quadratic	$y = 192.73x^2 - 2691.5x + 27773$	666,193,210.4	0.7041	3
Cubic	$y = 137.19x^3 - 6408.2x^2 + 99560x - 480740$	309,937,882.8	0.8623	4
Quartic	$y = -18.629x^4 + 1320.6x^3 - 33,910x^2 + 376,452x - 1,000,000$	2,742,520,000,000	0.8822	5
Quintic	$y = -11.169x^5 + 856.34x^4 - 25,603x^3 + 372,719x^2 - 3,000,000x + 7,000,000$	384,647,000,000,000	0.9222	6

Table 5 reveals the mathematical models that may predict elementary LEPT passers in the Philippines from 2010 to 2022. Of the functions fitted—linear, exponential, logarithmic, power, quadratic, cubic, quartic, and quintic, the quintic function fit the best ($R^2 = 0.9222$), followed closely by the quartic ($R^2 = 0.8822$) and cubic ($R^2 = 0.8623$) functions. Although these polynomial representations may be well-fit statistically, their predictive reliability is in question. In the quartic and quintic models, for example, sum of squared errors (SSE) never dropped below 384.6 trillion—suggesting overfitting and numerical instability which are typical limitations of high-order polynomial fit, as suggested by Montgomery et al. (2012).

While the exponential model has an R^2 of 0.7177 and an SSE of 649.2 million (compared to thousands of millions for the linear model) the forward predictions can prove to be unrealistic, particularly for outer-year estimates. This discourages its use for realistic prediction. However, on the other side the best linear model ($R^2 = 0.674$, SSE = 733.8) seem to provide realistic results regarding interpretability and plausibility of such forecasts. It does not have the highest R^2, but its two-dimensional nature qualifies its simplicity. This is consistent with the law of parsimony that favors simpler models that retains adequate fit and greater predictive stability, particularly when predicting beyond the range of the observed data.

Considering that LEPT administration was disrupted during the pandemic, especially in 2020, with a steep drop in SY 2021–2022, the model did not respond excessively to the latest deviations from the overall pattern. In this sense, the linear model can characterize the overall growth behavior without exaggerating the outliers, a fact that renders it a more powerful tool for planning. It enables a wider audience (including politicians, education strategists and university and college authorities) and supports evidence-informed decision-making.

Overall, higher-order and exponential models have shown impressive in-sample fits; however, the linear model is the most implementable and dependable model in predicting LEPT passers in the elementary level. It tends to provide a good balance between simplicity, predictive stability and realism, which justified its use as a forecasting device in education policy and teacher workforce planning.

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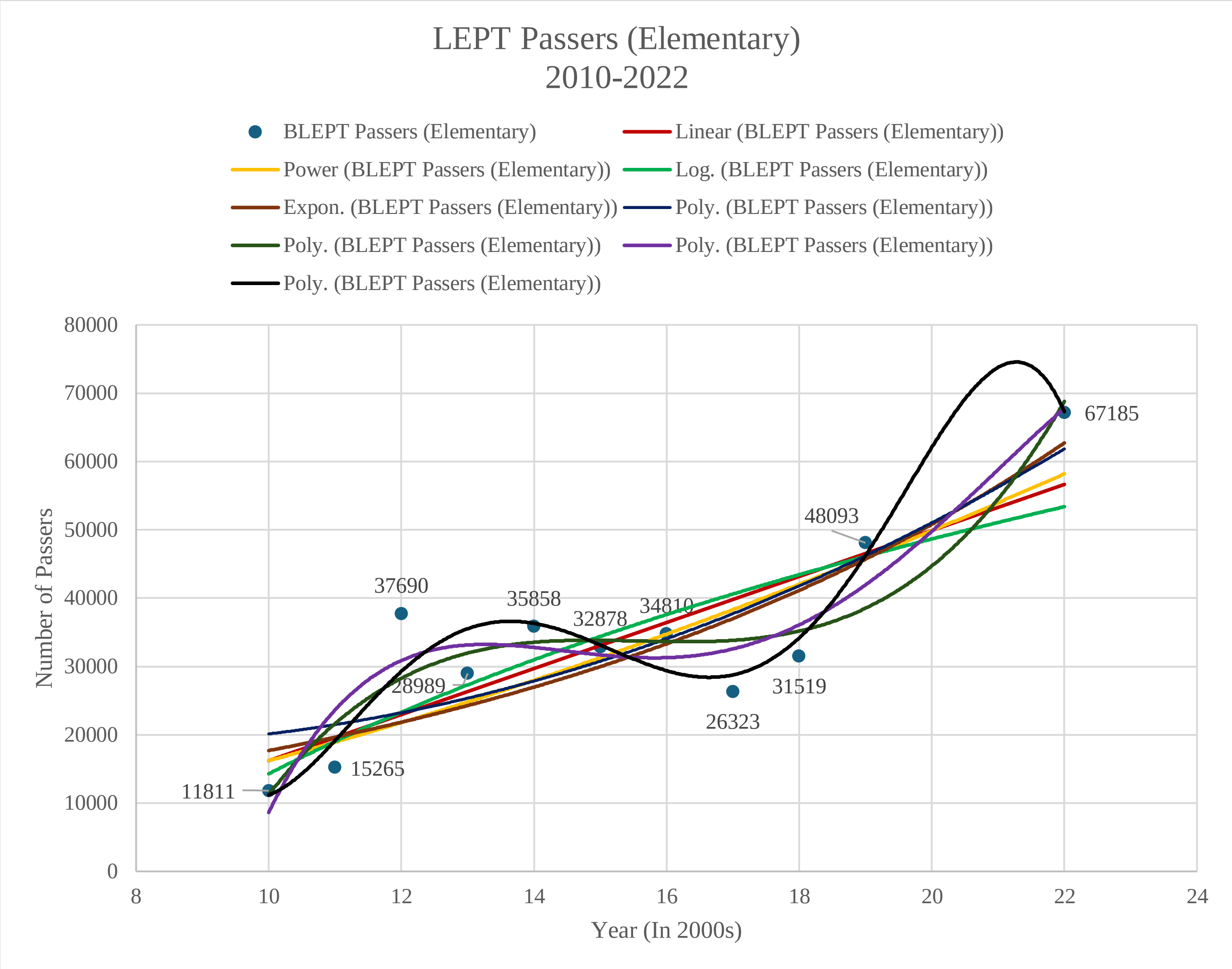
Figure 4. Scatterplot and the Trendline Graphs for the LEPT Passers (Elementary Level)



Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

Figure 4 depicts the LEPT passers for the elementary level along trendlines fitted by exponential, logarithmic, power, and other polynomial regressions. The scatterplot indicates a general upward drift but with some interruptions, perhaps reflecting changes in teacher education supply or exam policy. Even if the first two models (i.e., the quadratic and cubic models) can be considered as acceptable approximations, the introduction of the quartic and quintic trendlines induce a sharp inflection point, at the boundaries, which is not in line with the visual interpretation of the data. Overfitting is also responsible for the high curvature in these higher-degree models, which makes their application in forecasting difficult. This number highlights the necessity of model structures that are both statistically viable and practically plausible. Graphically, to avoid overfitting, the linear function is considered, as it is believed that the LEPT passers are steadily growing as years pass by, except for the years 2020 and 2021, where the LEPT procedures are disrupted due to the COVID-19 pandemic. Moreover, the increasing trend of number of LEPT passers will be anticipated, especially in the current year, specializations for Early Childhood Education and Special Needs Education, are to be released by the Professional Regulation Commission (PRC).

Table 6. Consolidated Mathematical Models for Secondary LEPT Passers Prediction

Type of Model	Equation	SSE	R^2	Parameters
Linear	y = 4464.6x - 33316	131,623,695	0.9529	2

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Exponential	$y = 3391.9e^{0.1444x}$	602,404,438	0.8506	2
Logarithmic	$y = 67221\ln(x) - 146599$	134,094,801	0.952	2
Power	$y = 74.177x^{2.2329}$	291,294,768	0.9159	2
Quadratic	$y = -78.122x^2 + 6921.5x - 51660$	120,509,802	0.9569	3
Cubic	$y = -25.401x^3 + 1144.1x^2 - 12011x + 42492$	108,297,204	0.9613	4
Quartic	$y = -5.733x^4 + 338.78x^3 - 7319.5x^2 + 73203x - 270933$	104,058,568	0.9628	5
Quintic	$y = 1.5861x^5 - 129.98x^4 + 4162.1x^3 - 65062x^2 + 501104x - 2{,}000{,}000$	2,578,569,636,302	0.9634	6

The comparison of regression models for predicting the number of secondary LEPT passers in the Philippines is shown in Table 6. The models examined are linear, exponential, logarithmic, power, quadratic, cubic, quartic, and quintic models. Of these, the quintic model proved to have the highest R^2 (0.9634), narrowly edging the quartic ($R^2 = 0.9628$) and cubic ($R^2 = 0.9613$) models. These high-degree polynomial regressions were good fits to the observed data from SY 2010–2011 to SY 2022–2023, suggesting that the regressions were able to capture complex patterns in the secondary teaching licensure outcomes over time.

While the quartic and quintic models mathematically closely matched historical data (showing high R^2 values), their massive error margins (SSE exceeding 2.5 trillion) render them practically useless for forecasting. This means these complex models suffer from 'overfitting'—they react too severely to past fluctuations. For educational planners relying on these metrics, using these models would lead to highly unstable and unreliable predictions for future licensure trends. (Montgomery, Peck, & Vining, 2012).

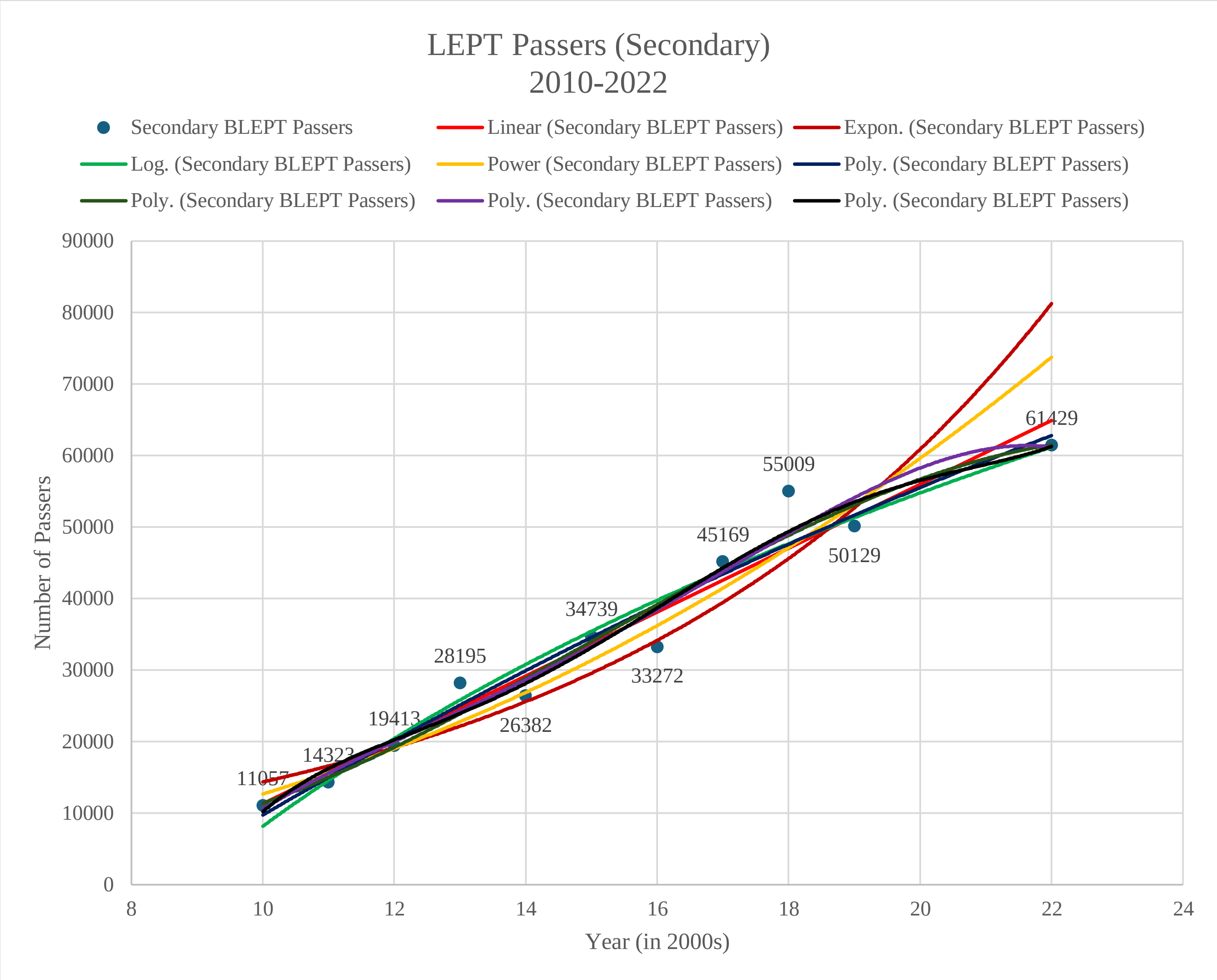
Less complex models, such as the logarithmic ($R^2 = 0.952$; SSE = 134,094,801) and linear ($R^2 = 0.9529$; SSE = 131,623,695) regressions, provide a better compromise between prediction accuracy and model interpretability. Although they have slightly smaller R^2 values, their small SSE and two parameters make them more robust and easier to interpret to non-statisticians such as educational planners and decision-makers.

This model reflects the real-life trends of workforce dynamics with an initial growth in licensure passers which can slow down with time either for resource restrictions, institutional capacity, or demographic exhaustions. Its shape lends itself naturally to these plateauing behaviors, and it is not only statistically appropriate, but also theoretically sound for long-term modeling of teacher supply.

The exponential model, being mathematically simpler, exhibited the poorest fit of all the models ($R^2 = 0.8506$; SSE = 602,404,438), suggesting that it does not portray the underlying trends of LEPT results as well. The power function had a better R^2 (0.9159) than the exponential but poorer than the logarithmic and the polynomial alternatives for accuracy and error functions.

Overall, despite strong R^2 support for the quintic model, it is statistically inferior to other models due to the very high SSE and its complexity, which makes it unsuitable to forecast with in practice. In the tradition of parsimony advocated by Montgomery et al. (2012), the more parsimonious model better attaining the trade-off between fit and interpretability is preferred. Therefore, the logarithmic model appears to be the best extrapolation model for the forecasting of the LEPT passers. It presents a robust and communicable model to depict the small slowdown of teacher licensure trends that exhibits both statistical power and field utility for prospective educational policy determination.

Figure 5. Scatterplot and the Trendline Graphs for the LEPT Passers (Secondary Level)



Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

Figure 5 shows the scatterplot and polynomial fit for LEPT passers in the secondary level. The data depicts much noise or instability compared to elementary levels, pointing to either greater fluctuation in pass rates or underlying drivers of licensure success. While the undulating pattern is reflected in the equations of all polynomial models, the cubic model appears to be a tradeoff between flexibility and stability. The quartic and quintic models, although otherwise a close fit to the data, show unpredictable behavior at extremes. The danger of overfitting may be further exposed especially with a thin underpinning of the theoretical basis. Hence, the logarithmic model shows an understandable fitting of the data without overly fitting future predictions and allows reasonable leverage for growth and decay as the model reaches its upper limit. Generally, Figure 5 affirms the finding that elementary versus secondary teacher data in terms of LEPT may require different modeling.

Number of Public-School Teachers Prediction by Factoring in Number of LEPT Passers

Table 7. Consolidated Mathematical Models for Number of Elementary Public-School Teachers Prediction by Factoring in Number of LEPT Passers

Type of Model	Equation	SSE	R^2	Parameters
Linear	y = 2.6532x + 345016	12,632,755,149	0.5564	2

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Exponential	$y = 351121e^{0.000006x}$	13,119,163,782	0.5428	2
Logarithmic	$y = 83852\ln(x) - 431602$	12,100,704,401	0.5751	2
Power	$y = 56750x^{0.1964}$	12,073,976,066	0.5789	2
Quadratic	$y = -0.00002x^2 + 4.3695x + 316755$	12,318,537,814	0.5726	3
Cubic	$y = 0.000000002x^3 - 0.0002x^2 + 11.526x + 252302$	85,228,720,264	0.5868	4
Quartic	$y = -0.0000000000004x^4 + 0.00000006x^3 - 0.0033x^2 + 75.43x - 183278$	269,102,984,740	0.6421	5
Quintic	$y = -0.00000000000000006x^5 + 0.00000000001x^4 - 0.0000007x^3 + 0.0211x^2 - 280.48x + 2,000,000$	174,140,136,155,098	0.7795	6

To determine the model with the best fit for predicting the number of elementary public-school teachers based on elementary LEPT passers as presented in Table 7. For application to policy making, each of the mathematical functions were evaluated using R^2, SSE, and model parsimony.

The moderate R^2 (0.5564) and SSE (12563000000) of linear model with only two parameters is observed. Although the model is simple and interpretable, the constant growth assumption is an oversimplification of the dynamic, nonlinear relationship between LEPT passers and teacher hiring. While it does offer a benchmark, the low information content renders it unsuitable for informed long-term prediction. The exponential model provides an R^2 of 0.5428 and an SSE of 13.12 billion with two parameters. This model relies on compound growth in teacher numbers, which might be difficult to achieve under institutional impediments to teacher deployment. Its slight reduction in R^2 and increase in SSE relative to the linear model indicate a slightly poorer fit to the data, with little operational advantage.

In the case of the logarithmic model the fit is improved with an R^2 of 0.5751 and SSE of 12.10 billion. This model assumes decreasing marginal gains of teachers as LEPT passers expand, which may indicate saturation in recruitment. Although this model makes conceptual sense, its performance is marginal and only marginally better than linear and exponential and is therefore of limited practical value. The power model is remarkable for highest R^2 (0.5789) and lowest SSE (12.07 billion) among all two-parameter models. It is also sufficiently flexible to describe non-linear growth with undue complexity, in the sense that much more of the variability in the relationship is modeled. Its statistical properties and interpretability offer the most robustness among the simpler models and are suitable for the applied forecasting and decision-making purpose.

The inclusion of a quadratic term adds a third parameter and improves the R^2 to 0.5726 at the expense of the SSE now being 12.32 billion. A negative coefficient of the quadratic term indicates decreasing number of teachers at higher level of LEPT passer, a somewhat unrealistic implication that reduces its policy parsimony, even as the fit slightly improves.

The cubic model leads to a higher R^2 of 0.5868, but the SSE increases to 85.23 billion, with four parameters. Although it explains more variance the large increase of error in prediction is evidence for overfitting and instability of the model which do not allow the reliable forecast. The quartic model also follows, with a lower R^2 of 0.6421 but a greater SSE of 269.10 billion and five parameters. Although its fit looks good on the surface, the model appears more likely to represent noise rather than signal, with a high likelihood of overfitting and lack of generalizability in terms of policymaking implications.

The least R^2 are obtained by the quadratic (a high SSE of 123.61 trillion) and linear functions (a high SSE of 168.29 trillion) and the highest R^2 is obtained by the quintic curve, but with over-fitting (a much higher model complexity, with 6 parameters) and a high SSE of 174.14 trillion. The excessive fit to the training data is clearly rejected for these scenarios in favor of a large complexity and unsteady behavior of predictions, which is unacceptable for long-term planning and policy decisions.

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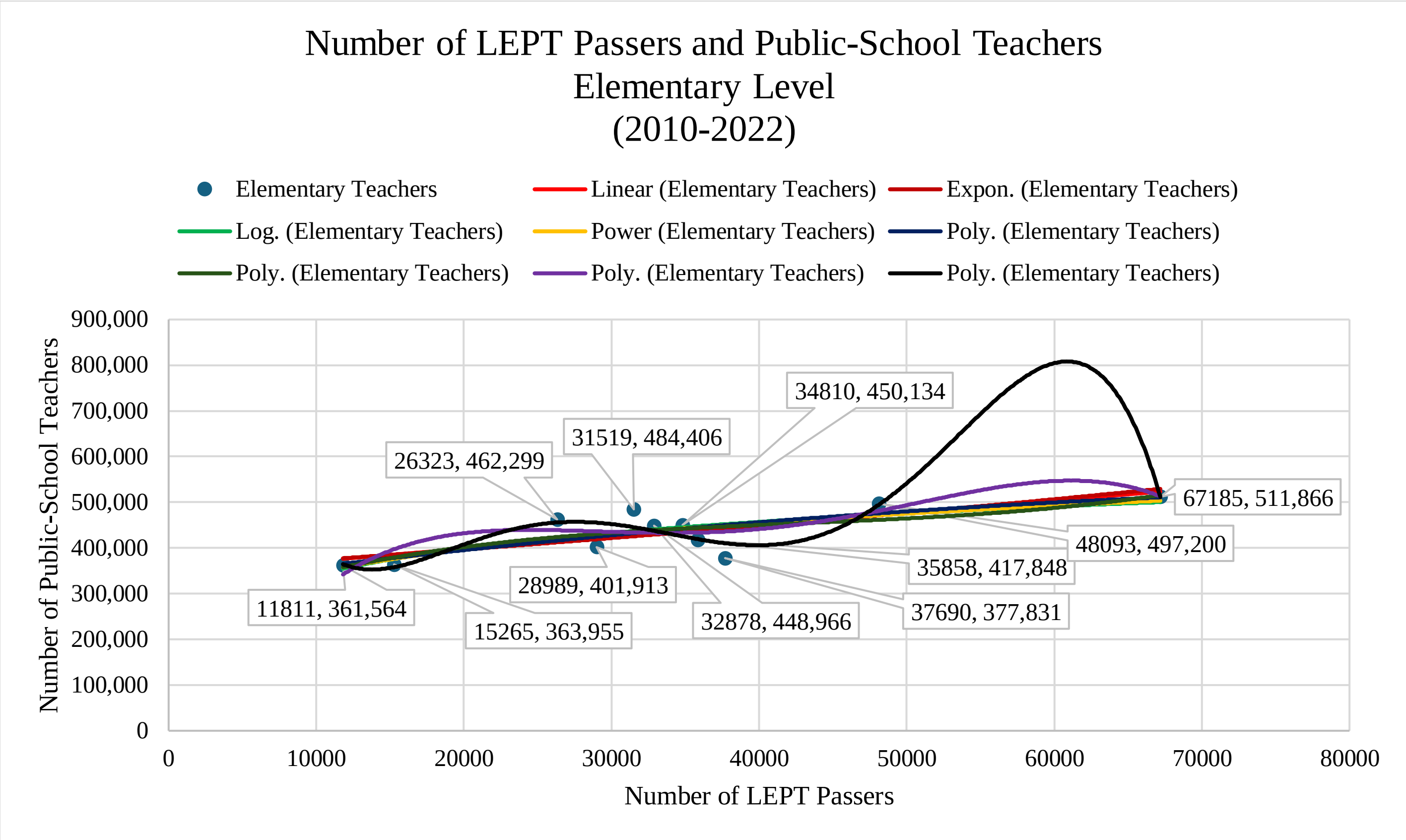
In conclusion, the power model is the best predictive model relatively to the tested alternatives. It gives the best trade-off between precision and simplicity as reflected by its R^2 and SSE of all the parsimonious models. Unlike higher order polynomial models which tend to overfit and are unstable, the power model is a robust, understandable, and scalable basis for teacher workforce policy development.

Figure 6. Scatterplot and the Trendline Graphs for the LEPT Passers as Predictors for Number of Public-School Teachers (Elementary Level)



Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

Figure 6 shows scatterplots and trendlines of the LEPT passers (elementary level) with respect to the number of public-school teachers. The plot suggests that the data have a positive nonlinear type of relationship, hence, the use of polynomial regression is merited. The quadratic and the cubic models can represent this relationship, but the possibility of oscillation does not work well. The quartic and the quintic system, on the other hand, have significant curvature, particularly towards the high end of the data, this may fail to be materialized in the real-world context by the system. Although the quintic model seems to fit the actual data, the inflection points appear to represent overfitting. Generally, to avoid overfitting, the best choice among the models was the power model, which signifies a proportional increase in the number of public-school teachers dependent to the number of LEPT passers. This graph stresses the necessity of adopting models which match with both theoretical expectations and data behavior.

Table 8. Consolidated Mathematical Models for Number of Secondary Public-School Teachers Prediction by Factoring in Number of LEPT Passers

Type of Model	Equation	SSE	R^2	Parameters
Linear	$y = 2.89x + 123254$	1,915,385,883	0.9242	2
Exponential	$y = 135875e^{0.00001x}$	13,824,818,895	0.8812	2

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Logarithmic	$y = 88310\ln(x) - 688591$	1,120,982,930	0.9556	2
Power	$y = 2690.3x^{0.4255}$	1,108,227,903	0.9563	2
Quadratic	$y = -0.00004x^2 + 5.7991x + 81376$	993,565,354	0.961	3
Cubic	$y = 0.0000000005x^3 - 0.00009x^2 + 7.4977x + 66552$	1,667,803,821	0.962	4
Quartic	$y = 0.0000000000001x^4 - 0.00000002x^3 + 0.0008x^2 - 10.13x + 182201$	1,632,299,101,480	0.9705	5
Quintic	$y = -0.000000000000000004x^5 + 0.0000000000009x^4 - 0.00000007x^3 + 0.0024x^2 - 33.71x + 303166$	14,596,743,087	0.9723	6

To select the best model that could be used to forecast the number of elementary public-school teachers from the LEPT passers, several mathematical models as gleaned upon in Table 8 were compared by their R^2, SSE, and number of parameters and relating it to simplicity and policy implication.

The linear model has a high R^2 value of 0.9242 and a smaller SSE of 1.92 billion, and it constitutes of only two parameters. It is simple and has a high explanation power so that, we consider it a strong baseline-model. Although it is not able to depict nonlinear trends, due to being overly simplified, the model has clarity and robustness that make it a viable method for simple extrapolations and rapid policy communication.

On the other hand, the exponential model, with two parameters, has a lower R^2 (0.8812), a larger SSE (13.82 billion). While conceptually applicable to systemic expansion processes, the significantly lower model fitness and degree of error involved highlight its lack of empirical correspondence with the structure of the LEPT passers–teacher relationship, thereby diminishing its practical utility.

The log version of the model provides a much better fit with R^2 of 0.9556, and reduces the SSE to 1.12 billion, at only two parameters. It encapsulates the declining increment in teacher quantities as LEPT passers accumulate, which is reflective of the real-world limitations of recruitment saturation. Among the three models, its interpretability, small error and fit-quality make it quite an attractive for data-driven planning.

The table exhibits the power function as having an R^2 of 0.9563 and smallest SSE of the two-parameter models, measuring 1.11 billion. This implies a robust non-linear relationship that is also more flexible than the linear model without overfitting. Its trade-off between model strength and model simplicity colors its usefulness for policy as well as operational forecasting.

Considering the quadratic model, another factor was added for R^2= 0.961, and SSE= 993.57 million. Its parabolic form is flexible to capture slowdown in the deployment of teachers, potentially as systems mature. Nonetheless, the negative leading coefficient indicates a concave down curve, which would mean that eventually teacher numbers would decrease while LEPT passers increase — a rather counterintuitive, paradoxical conclusion. Despite its good statistical fit, interpretive difficulties such as these might present barriers to its adoption in policy settings.

The cubic results in a slight increase in the R^2 (0.962) at the expense of a sharp increase in SSE (1.67 billion with 4 parameters). This explained more variation while being more wrong – adding noise and reducing generalizability. Whilst capturing some of this nuance, the model's increased complexity is not justified by an equivalent improvement in accuracy.

The quintic model, five parameters, gives R^2 = 0.9705, but an extreme SSE = 1.63 trillion – oh, so much higher than all the other model fits. With low RMSE but high R^2, this large jump in error indicates numerical

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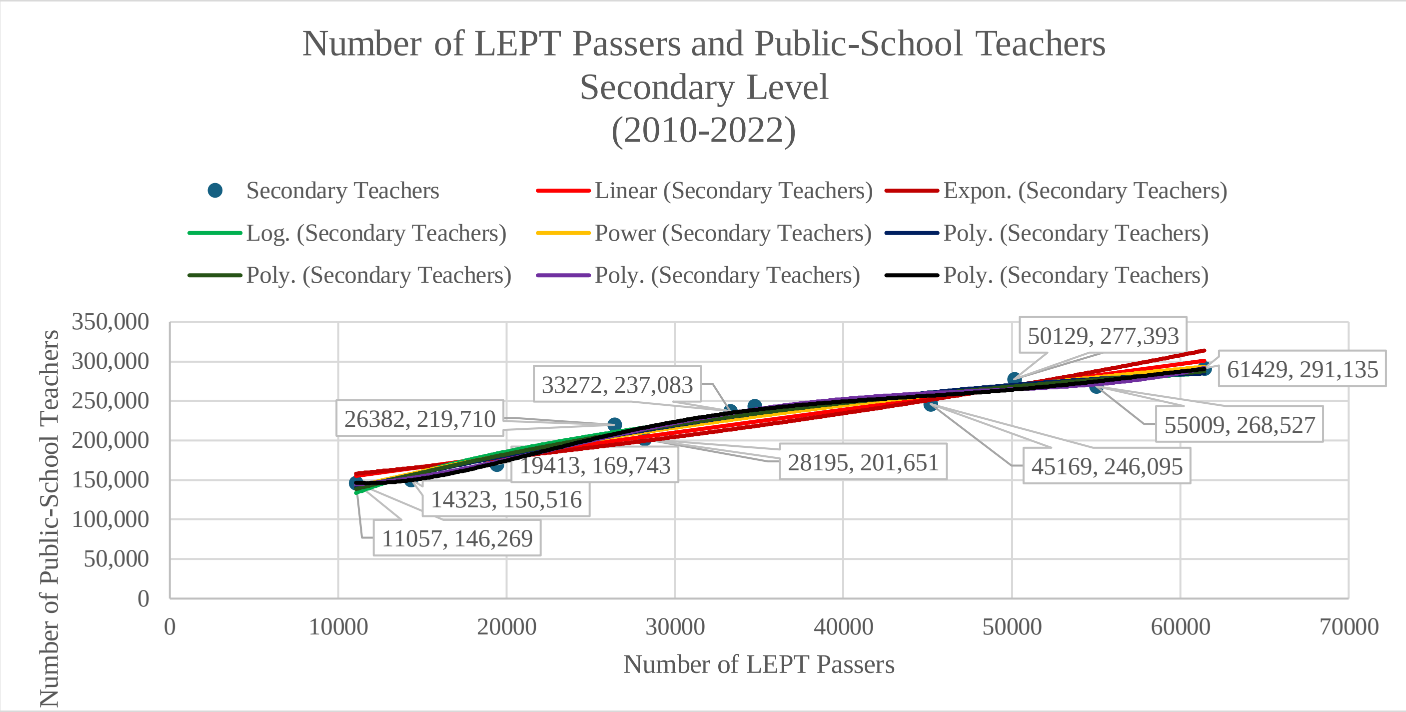
instability and strong overfitting, which makes it unsuitable to making useful predictions or policy recommendations.

The fifth-degree model has the largest $R^2 = 0.9723$, but the SSE = 14.60 billion, is largest and it also has the highest model complexity with 6 parameters. Even though it may fit the training data very well, its inferior error performance and risk of overfitting, in comparison to other more reasonable model techniques in general, render it a less suitable tool for well informed and sound policy decisions.

Finally, the power model also appears to better fit the purpose needed for policy. It has one of the lowest SSE of all models, the highest R^2 and only two parameters, therefore it is the best trade-off between simplicity and prediction power. It sidesteps misleading structural implications and maintains interpretive clarity, making it a reliable tool for predicting teacher workforce needs in response to LEPT outputs.

Figure 7. Scatterplot and the Trendline Graphs for the LEPT Passers as Predictors for Number of Public-School Teachers (Secondary Level)



Remark: Dark Blue for Quadratic, Dark Green for Cubic, Violet for Quartic, Black for Quintic

Results for secondary LEPT passers as predictors of number of public-school teachers are presented in Figure 7. Data points appear to be moving away from each other, indicating an upward trend to the exhibited data set. The polynomial trendlines demonstrate that the higher-order model test is prone to introducing excessive fitting that the distribution of the data does not justify the actual observations. Cubic model emerges as a better fit, resulting in a smooth and responsive curve with relatively little bending away from the data. This influence is significant as, although LEPT passers are a good predictor of teacher population, an attempt to rely on overly complex models may degrade forecasting accuracy and obfuscate understanding necessary for policy purposes. However, upon gleaning upon the mathematical model for a cubic function, it does not seem to be comprehensible with the other models. Hence, the most appropriate model to use in this context is the power model where it also shows close approximation to the actual observations and allow consideration of a proportional relationship with the two variables.

DISCUSSIONS

In this section, the best models for each specific context were refined and are given further simplicity to communicate results better to the policymakers and stakeholders.

Number of Predicted Public-School Teachers

From the yielded mathematical models in the Trendlines Function of Excel, the logarithmic model was the best fit for the actual data, considering also its simplicity, and more direct impacts to the real-world setting. The logarithmic model **y = 220,031ln(x) – 157,783** only contains two integral parameters which made it simple and more realistic to the model, as it can produce realistic results. In addition, a similarly constructed logarithmic model of **y = 201,951ln(x) – 321,317** was developed for predicting the number of secondary public-school teachers. The modeler did not reduce the models into other forms to reflect a more direct approach in determining the prediction of number of public-school teachers, reducing the utilization of decimal numbers, which are deemed irrelevant in the process.

Note that in these models, x refers to the year within the 2000s, where the last two digits of the year are accounted for. Moreover, to simplify the understanding of the data, the number of elementary public-school teachers identified during the Beginning of the School Year (BOSY) was reflected in the data analysis.

To simplify the following model for stakeholders, Table 9 reveals the prediction, in the nearest thousand, of the number of elementary and secondary public-school teachers in the next ten years.

Table 9. Predicted Number of Elementary Public-School Teachers in the Next 10 Years (Nearest Thousand)

School Year	Predicted Number of Elementary Public-School Teachers	Predicted Number of Secondary Public-School Teachers
2025-2026	550,000	329,000
2026-2027	559,000	337,000
2027-2028	567,000	344,000
2028-2029	575,000	352,000
2029-2030	583,000	359,000
2030-2031	591,000	366,000
2031-2032	598,000	372,000
2032-2033	605,000	379,000
2033-2034	612,000	385,000
2034-2035	618,000	391,000
2035-2036	625,000	397,000

Number of Predicted Elementary and Secondary LEPT Passers

The linear model for predicting the number of LEPT passers determined at the elementary level and the logarithmic model determined at the secondary level were established based on empirical comparative evaluation of models' performance according to R^2, SSE, and parsimony in the number of parameters. For elementary LEPT passers, the considered linear model $y = 3369.7x - 17483$ was determined as the most adequate, which balances parsimony and predictive realism. This trend is consistent with continued systemic efforts to improve teacher education and licensure at the national level, however, on a slow and carefully paced movement. Due to its simple 2-parameter form, the model is interpretable and readily used by decision-makers without losing its prediction power. The rounding of the coefficients used in the model increases the communication potential of the model and the model's ability for long-term forecast and planning for the education sector. Hence, the model is rewritten as **y = 3370x – 17483** to retain integral values in the model. By doing so, the coefficient of determination slightly decreased from 921,249,926.05 to 921,181,984.00 making it more credible than the original version of the model.

Conversely, the logarithmic model for predicting secondary LEPT passers was the equation **y = 67221ln(x) – 146599** as it was selected based on its parsimony and applicability to growth within the given range of time frame. The two-parameter model is interpretable and computationally efficient and can be used for administrative planning when a high level of statistical knowledge is not necessitated. It was appropriate to model with integer coefficients (i.e. no decimals) so that this can be easily transformed in a more understood context and application, especially when the data is discrete.

The models were developed to aid the stakeholders in understanding and contextualizing the current LEPT situation, but they may apply this to model future LEPT passer in the next years. As with the public-school teacher forecasting models, the projections are presented which are rounded to the nearest thousand with an accompanying tabular description for the reader’s convenience. It allows educational planners and policymakers to implement the models directly for strategic workforce planning and teacher allocation without the need for technical model construction.

Like the previous models, x refers to the year within the 2000s, where the last two digits of the year are accounted for. The total number of LEPT passers for the entire year is considered, which combines the trajectory for the two LEPT executions held every March and September of the year. To simplify the following model for stakeholders, Table 10 reveals the prediction, in the nearest thousand, of the number of elementary and secondary LEPT passers in the next ten years.

Table 10. Predicted Number of LEPT Passers in the Next 10 Years (Nearest Thousand)

Year	Predicted Number of Elementary LEPT Passers	Predicted Number of Secondary LEPT Passers
2025	67,000	70,000
2026	70,000	72,000
2027	74,000	75,000
2028	77,000	77,000
2029	80,000	80,000
2030	84,000	82,000
2031	87,000	84,000
2032	90,000	86,000
2033	94,000	88,000
2034	97,000	90,000
2035	100,000	92,000

Predicted Number of Public School Teachers Given the Number of LEPT Passers

Based on the fitted mathematical models from the Trendline Function in Excel, the power function resulted as the best curve to estimate the number of public-school teachers with the use of the number of LEPT passers. These two models showed mathematical adequacy, practical applicability, simplicity, parsimony and realistic

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predictor outputs. When the elementary level is concerned, the power model $y = 56750x^{0.1964}$ was obtained, showing slight upward alignment between number of examinees and teachers and LEPT passers. The power model for prediction of secondary level teachers was $y = 2690.3x^{0.4255}$ which implies a weaker increase in the number of secondary public-school teachers from higher LEPT passers. Each model includes only two parameters, and operate with rounded coefficients, making them user friendly and straightforward to interpret for education professionals and policymakers.

The power functions imply that the relationship between the number of power of teachers hired is more complex than just a linear increase and addresses the fact that growth in teacher hirings may not strictly follow that of the LEPT passer counts. Such models assist in depicting how the marginal return to additional trainee output continues to decrease as LEPT passers continue growing and such is a realistic phenomenon based on resource limitations and industry's absorptive capability. Critically, these models were reduced into the fewest decimal places, whenever possible, which may lead to an easier understanding of the model. Hence, the model for predicting elementary public-school teachers can be rewritten as $\mathbf{y = 56750x^{0.2}}$ while the model for predicting secondary public-school teachers can be rewritten as $\mathbf{y = 2690x^{0.43}}$**.**

In these models, *x* is the number of LEPT passers in a year and *y* is the predicted number of public-school teachers. To maintain consistency and continuity, teacher-level model input was based on yearly data so that the model was in coordination with empirical data. To help decision-makers map these functions on to practical planning tools, the projection for the possible number of public-school elementary and secondary teachers is carefully considered within the context of the variables of this paper. In doing so, these sophisticated and simplified models provide education leaders with statistically fit methods that not only offer robust predictions but are also consistent with the practical constraints of the world and the needs of policy decision making. Table 11 reveals a consolidated and simplified results of these models, factoring in the year, number of LEPT passers, and number of public-school teachers in a single representation. Note that in the construction of Table 11, the following models were applied for seamless understanding.

Description	**Model**	**Condition**
Number of LEPT Passers (Elementary)	$y = 3370x – 17483$	where x is the year in 2000s
Number of LEPT Passers (Secondary)	$y = 67221\ln(x) - 146599$	where x is the year in 2000s
Number of Public-School Teachers (Elementary)	$y = 56750x^{0.2}$	where x is the number of LEPT Passers
Number of Public-School Teachers (Secondary)	$y = 2690x^{0.43}$	where x is the number of LEPT Passers

Table 11. Summary of Predictions for LEPT Passers and Public-School Teachers in the Next 10 Years

School Year	**25-26**		**26-27**		**27-28**		**28-29**		**29-30**		**30-31**		**31-32**		**32-33**		**33-34**		**34-35**	
Level	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**	**ELEM**	**SEC**
Number of LEPT Pass	66,767	69,777	70,137	72,414	73,507	74,950	76,877	77,395	80,247	79,754	83,617	82,033	86,987	84,237	90,357	86,371	93,727	88,440	97,097	90,446

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Number of Public-School Teachers	523,454	325,498	528,634	330,732	533,619	335,663	538,425	340,329	543,065	344,751	547,551	348,953	551,895	352,954	556,107	356,772	560,194	360,422	564,166	363,915

Legend: ELEM stands for Elementary, SEC stands for Secondary.

CONCLUSIONS

The present research aimed to respond to the problem of shortage of public-school teachers in the Philippines by building predictive models, which link passers of LEPT to the quantity of employed teachers and to forecast the condition of licensure examination results and staffing. Appropriate models were found through different regression establishing for both statistical fit (R^2, SSE), parsimony, and practical interpretability. The linear model was chosen for elementary and logarithmic model for secondary levels by projecting LEPT passers. For the predicting the number of teachers from the LEPT passers, power models were most successful in elementary and secondary level. Additionally, the logarithmic and linear models for primary and secondary teachers, respectively, were selected as the most reliable tools for estimating the actual number of employed public-school teachers across future years. These models provide a sound foundation for educational planning in teacher education courses, policy making and teacher staff allocation. The finalized models are summarized below:

Prediction Context	Final Model	Notes
Public-School Teachers (Elementary) over Time	$y = 220031\ln(x) - 157783$	Logarithmic; x = year (last two digits of 2000s)
Public-School Teachers (Secondary) over Time	$y = 201951\ln(x) - 321317$	Logarithmic; x = year (last two digits of 2000s)
LEPT Passers (Elementary)	$y = 3370x - 17483$	Linear; x = year (last two digits of 2000s)
LEPT Passers (Secondary)	$y = 67221\ln(x) - 146599$	Logarithmic; x = year (last two digits of 2000s)
Public-School Teachers (Elementary) given LEPT Passers	$y = 56750x^{0.2}$	Power model; x = LEPT passers
Public-School Teachers (Secondary) given LEPT Passers	$y = 2690x^{0.43}$	Power model; x = LEPT passers

RECOMMENDATIONS

With the validated prediction models, it is suggested that Department of Education (DepEd), in partnership with the Professional Regulation Commission (PRC) and teacher education institutions, employ the newly developed equations as strategic instruments to forecast teachers demand and synchronize the licensure output with the real demand for hiring. The parametric models of the LEPT passer prediction, which are linear and logarithmic forms, and the power form of the teacher projection, provide theoretically interpretable and empirically sound observations that can aid in evidence-informed planning especially on short- and long-term teacher scarcity which can be validated further through other applications such as the Python. These models need to be incorporated into the national and regional human resource and budgeting systems for the LEPT to have direct consequences on recruitment, deployment and training programs. In addition, such models should be updated on a regular basis with the latest LEPT and staffing data to maintain their timeliness and reflect the changing dynamics of teacher supply and demand. Lastly, other variables such as geographical distribution, specialization in each subject, age distribution and attrition rates can be included in future modeling to make the forecasting tools more sophisticated and location specific.

Limitations

While these models are useful for predicting LEPT passers and teachers in the public-school sector, the models are not without limitation. There are several reasons for the observed differences between the models, the main one being that the models are calibrated using only historical quantitative data, and do not consider qualitative factors such as severe changes in school personnel assignation that could potentially occur due to government hiring restraints, policy decisions on licensure, or the re-allocation of educational funds. Second, the used LEPT data have existing gap for School Year 2020–2021, where no licensure examination was held due to COVID-19 pandemic which may cause structural noise that may affect the fit and the smoothness of the sliding trend lines. Third, the models grow continuously from one year to the next, which might not be the case when socio-political or economic conditions are turbulent. Moreover, the presented models are national and do not disaggregate the predictions by region, subject or grade, which are crucial for the targeted teacher workforce planning. Lastly, only simple models were selected and although it increases the possibility of contributory (non-technical) stakeholders, where accuracy of the predictions would be compromised in a complex (dynamic) educational system. These shortcomings suggest directions for future research including finer scale regional data and multivariate modeling techniques.

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