

Mathematical Modeling of Student Enrollment Trends in Higher Education in Nepal

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Abstract

Rapid enrollment growth in Nepal's higher education sector has outpaced the expansion of institutional capacity, faculty strength, and public investment. This study analyzed historical enrollment trends and compared mathematical models to generate projections for sectoral planning. Secondary data from the University Grants Commission Nepal, the Ministry of Education, Science and Technology, and the Central Bureau of Statistics covered the academic years 2016/17–2025/26. Linear regression, exponential growth, and logistic (Verhulst) growth models were fitted using least-squares estimation and evaluated using the coefficient of determination (R^2). Enrollment increased from approximately 371,000 to 749,392 students, corresponding to a compound annual growth rate of approximately 8.1%. All three models closely fitted the historical observations, with R^2 values of 0.987, 0.984, and 0.987 for the linear, exponential, and logistic models, respectively. The logistic model incorporated finite enrollment capacity, estimating a long-run carrying capacity of approximately 1.57 million students. Under current conditions, it projected approximately 912,000 students by 2030, compared with 888,000 under the linear model and more than one million under the exponential model. Structural analysis identified an increase in management education's enrollment share from 39% in 2015 to 47.1% in 2025 and a gender parity index of 1.3 in 2023/24. Community and private campuses enrolled 62% of students but were not required to report full-time faculty data, constraining assessment of staffing capacity. The findings indicate continued enrollment growth alongside capacity and reporting challenges. The study provides a quantitative basis for capacity-sensitive planning and emphasizes proportionate investment in faculty

recruitment, infrastructure, and quality assurance to support sustainable expansion.

Keywords: Mathematical Modeling; Enrollment Forecasting; Higher Education; Logistic Growth Model; Nepal

INTRODUCTION

Higher education is widely regarded as the principal engine of human capital formation, economic productivity, and social mobility in developing nations. In Nepal, the higher education system has undergone a remarkable structural transformation since the establishment of Tribhuvan University (TU) in 1959, which remained, together with Mahendra Sanskrit University (established in 1986), the only university in the country until the early 1990s. The promulgation of the University Grants Commission Act in 1993 and the subsequent establishment of the University Grants Commission (UGC) as an autonomous statutory body marked a turning point in the governance, regulation, and expansion of tertiary education in Nepal. Since then, the number of universities and academies operating in the country has grown substantially, and as of the 2025/26 academic year, Nepal's higher education landscape comprises 21 universities (15 central and 6 provincial) and 8 health science academies, delivering instruction through 1,608 constituent and affiliated campuses nationwide.

This institutional expansion has been accompanied by an equally striking rise in student enrollment. According to UGC annual reports, total higher education enrollment stood at approximately 407,000 students in the 2015 reporting cycle. A decade later, the Ministry of Education, Science and Technology reported that 749,392 students were enrolled in universities and academies across the country in the 2025/26 fiscal year, representing an increase of 76,903 students, or nearly 10 percent, over the previous fiscal year alone. Over the ten-year period, enrollment therefore very nearly doubled. Such rapid, sustained growth raises pressing questions for planners, policymakers, and institutional administrators: How fast is enrollment actually growing? Is the growth trajectory linear, exponential, or does it show signs of approaching a structural limit? What long-run enrollment level should the system plan for, and is the corresponding institutional capacity being built at a matching pace?

Mathematical modeling offers a rigorous, quantitative framework for answering these questions. Rather than relying solely on descriptive year-on-year percentage changes, growth models such as linear regression, exponential growth functions, and logistic (Verhulst-type) growth functions allow researchers to characterize the underlying dynamics of enrollment growth, test competing hypotheses about the nature of that growth, and generate defensible forecasts that can inform infrastructure planning, faculty recruitment, and budgetary allocation. This study undertakes such an analysis for Nepal, using enrollment data compiled from UGC and MOEST sources over the period 2016/17 to 2025/26.

Recent studies show that mathematical modelling, numerical methods, and machine learning are increasingly used to solve complex problems in different fields. Sah et al. (2024) highlighted the major challenges in Nepal's education system and emphasized the need for effective improvements. Sahani et al. (2023, 2024, 2025) explored how mathematical models and simulations can help understand cultural, educational, and social issues. Later studies by Sahani et al. (2026) extended these approaches by combining machine learning with analytical models for risk management and decision-making. Overall, the literature suggests that integrating mathematics and artificial intelligence can support better prediction, planning, and solutions for complex real-world challenges.

Despite the availability of annual statistical reports from the University Grants Commission, mathematical and quantitative modeling of Nepal's higher education enrollment trends remains scarce in the published literature. Most existing studies of Nepal's higher education sector are descriptive in nature, reporting year-wise enrollment figures, gender ratios, and pass rates without applying formal growth models or providing statistically grounded forecasts. At the same time, evidence from recent UGC and journalistic analyses indicates a widening gap between the rate of student enrollment growth and the rate of growth in teaching faculty and public investment: between 2016/17 and 2023/24, overall higher education enrollment increased by around 71 percent, while the number of full-time teachers in constituent campuses increased by less than 30 percent over the same period. Without a rigorous mathematical characterization of the enrollment growth curve, it is difficult for planners to anticipate whether current trends are sustainable, whether growth is beginning to saturate, or what enrollment level the system should be sized for in the next five to ten years. This study addresses that gap by constructing and comparing linear, exponential, and logistic mathematical models of Nepal's higher education enrollment trend.

Objectives of the Study

The general objective of this study is to mathematically model and forecast student enrollment trends in Nepal's higher education system. The specific objectives are as follows:

- (i) To compile and analyze secondary time-series data on higher education enrollment in Nepal published by the University Grants Commission and the Ministry of Education, Science and Technology.
- (ii) To develop and fit linear, exponential, and logistic mathematical growth models to the compiled enrollment data using the method of least squares.
- (iii) To evaluate and compare the goodness of fit of the three models using the coefficient of determination (R^2) and to identify the most appropriate model for describing Nepal's enrollment trajectory.
- (iv) To forecast student enrollment in Nepal's higher education institutions for the period 2027 to 2030 using the fitted models.
- (v) To examine structural dimensions of enrollment growth, including institutional expansion, gender parity, discipline-wise distribution, and the student-to-faculty ratio, and to discuss their implications for higher education planning in Nepal.

This study contributes to the limited body of quantitative research on Nepal's higher education sector in several ways. First, it provides one of the few mathematically grounded forecasts of enrollment in Nepal's higher education system, offering planners at the UGC, MOEST, and individual universities an evidence base for capacity planning. Second, by comparing three distinct classes of growth models, the study offers methodological guidance on which mathematical framework best captures the dynamics of enrollment growth in a developing-country context characterized by demographic transition, expanding access, and resource constraints. Third, the study situates the mathematical analysis within the broader structural context of Nepal's higher education system, connecting the numerical forecast to substantive policy issues such as faculty shortages, discipline-wise imbalances, and gender disparities. Finally, the study is intended to serve as a reference for students, researchers, and policy analysts interested in applying mathematical and statistical modeling techniques to educational planning problems in Nepal and other developing countries.

This study relies entirely on secondary data compiled from published UGC, MOEST, and CBS reports; no primary survey or institutional-level microdata was collected. Enrollment figures reported by different UGC annual reports and by news outlets summarizing UGC data occasionally show minor inconsistencies attributable to differences in reporting cycles (Nepali fiscal year versus academic year), revisions between preliminary and final figures, and changes in the set of institutions covered as new universities and academies were established. Where such inconsistencies were identified, the most recent and authoritative figure was used, and the discrepancy is noted explicitly in the relevant section. The mathematical models developed in this study are extrapolative and assume that the structural conditions driving enrollment growth (demographic trends, government policy, and institutional capacity) remain broadly stable; unforeseen shocks such as major policy reform, large-scale student migration abroad, or macroeconomic disruption could cause actual enrollment to deviate from the forecasts presented here.

Literature Review

Theoretical Perspectives on Higher Education Expansion

The transition of higher education systems from serving a small elite to serving a mass, and eventually universal, share of the relevant age cohort was classically described by Trow (1974), who proposed that systems enrolling less than 15 percent of the age cohort are “elite” systems, those enrolling between 15 and 50 percent are “mass” systems, and those exceeding 50 percent are “universal” systems. Nepal's current Gross Enrollment Ratio (GER) in higher education stands at approximately 22 percent according to the 2023/24 UGC Education Management Information System (EMIS) report, placing the country firmly within Trow's “mass” category and suggesting substantial further room for numerical expansion before the system approaches saturation of the eligible age cohort. Regmi (2019) situates Nepal's post-1990 higher education expansion within a broader critique of neoliberal instrumentalism, arguing that the rapid proliferation of private and community campuses has been driven as much by market demand for credentials as by centrally planned expansion of public higher education capacity, a dynamic that helps explain why 62 percent of Nepal's current higher education enrollment is concentrated in community and private affiliated campuses rather than public constituent campuses.

Mathematical and Statistical Approaches to Enrollment Modeling

A substantial international literature has applied regression-based and probabilistic models to enrollment prediction, although this literature is concentrated mainly on individual-level admissions and matriculation prediction rather than system-level aggregate forecasting. Logistic regression, in particular, has been widely used to predict whether an individual admitted student will enroll at a given institution; DesJardins and colleagues' methodology for enrollment management, later adapted and tested at institutions such as the University of Michigan Medical School, demonstrated that logistic regression models could accurately predict matriculation decisions using applicant demographic and academic variables. More recent work compiled by the American Association of Collegiate Registrars and Admissions Officers (AACRAO) has compared logistic regression against machine learning techniques such as Ridge regression, Elastic Net, and Random Forests for enrollment-yield prediction, generally finding that regression-based approaches remain competitive with more complex algorithms while offering greater interpretability for institutional planners. While these studies operate at the level of individual student choice, the underlying mathematical machinery, particularly the logistic function, is directly analogous to the aggregate, system-level logistic growth model applied in the present study, in which the “probability of enrollment” of an individual is replaced by the “saturation fraction” of a growing population approaching a carrying capacity.

At the aggregate, population level, growth modeling has a long mathematical pedigree. Malthus (1798) proposed that populations, in the absence of constraint, grow geometrically (exponentially) over time, a proposition later formalized as the exponential growth model $dN/dt = rN$, where N is population size, t is time, and r is the intrinsic growth rate. Verhulst (1838) refined this model by introducing a finite carrying capacity K , yielding the logistic growth equation $dN/dt = rN(1 - N/K)$, whose solution is the well-known S-shaped (sigmoid) logistic curve. Although originally developed for biological populations, the logistic growth model has since been applied extensively to the diffusion of technologies, products, and social phenomena, including the growth of educational systems, because enrollment growth in any country is ultimately bounded by the size of the eligible age cohort, the physical and human resource capacity of institutions, and the level of public and private investment available to the sector. The present study draws on this classical mathematical tradition, alongside standard econometric regression methodology as presented in texts such

as Gujarati and Porter (2009) and Montgomery, Peck, and Vining (2012), to construct linear, exponential, and logistic models of Nepal's enrollment trend.

Empirical Studies on Higher Education Enrollment Trends in Nepal

Empirical, Nepal-specific research on enrollment trends remains limited but growing. A comprehensive descriptive analysis published in the CDC Journal examined enrollment and graduation trends in Nepal's tertiary education sector from 2010/11 to 2021/22, drawing on UGC annual reports and Statistical Year Book data, and documented year-wise enrollment and graduation figures across faculties and universities, noting that Tribhuvan University alone accounts for approximately 80 percent of tertiary enrollment in most years. That study reported enrollment figures reaching as high as approximately 604,000 students within the 2010/11-2021/22 window and highlighted a growing share of female participation, with Tribhuvan University's female enrollment reaching 54.66 percent in fiscal year 2078/79 (2021/22), while other universities such as Far Western University reported female enrollment shares as high as 61.65 percent, and Nepal Open University reported the lowest female share at 11.34 percent.

More recent reporting drawing on the UGC's 2023/24 EMIS report and the government's Economic Survey documents a continuing acceleration of enrollment: total higher education enrollment rose from 579,448 students in 2021/22 to 633,053 in 2023/24, 672,489 in 2024/25, and 749,392 in 2025/26. A Kathmandu Post opinion analysis (2026) juxtaposed this enrollment growth against the much slower growth of full-time teaching faculty in constituent campuses, from 9,299 in 2016/17 to 12,082 in 2023/24 (an increase of less than 30 percent against a 71 percent increase in enrollment over the same period), and against the growth of public funding for higher education, from NPR 9.3 billion in 2017/18 to NPR 17.5 billion in 2023/24, funding that has been directed disproportionately toward infrastructure and block grants rather than full-time faculty recruitment. This body of literature establishes the descriptive foundation upon which the present study's mathematical modeling is built, while highlighting the absence, prior to this study, of a formal comparative mathematical treatment of Nepal's aggregate enrollment growth curve.

Demographic Context: Nepal's Youth Population

The demand-side driver of higher education enrollment growth in Nepal is closely linked to the country's demographic structure. According to the 2021 National Population and Housing Census conducted by the Central Bureau of Statistics, Nepal's total population

stood at 29,164,578, with 61.96 percent of the population falling within the 15-59 age group, up from 56.96 percent in the 2011 census. UNFPA Nepal's demographic analysis of the 2021 census further indicates that the youth population aged 16 to 40 years, as defined under Nepal's National Youth Policy 2072 (2015), reached 12,398,017, or 42.5 percent of the total population, while the narrower 16-25 age cohort most directly relevant to higher education enrollment constitutes approximately 20.8 percent of the national population. This demographic profile, often characterized as a “youth bulge” or early-stage “demographic dividend,” provides the underlying population base against which the mathematical carrying capacity of Nepal's higher education system, estimated later in this study, should be interpreted.

Research Gap

The literature reviewed above establishes three things clearly: first, that Nepal's higher education enrollment has grown rapidly and consistently over the past decade; second, that this growth has outpaced the growth of teaching faculty and, in per-student terms, public investment; and third, that the demographic base of potential entrants remains large relative to current enrollment. What is missing from the existing literature is a formal, comparative mathematical treatment that fits alternative growth models to the available time-series data, evaluates their statistical fit, and derives quantitative forecasts and an estimated carrying capacity for the system. This study is designed to fill that specific gap.

METHODOLOGY

Research Design

This study adopts a quantitative, analytical research design based entirely on secondary time-series data. The approach follows three sequential stages: (a) compilation of a consistent enrollment time series from official Nepali sources; (b) mathematical model fitting using least-squares estimation; and (c) model evaluation, comparison, and forecasting. This design is appropriate for the study's objective of characterizing and projecting an aggregate national trend, as opposed to explaining individual-level enrollment decisions, which would require primary survey data.

Data Sources

Enrollment data were compiled from the following official and peer-reviewed sources: the University Grants Commission (UGC) Nepal Operations Manual and Education Management Information System (EMIS) reports for the academic years 2021/22 and 2023/24; the Kathmandu Post's analysis of UGC EMIS figures for 2023/24 and government Economic Survey data for 2024/25 and 2025/26; UGC's 2015 Annual Report as cited in subsequent secondary analysis; and the peer-reviewed CDC Journal article “A Comprehensive Analysis of Students' Enrollment Trends in Tertiary Education” (2023), which itself draws on UGC annual reports and the Statistical Year Book of Nepal. Demographic data were obtained from the Central Bureau of Statistics' 2021 National Population and Housing Census and UNFPA Nepal's demographic factsheets. All figures used are publicly available and are cited in the reference list.

Construction of the Enrollment Time Series

Because Nepal's higher education statistics are published on differing cycles (academic year versus government fiscal year) by different agencies, a single, internally consistent time series was constructed for the purpose of model fitting by selecting five data points for which enrollment figures were unambiguously reported by MOEST, UGC, or corroborating secondary sources for the most recent and complete decade of data: academic year 2016/17 (371,000 students), 2021/22 (579,448 students), 2023/24 (633,053 students), 2024/25 (672,489 students), and 2025/26 (749,392 students). Earlier UGC figures (for example, the approximately 407,000 students reported for the 2015 cycle) were examined but excluded from the regression time series because of a reporting-cycle inconsistency noted in Section 1.5; they are nonetheless referenced descriptively in Section 4 to illustrate the longer-run trend. For model-fitting purposes, each academic year was converted to a numeric time index t , measured in years since 2017 (i.e., $t = 0$ for 2016/17, $t = 5$ for 2021/22, $t = 7$ for 2023/24, $t = 8$ for 2024/25, and $t = 9$ for 2025/26).

Mathematical Models Employed

Linear Regression Model

The linear model assumes that enrollment $N(t)$ grows by a constant absolute number of students per year and takes the form:

$$N(t) = a + b \cdot t$$

where a is the intercept (fitted enrollment at $t = 0$) and b is the slope, representing the average annual absolute increase in enrollment. Parameters were estimated by ordinary least squares (OLS), minimizing the sum of squared residuals $\sum(N_i - (a + b \cdot t_i))^2$.

Exponential Growth Model

The exponential (Malthusian) model assumes a constant proportional (percentage) growth rate and takes the form:

$$N(t) = A \cdot e^{rt}$$

where A is the fitted enrollment at $t = 0$ and r is the continuous instantaneous growth rate. This model was linearized by taking the natural logarithm, $\ln N(t) = \ln A + r \cdot t$, and estimated using OLS on the log-transformed data, following the classical approach of Malthus (1798).

Logistic (Verhulst) Growth Model

The logistic model, following Verhulst (1838), assumes that growth is initially near-exponential but decelerates as enrollment approaches a finite carrying capacity K , reflecting constraints such as the size of the eligible youth population, physical campus capacity, and available faculty and public financing. The model takes the form:

$$N(t) = K / (1 + e^{-r(t - t_0)})$$

where K is the carrying capacity (long-run maximum sustainable enrollment), r is the intrinsic growth rate, and t_0 is the inflection point at which growth rate is maximal (i.e., $N(t_0) = K/2$). Because this model is non-linear in its three parameters (K , r , t_0), parameters were estimated using non-linear least squares (the Levenberg-Marquardt algorithm), minimizing $\sum(N_i - \hat{N}(t_i))^2$ directly on the untransformed data.

Model Evaluation Criteria

The goodness of fit of each model was evaluated using the coefficient of determination, $R^2 = 1 - (SS_{\text{res}}/SS_{\text{tot}})$, where SS_{res} is the residual sum of squares of the fitted model and SS_{tot} is the total sum of squares of the observed data about its mean. R^2 values closer to 1 indicate a better fit. In addition, each model's economic and demographic plausibility was assessed qualitatively: an exponential model with no upper bound is, by construction, an implausible description of enrollment over a multi-decade horizon because it implies unbounded growth, whereas the logistic model's finite carrying capacity parameter

can be directly compared against independent estimates of Nepal's eligible youth population, providing an external plausibility check that a purely statistical goodness-of-fit measure cannot provide on its own.

RESULTS

Year-wise Enrollment and Institutional Growth

Table 1 presents the compiled year-wise enrollment and institutional data used in this study, drawn from UGC and MOEST sources described in Section 3.2. The data show a clear and sustained upward trend, with total enrollment increasing from approximately 371,000 in 2016/17 to 749,392 in 2025/26, an absolute increase of 378,392 students, or approximately 102 percent, over nine years. The number of degree-granting institutions similarly expanded, from 12 universities and academies around 2015/16 to 30 universities and academies by 2025/26, operating through 1,608 constituent and affiliated campuses, up from 1,455 campuses in 2021/22 alone — an increase of 153 campuses in just four years.

Table 1. Year-wise Higher Education Enrollment and Institutional Expansion in Nepal, 2015/16–2025/26

Academic Year	Total Enrollment	Number of Campuses	Number of Universities/Academies
2015/16 (approx.)	407,000	N/A	12
2016/17	371,000	N/A	12
2021/22	579,448	1,455	14 (12 fully operating)
2023/24	633,053	n/a (16 universities + 7 academies)	16 universities + 7 medical academies
2024/25	672,489	n/a	n/a
2025/26	749,392	1,608	21 universities + 8 health academies (30 total)

Source: University Grants Commission (UGC) Nepal Operations Manual (2024); UGC Education Management Information System Report 2023/24; Kathmandu Post analysis of UGC/MOEST data (2026); Asia News Network (2026).

Growth Rate Analysis

The compound annual growth rate (CAGR) of enrollment between 2016/17 and 2025/26 was computed as $CAGR = (N_{2025/26} / N_{2016/17})^{1/9} - 1 = (749,392/371,000)^{1/9} - 1 \approx 0.0813$, or approximately 8.13 percent per year. This growth rate substantially exceeds Nepal's national population growth rate of 0.92 percent per year (2011–2021 intercensal

period, CBS 2021), confirming that enrollment growth is being driven predominantly by rising participation rates (an increasing share of the eligible age cohort accessing higher education) rather than by underlying population growth alone. The most recent year-on-year increase, from 672,489 in 2024/25 to 749,392 in 2025/26, represents a single-year growth rate of approximately 11.4 percent, the fastest annual increase observed in the compiled series.

Gender-wise Enrollment Trends

Nepal's higher education system has recorded a Gender Parity Index (GPI) of 1.3 in the 2023/24 EMIS report, indicating that, in aggregate, female enrollment now numerically exceeds male enrollment nationally. This aggregate figure, however, masks considerable variation across institutions. Tribhuvan University, the largest institution, reported female enrollment of 54.66 percent in fiscal year 2078/79 (2021/22). Far Western University reported the highest female enrollment share among major universities, at 61.65 percent, followed by Mid-Western University, Kathmandu University, the Agriculture and Forestry University, and Pokhara University, each exceeding 40 percent female enrollment. Nepal Open University, by contrast, reported the lowest female enrollment share of any major university, at 11.34 percent, a disparity attributable in part to that institution's distance/open-learning delivery model and its student demographic, which tends to skew toward working adults. This variation underscores that national-level gender parity statistics should be interpreted alongside institution-level data when designing targeted equity interventions.

Discipline-wise Distribution of Enrollment

A pronounced and increasing concentration of students in management education characterizes Nepal's higher education system. According to UGC data, management programs accounted for 39 percent of total higher education enrollment in 2015; by 2025, this share had risen to 47.1 percent, meaning that nearly one in every two higher education students in Nepal is enrolled in a management-related program. Education programs, the second-largest discipline, accounted for 31.6 percent of enrollment in 2015 but represent a considerably smaller share today, with approximately 150,000 of the 749,392 total students (about 20 percent) enrolled in education programs in 2025/26; humanities enrolls approximately 70,000 students (about 9 percent). Engineering programs, while numerically smaller, have also recorded notable growth in recent years. This discipline-wise concentration has implications for labor-market alignment and is discussed further in Section 6.

Faculty Capacity and Public Investment

The growth in enrollment has significantly outpaced the growth in teaching capacity. Full-time faculty in constituent campuses increased from 9,299 in 2016/17 to 12,082 in 2023/24, a rise of 29.9 percent, compared to a 71 percent increase in overall enrollment over the same period. Because community and private affiliated campuses, which together enroll approximately 62 percent of Nepal's 633,053 higher-education students as of 2023/24, are not required to submit full-time faculty registers to UGC, a comprehensive national student-to-faculty ratio cannot be directly computed from published data. However, restricting the calculation to constituent campuses, where an estimated 38 percent of the 633,053 total enrollment (approximately 240,560 students) is concentrated, yields an implied student-to-faculty ratio of approximately 19.9:1, near the upper bound of the internationally recommended planning range of 10:1 to 20:1. Because faculty data are unavailable for the majority (62 percent) of enrolled students, the true national ratio, if community and private campuses were included, is very likely substantially higher than this constituent-campus estimate, a data-transparency gap that itself constitutes a significant planning concern. Public funding for higher education rose from NPR 9.3 billion in 2017/18 to NPR 17.5 billion in 2023/24, an increase of approximately 88 percent in nominal terms; however, UGC and independent analyses indicate that this additional funding has been directed predominantly toward infrastructure and block grants rather than full-time faculty recruitment, which helps explain the persistent lag in faculty growth relative to enrollment growth.

Mathematical Model Development and Analysis

Linear Regression Model Results

Fitting the linear model $N(t) = a + b \cdot t$ to the five-point enrollment series (t measured in years since 2016/17) by ordinary least squares yields the estimated equation:

$$\hat{N}(t) = 370,236.9 + 39,799.9 \cdot t, \quad R^2 = 0.987$$

The slope coefficient $b = 39,799.9$ indicates that, under the linear specification, Nepal's higher education enrollment has grown, on average, by approximately 39,800 students per year over the study period. The high R^2 value of 0.987 indicates that the linear model explains approximately 98.7 percent of the variance in observed enrollment, confirming a strong linear trend over the observed range. However, a linear model implies

that this fixed absolute increment will continue indefinitely, an assumption that becomes increasingly implausible over long forecast horizons because it takes no account of the finite size of the underlying eligible population.

Exponential Growth Model Results

Fitting the exponential model $N(t) = A \cdot e^{rt}$ by log-linear least squares yields:

$$\hat{N}(t) = 377,309.8 \cdot e^{0.07565 \cdot t}, \quad R^2 = 0.984$$

The estimated instantaneous growth rate $r = 0.07565$ corresponds to a continuous annual growth rate of approximately 7.57 percent (equivalently, a discrete compound growth rate of approximately 7.86 percent per year), broadly consistent with the empirically observed CAGR of 8.13 percent computed in Section 4.2. The exponential model achieves a slightly lower R^2 (0.984) than the linear model over the observed range, but, more importantly, it implies compounding, unbounded growth: projected forward without constraint, the exponential model would predict enrollment exceeding one million students by 2030 and would imply implausibly large enrollment figures within two to three decades, eventually exceeding the entire youth population of Nepal. This makes the unconstrained exponential model theoretically unsuitable as a long-run planning tool, even though it fits the recent historical data reasonably well.

Logistic Growth Model Results

Fitting the three-parameter logistic model $N(t) = K / (1 + e^{-r(t-t_0)})$ by non-linear least squares (Levenberg-Marquardt algorithm) yields:

$$\hat{N}(t) = 1,565,322 / (1 + e^{-0.11453(t - 10.085)}), \quad R^2 = 0.987$$

This fit implies a long-run carrying capacity of $K \approx 1,565,322$ students, an intrinsic growth rate of $r \approx 0.1145$, and an inflection point at $t_0 \approx 10.085$, corresponding to approximately the year 2027, at which point the growth rate of enrollment is predicted to be at its maximum before beginning to decelerate. The logistic model achieves an R^2 of 0.987, matching the linear model's fit and exceeding the exponential model's fit, while additionally providing a theoretically grounded upper bound on enrollment that is broadly consistent with independent demographic evidence: UNFPA's analysis of the 2021 census places Nepal's 16–25 age cohort, the population segment most directly relevant to higher education participation, at approximately 20.8 percent of the national population of 29.16 million, or roughly 6.1 million individuals. A long-run enrollment carrying capacity of 1.57 million would

therefore correspond to an eventual Gross Enrollment Ratio of approximately 26 percent among this age cohort, a modest and demographically plausible increase from the current GER of 22 percent reported by UGC, lending external credibility to the logistic model's estimated carrying capacity.

Model Comparison and Fitted Values

Table 2 compares the actual enrollment figures against the values predicted by each of the three fitted models at each observed data point, illustrating the closeness of fit achieved by all three specifications over the historical period.

Table 2. Comparison of Actual and Model-Predicted Enrollment, 2016/17–2025/26

Academic Year (t)	Actual Enrollment	Linear Model $\hat{N}(t)$	Exponential Model $\hat{N}(t)$	Logistic Model $\hat{N}(t)$
2016/17 (t=0)	371,000	370,237	377,310	375,003
2021/22 (t=5)	579,448	569,236	550,760	560,986
2023/24 (t=7)	633,053	648,836	640,720	645,816
2024/25 (t=8)	672,489	688,636	691,068	689,657
2025/26 (t=9)	749,392	728,436	745,373	734,098

Source: Author's calculations based on data compiled in Table 1.

All three models achieve a strong fit to the historical data, with R^2 values between 0.984 and 0.987. Because the linear and logistic models achieve statistically indistinguishable fits over the observed period, model selection for forecasting purposes is guided primarily by theoretical plausibility rather than by in-sample fit alone. As discussed in Section 5.3, the logistic model is preferred on theoretical grounds because it is the only specification among the three that incorporates a finite, demographically defensible upper bound on enrollment.

Forecast of Enrollment, 2027–2030

Table 3 presents enrollment forecasts for the period 2027 to 2030 generated by each of the three fitted models. As expected, the exponential model produces the most aggressive forecast, exceeding one million students by 2030, while the linear and logistic models produce more moderate and mutually consistent forecasts, diverging only gradually as the logistic model's growth begins to decelerate approaching its inflection point.

Table 3. Forecasted Higher Education Enrollment in Nepal, 2027–2030

Year	Linear Forecast	Exponential Forecast	Logistic Forecast
2027	768,236	803,945	778,855
2028	808,036	867,120	823,638

Year	Linear Forecast	Exponential Forecast	Logistic Forecast
2029	847,836	935,260	868,153
2030	887,636	1,008,753	912,115

Source: Author's calculations based on the fitted linear, exponential, and logistic models presented in Sections 5.1–5.3.

Under the preferred logistic specification, Nepal's higher education enrollment is projected to reach approximately 779,000 in 2027, 824,000 in 2028, 868,000 in 2029, and 912,000 by 2030. This represents a further increase of approximately 162,700 students, or 21.7 percent, above the 2025/26 enrollment of 749,392 over a five-year horizon, a substantial but decelerating rate of growth compared to the 8.13 percent average annual growth recorded over the preceding decade. Institutional and policy planning, discussed in Section 7, should be calibrated against this range of forecasts rather than against a single point estimate, given the inherent uncertainty in extrapolating from a short historical series.

RESULTS AND DISCUSSION

Interpretation of the Preferred Model

The comparative analysis in Section 5 indicates that while all three mathematical models describe Nepal's recent enrollment history with high statistical fidelity, the logistic growth model offers the most defensible basis for medium- and long-term forecasting. Its estimated inflection point of approximately 2027 suggests that Nepal's higher education system is currently at or very near the point of maximum absolute annual growth, after which the rate of increase in student numbers is expected to gradually decelerate as enrollment approaches its estimated carrying capacity of approximately 1.57 million students. This finding is consistent with, and provides mathematical grounding for, the qualitative observation that Nepal's higher education system, while still expanding rapidly in absolute terms, is beginning to encounter structural constraints, most visibly evidenced by the widening gap between enrollment growth and faculty growth documented in Section 4.5.

Comparison with Demographic Trends

The logistic model's estimated carrying capacity of 1.57 million students, corresponding to an eventual Gross Enrollment Ratio of approximately 26 percent of the 16–25 age cohort, should be interpreted cautiously. It is derived purely from the

mathematical extrapolation of a nine-year enrollment series and represents a projection of current structural conditions rather than a hard demographic ceiling. Nepal's actual demographic ceiling is far higher: with an estimated 6.1 million individuals in the 16–25 age cohort, a Gross Enrollment Ratio comparable to upper-middle-income countries in South Asia (commonly in the 30–40 percent range) would imply a demand-side potential enrollment of 1.8 to 2.4 million students, well above the model's estimated supply-constrained carrying capacity. This gap between demographic potential and the modeled carrying capacity suggests that the binding constraint on Nepal's higher education growth is not the availability of eligible young people but rather institutional capacity, faculty availability, financing, and, as discussed further below, patterns of outward student migration.

Discipline-wise Imbalance and Labour Market Implications

The pronounced and increasing concentration of enrollment in management education, from 39 percent of students in 2015 to 47.1 percent in 2025, represents one of the most consequential structural features of Nepal's enrollment growth uncovered in this analysis. While demand-driven, market-responsive expansion of management education is not inherently problematic, a system in which nearly half of all higher education students are concentrated in a single broad discipline raises concerns about oversupply of management graduates relative to labour-market absorption capacity, and about the crowding-out of enrollment in science, technology, engineering, and mathematics (STEM) fields that are typically associated with higher productivity spillovers in developing economies. Because the community and private campuses that enroll the majority of Nepal's higher education students operate with strong incentives to offer lower-cost, higher-demand programs such as management, this discipline-wise imbalance is likely to persist or intensify unless addressed through targeted public investment in STEM capacity at public constituent campuses.

The Faculty and Financing Gap

The finding that full-time faculty in constituent campuses grew by only 29.9 percent between 2016/17 and 2023/24, against a 71 percent increase in enrollment over the same period, is among the most policy-relevant results of this study. Combined with the estimated constituent-campus student-to-faculty ratio of approximately 19.9:1, near the upper bound of internationally recommended norms, and the fact that comparable faculty data are entirely unavailable for the 62 percent of students enrolled in community and private campuses, this finding suggests that Nepal's reported aggregate enrollment growth may be substantially

outpacing the growth of instructional capacity available to support that growth, particularly outside the constituent-campus sector. If, as is plausible, community and private campuses maintain lower average faculty ratios than constituent campuses, the true national student-to-faculty ratio could considerably exceed the constituent-campus estimate, with direct implications for the quality of instruction and learning outcomes. This is compounded by the observation that increased public funding for higher education (from NPR 9.3 billion to NPR 17.5 billion between 2017/18 and 2023/24) has been directed predominantly toward infrastructure and block grants rather than faculty recruitment.

International Student Mobility as a Contextual Factor

Recent reporting indicates that global economic and geopolitical tensions have contributed to a moderation in the outflow of Nepali students seeking higher education abroad, with the number of no-objection certificates issued for overseas study declining relative to the previous fiscal year, even as domestic enrollment climbed by nearly 10 percent. This suggests that a portion of the observed acceleration in domestic enrollment growth, particularly the 11.4 percent single-year increase recorded between 2024/25 and 2025/26, may reflect a substitution effect, in which prospective students who might otherwise have studied abroad are instead enrolling in Nepali institutions. If this substitution effect persists or intensifies, actual future enrollment could track closer to the upper end of the forecast range presented in Table 3 (the exponential or upper logistic trajectory) than to the lower end, underscoring the importance of external economic and policy monitoring alongside the purely mathematical extrapolation presented in this study.

Challenges and Policy Implications

Based on the mathematical modeling and structural analysis presented above, several challenges and corresponding policy implications emerge for Nepal's higher education planners:

First, faculty recruitment must accelerate substantially beyond its historical trajectory. If enrollment follows the logistic forecast presented in Table 3, reaching approximately 912,000 students by 2030, and if UGC seeks to maintain even the constituent-campus benchmark ratio of approximately 20 students per full-time faculty member across the system, several thousand additional full-time faculty positions would need to be created over the next five years, a rate of recruitment far exceeding the historical rate of approximately

400 net new constituent-campus faculty positions per year observed between 2016/17 and 2023/24.

Second, the extension of mandatory full-time faculty reporting requirements to community and private affiliated campuses, which together enroll 62 percent of the system's students, should be considered a data-transparency priority, since the absence of such data currently prevents accurate national-level assessment of instructional capacity and quality assurance.

Third, targeted incentives to diversify discipline-wise enrollment away from the growing concentration in management education, and toward STEM and applied technical fields more directly aligned with Nepal's economic development priorities, warrant consideration, potentially through differentiated public subsidies or scholarship programs at constituent campuses offering STEM programs.

Fourth, continued monitoring of the relationship between domestic enrollment and outward student mobility is warranted, given evidence that global economic conditions are currently associated with a substitution of domestic for overseas enrollment; planners should be prepared for enrollment growth to track toward the upper end of the forecast range presented in this study if this substitution effect persists.

Fifth, future research should extend the mathematical modeling approach presented here by incorporating a longer historical time series, disaggregating models by university, discipline, and province, and by testing more flexible growth specifications such as the Gompertz or Richards curves, which relax the logistic model's assumption of a symmetric S-shaped growth path.

CONCLUSION

This study set out to mathematically model and forecast student enrollment trends in Nepal's higher education system using secondary data compiled from official UGC and MOEST sources for the period 2016/17 to 2025/26. Three growth models, linear, exponential, and logistic, were fitted to the data using least-squares methods and compared on the basis of statistical fit and theoretical plausibility. All three models achieved a strong fit to the historical data (R^2 between 0.984 and 0.987), but the logistic model was identified as the most theoretically appropriate for forecasting purposes because it uniquely

incorporates a finite, demographically defensible carrying capacity, estimated at approximately 1.57 million students, and identifies an inflection point at approximately 2027, after which the rate of enrollment growth is expected to gradually decelerate.

The study's broader analysis of Nepal's higher education system, encompassing institutional expansion, gender parity, discipline-wise distribution, faculty capacity, and public financing, reveals a system that has grown remarkably in numerical terms, with enrollment nearly doubling over the past decade and the number of degree-granting institutions expanding from 12 to 30, but that faces mounting structural strains, most notably a widening gap between enrollment growth (71 percent between 2016/17 and 2023/24) and full-time faculty growth (under 30 percent over the same period), alongside a growing concentration of students in management education and persistent institution-level gender disparities. These findings collectively suggest that Nepal's higher education system, while approaching neither its demographic ceiling nor, under the logistic model, its full mathematical carrying capacity, is nonetheless entering a phase in which the quality and sustainability of continued expansion will depend critically on whether faculty recruitment, infrastructure investment, and discipline-wise diversification can be brought into closer alignment with the pace of enrollment growth documented in this study.

Mathematical modeling, as demonstrated in this study, offers Nepali higher education planners a rigorous, replicable, and updatable tool for anticipating future enrollment levels and for stress-testing policy scenarios against a quantitatively grounded baseline. As more recent and more granular data become available, particularly disaggregated faculty and financing data for community and private campuses, the models presented here can and should be refined and re-estimated to support ongoing evidence-based planning of Nepal's higher education sector.

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