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Higher Education Financing in Nepal: A Mathematical Analysis of Government Expenditure, Enrollment, and Educational Outcomes

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Abstract

Nepal's higher education system has expanded substantially over the past decade, yet whether increased public financing has generated commensurate improvements in access and educational outcomes remains unclear. This study assesses the relationship among government expenditure, student enrollment, and institutional outcomes in Nepalese higher education. It applies growth-rate, expenditure-elasticity, dispersion, and ratio-based analyses to publicly available data from government sources, the University Grants Commission, the World Bank, and UNESCO. Enrollment increased by approximately 71%, from about 371,000 students in fiscal year (FY) 2016/17 to 633,053 in FY 2023/24, while nominal public financing for higher education institutions rose from NPR 9.3 billion in FY 2017/18 to NPR 17.5 billion in FY 2023/24. The estimated expenditure elasticity of enrollment ranges from 0.71 to 0.80, indicating that financing grew faster than enrollment and suggesting rising unit costs rather than proportional access expansion. Despite higher nominal expenditure, education spending declined from 4.77% to 3.69% of gross domestic product following its 2017 peak, a reduction of approximately 23%, and from 25.5% to 14.1% of total government expenditure since 2006, a decline of nearly 45%. Pass rates across constituent universities display substantial dispersion, with a coefficient of variation of approximately 31%; Tribhuvan University, the largest and most heavily subsidized institution, records the lowest completion outcomes, a pattern consistent with congestion associated with adverse student–faculty ratios. Moreover, annual household expenditure on overseas education, estimated at

NPR 67 billion, is approximately 3.8 times the state's expenditure on the entire domestic higher education system, indicating substantial private substitution toward foreign education. These findings reveal a divergence among nominal financing growth, budgetary prioritization, institutional performance, and public confidence in domestic higher education. The study contributes a quantitative framework for evaluating financing efficiency and identifies policy priorities concerning resource allocation, institutional capacity, and educational quality, while proposing a formal regression specification for future panel-data analysis when more granular annual data become available.

Keywords: Educational Outcomes; Enrollment Elasticity; Higher Education Financing; Nepal; Public Expenditure

Introduction

Higher education financing sits at the intersection of three national priorities for Nepal: expanding access for a young and rapidly urbanizing population, improving the quality and labor-market relevance of degree programs, and containing the fiscal cost of an expanding system inside a lower-middle-income economy with a GDP of approximately USD 49.1 billion (2026 forecast) and a per-capita income of roughly USD 1,658. Since the 2015 constitution introduced federalism and since the 2015 earthquake damaged education infrastructure, Nepal has faced simultaneous pressure to decentralize education governance, rebuild capacity, and respond to an unprecedented outflow of students seeking higher education abroad.

The integration of mathematical modeling and numerical techniques into interdisciplinary research has gained increasing attention due to its ability to analyze complex systems and optimize decision-making processes. Recent studies by Sahani and colleagues demonstrate the application of differential equations, numerical methods, and computational frameworks across diverse fields, including cultural studies, aerospace engineering, and scientific education. These works highlight how mathematical approaches can provide structured solutions to complex real-world problems. Sahani and Sah (2025) explored the optimization of cultural education programs using numerical techniques. The study emphasized the potential of mathematical models to evaluate educational strategies and improve cultural learning outcomes. By applying optimization approaches, the authors demonstrated that numerical methods can support systematic decision-making in social and educational environments. This research expands the application of computational

techniques beyond traditional scientific fields and shows their relevance in addressing human-centered challenges. Similarly, Sahani et al. (2025) investigated cultural value conflicts in multicultural societies through numerical simulation. The authors developed a computational perspective for understanding interactions between different cultural values and social factors. The study suggested that numerical simulations can help represent complex social dynamics and provide insights into conflict management and cultural adaptation. This approach reflects the growing importance of mathematical modeling in analyzing systems where multiple variables influence outcomes. Sahani and Karna (2025) further contributed to this area by examining culture education optimization through numerical methods. Their work reinforced the idea that mathematical frameworks can assist in designing effective educational programs. The study indicated that optimization models may help identify efficient strategies for cultural education planning, resource allocation, and program improvement. Beyond social sciences, differential equations have been widely applied in aerospace engineering and physical sciences. Sahani et al. (2024) presented analytical frameworks involving differential equations in aerospace engineering, highlighting their importance in describing dynamic systems and predicting engineering behavior. Differential equations provide essential tools for modeling motion, forces, and system changes over time, making them fundamental in aerospace analysis. Jha et al. (2023) examined stellar evolution through differential equations, demonstrating how mathematical models contribute to understanding complex astronomical processes. The study showed that differential equations allow researchers to represent changes occurring in celestial systems and analyze long-term evolutionary patterns. This illustrates the broader significance of mathematical modeling in explaining natural phenomena. Sharma et al. (2024) explored rocket motion using differential equations, focusing on how mathematical principles can explain propulsion and movement in aerospace systems. Their work highlighted the educational value of connecting theoretical mathematics with practical engineering applications. The study demonstrated that differential equations are not only analytical tools but also effective methods for developing scientific understanding. Overall, the reviewed literature demonstrates the versatility of numerical methods and differential equations across interdisciplinary domains. From optimizing cultural education programs to modeling aerospace systems, these studies reveal the capability of mathematical approaches to address complex problems involving multiple interacting variables. However, further research is needed to validate these models using larger datasets and real-world applications. Future

studies may focus on integrating advanced computational techniques, artificial intelligence, and data-driven approaches to enhance the accuracy and applicability of mathematical models in diverse fields. This paper asks a narrow but consequential question: does the mathematical relationship between government expenditure, enrollment, and outcomes in Nepal's higher education sector show that public money is being converted into proportional access and quality gains — or is the system absorbing more money per unit of outcome over time? To answer this, the paper does not build a purely theoretical or synthetic model; instead it applies transparent, reproducible quantitative methods — compound annual growth rates (CAGR), elasticity ratios, per-unit expenditure calculations, dispersion statistics, and comparative ratios — to the best publicly available anchor-year data from the University Grants Commission (UGC), the Ministry of Education, Science and Technology (MOEST), and World Bank/UNESCO cross-country education finance indicators.

Institutional and Policy Context

Nepal's higher education system, defined as all education beyond Grade 12, comprises 22 operational universities (16 federal and 6 provincials as of 2026), six health science academies, and roughly 1,455 campuses divided into three ownership types: constituent (fully public, 162 campuses), community (partially subsidized, 539 campuses), and private (754 campuses). Tribhuvan University (TU), the oldest and largest institution, enrolls approximately 75–76% of all students and produces roughly the same share of graduates nationally, making it the dominant node in any system-level financing analysis.

A defining feature of the current period is the divergence between two enrollment trends moving in opposite directions: domestic higher education enrollment has grown (371,000 → 633,053 students, FY 2016/17–2023/24), while the number of students obtaining No Objection Certificates (NOC) to study abroad has grown even faster in percentage terms, from 44,800 in 2021 to a peak of roughly 121,000 in 2022, settling at 110,217 in 2023 — cumulatively over 404,000 students in the five years to 2024. This "parallel system" of outbound private financing is treated in this paper as an outcome variable in its own right, because it reflects a revealed preference against the domestic system that public financing has not reversed.

Data Sources and Methodology

Data sources

Variable	Source	Years available
Public HEI expenditure (NPR)	UGC Red Book figures, reported via Kathmandu Post analysis of UGC data	FY 2017/18, FY 2023/24
Higher education enrollment	UGC Education Management Information System (EMIS) reports; UGC Operations Manual	FY 2016/17, FY 2021/22, FY 2023/24
Government education expenditure, % of GDP	World Bank / UNESCO Institute for Statistics	1998–2024 (selected years)
Government education expenditure, % of total government expenditure	UNESCO Institute for Statistics	2000–2018 (selected years)
Full-time faculty (constituent campuses)	UGC EMIS 2023/24	FY 2023/24
University-level pass rates	UGC EMIS Report on Higher Education 2023/24	FY 2023/24
Outbound student financing (NOC data)	MOEST NOC branch, reported via Kathmandu Post	2021–2024
Macroeconomic indicators (GDP, population, HDI)	World Bank, IMF, UNDP (via national economic statistics)	2020s

Methodological approach

Given that Nepal does not publish a complete, granular annual panel linking expenditure, enrollment, and outcomes at the campus level, this paper uses anchor-year mathematical analysis rather than a fabricated multi-point regression. Five classes of calculation are applied:

1. Compound Annual Growth Rate (CAGR): CAGR = (Vt / V0)^(1/n) − 1 where V0 and Vt are the variable's value at the start and end years and n is the number of years elapsed.

2. Expenditure elasticity of enrollment, a discrete analogue of ε = (%Δ Enrollment) / (%Δ Expenditure), computed both from total-period growth and from the ratio of CAGRs.

3. Per-student public expenditure: ē_t = E_t / N_t, where E_t is total public HEI expenditure and N_t is total enrollment in year t, with an illustrative real-terms adjustment using an assumed average inflation rate.

4. Dispersion statistics (mean, variance, standard deviation, coefficient of variation) applied to the cross-sectional distribution of university-level pass rates.

5. Ratio analysis comparing domestic public financing to private outbound financing, and enrollment stock to outbound-flow stock.

For future work, once annual panel data (≥15–20 years, all variables) becomes publicly available at consistent granularity, the following econometric specification is proposed:

$$\ln(N_t) = \beta 0 + \beta 1 \cdot \ln(E_t) + \beta 2 \cdot GDP_t + \beta 3 \cdot Policy_t + \varepsilon_t$$

where N_t is enrollment, E_t is real public HEI expenditure, GDP_t controls for macroeconomic scale, $Policy_t$ is a vector of structural-break dummies (e.g., the 2015 federalization, the 2015 earthquake, COVID-19 closures), and $\beta 1$ is directly interpretable as the expenditure elasticity of enrollment. This paper's elasticity estimate in Section 4.2 should be read as a two-point approximation of $\beta 1$, not a full econometric estimate.

Mathematical and Statistical Analysis

Growth dynamics: CAGR of expenditure and enrollment

Enrollment, FY 2016/17 → FY 2023/24 (n = 7 years): 371,000 → 633,053

CAGR (enrollment) = (633,053 / 371,000)^(1/7) − 1 ≈ 7.9% per year

Public HEI expenditure, FY 2017/18 → FY 2023/24 (n = 6 years): NPR 9.3bn → NPR 17.5bn

CAGR (funding) = (17.5 / 9.3)^(1/6) − 1 ≈ 11.1% per year

Finding: Nominal public funding for higher education has grown roughly 40% faster, on an annualized basis, than enrollment (11.1% vs. 7.9% per year).

Expenditure elasticity of enrollment

Using total-period growth rates over the overlapping window (~70.6% cumulative enrollment growth vs. ~88.2% cumulative funding growth):

$\varepsilon \approx 70.6\% / 88.2\% \approx 0.80$

Using the ratio of annualized CAGRs instead (a more defensible measure given the slightly different reference periods):

$\varepsilon(CAGR) \approx 7.9\% / 11.1\% \approx 0.71$

Interpretation: An elasticity below 1.0 in both estimates means Nepal's higher education system is in the inelastic range: each 1% increase in public funding is associated with less than a 1% increase (roughly 0.71–0.80%) in enrollment. In a simple access-maximizing model, this gap between funding growth and enrollment growth must be absorbed somewhere — most plausibly in rising per-student costs, infrastructure/capital catch-up spending, or administrative overhead, rather than proportional access expansion.

Per-student public expenditure and real-term erosion

$$\bar{e}(2017/18) = \text{NPR } 9{,}300{,}000{,}000 / 371{,}000 \approx \text{NPR } 25{,}067 \text{ per student}$$

$$\bar{e}(2023/24) = \text{NPR } 17{,}500{,}000{,}000 / 633{,}053 \approx \text{NPR } 27{,}644 \text{ per student}$$

Nominal growth over the period: (27,644 / 25,067) − 1 ≈ 10.3% cumulative (roughly 1.6% per year).

Nepal's CPI inflation has averaged in the range of roughly 5–6% per year across this period (2024 CPI inflation alone was recorded at 4.7%). Applying an illustrative average of 5.5% per year compounded over six years:

(1.055)^6 − 1 ≈ 37.9% cumulative inflation

Real change ≈ 10.3% − 37.9% ≈ −20% to −25%

Finding (illustrative, assumption-dependent): Although nominal per-student public expenditure rose modestly, real (inflation-adjusted) per-student public expenditure likely *fell* by roughly one-fifth to one-quarter over the FY 2017/18–2023/24 period. This is presented as an order-of-magnitude estimate given that a precise HEI-specific price deflator is not publicly available.

Budgetary prioritization: share of GDP and share of total government spending

Government education expenditure as a share of GDP shows a hump shape: from 2.89% (1998) it rose to a peak of 4.77% (2017), then declined to approximately 3.69% by 2024.

Relative decline since 2017 peak = (4.77% − 3.69%) / 4.77% ≈ 22.7%

Government education expenditure as a share of *total* government expenditure declined even more sharply, from a peak of 25.5% (2006) to 14.1% (2018):

Relative decline = (25.5% − 14.1%) / 25.5% ≈ 44.7%

Finding: Even though nominal higher education spending has risen (Section 4.1), education's *relative* claim on the national budget has nearly halved over roughly a decade, and

its share of GDP has fallen by close to a quarter since its 2017 peak. Nepal's economy and total state budget have both grown faster than the education allocation — a classic sign of relative de-prioritization masked by rising absolute figures.

Access-quality trade-off: student-faculty ratio analysis

UGC EMIS data (FY 2023/24) records 12,082 full-time teachers in constituent (fully public) campuses. Constituent campuses enrolled approximately 37.5% of total students in the most recent year with a reported breakdown (FY 2021/22 share applied to FY 2023/24 total enrollment as an approximation):

$$N(\text{constituent}) \approx 0.375 \times 633{,}053 \approx 237{,}000 \text{ students}$$

$$\text{Student-faculty ratio (constituent)} \approx 237{,}000 \,/\, 12{,}082 \approx 19.6 : 1$$

This sits at the upper (more crowded) end of the internationally cited planning range of 10:1 to 20:1. However, community and private affiliated campuses — which enroll the remaining ~62% of students (≈ 392,000) — are not required to report full-time faculty data to UGC's EMIS system. This means the actual system-wide student-faculty ratio cannot be computed, and the true figure for the majority of enrolled students is opaque and, based on qualitative reporting, likely substantially worse than 19.6:1.

Finding: The segment of the system that is best-funded and most visible in official statistics (constituent campuses) already operates near the international quality ceiling for staffing ratios; the majority-enrollment segment (community/private) is a statistical blind spot, meaning aggregate "average" ratios likely understate real crowding.

This crowding sits on top of a long-documented allocation problem: a 2015 World Bank project appraisal for the Nepal Higher Education Reforms Project found that per-student government funding ranged from roughly USD 40 to USD 1,800 per year *depending on the institution*, with allocations "subject to extensive negotiations and not linked to performance." A ratio of the extremes:

$$1{,}800 \,/\, 40 = 45\times$$

Finding: Even a decade later, this paper's aggregate per-student figure (Section 4.3, ≈ NPR 27,644, or roughly USD 205 at recent exchange rates) is only a *system-wide average*; the underlying institutional spread is likely still an order of magnitude wide, meaning the "average student" figure masks students at some institutions receiving up to 45 times more public

subsidy per year than students at others — a horizontal-equity problem distinct from, and compounding, the vertical (over-time) erosion identified in Section 4.3.

Outcome dispersion: pass-rate statistics across universities

UGC's EMIS Report on Higher Education 2023/24 provides institution-level pass rates:

University	Pass rate (%)	Approx. share of national graduates
Tribhuvan University	30.1	76.0%
Nepal Sanskrit University	30.0	—
Far Western University	40.1	—
Mid-Western University	44.7	—
Pokhara University	45.0	7.8%
Agriculture and Forestry University	66.0	—
Lumbini Boudha University	68.0	—

Basic descriptive statistics across these seven institutions (n = 7):

$\bar{x} = (30.1+30.0+40.1+44.7+45.0+66.0+68.0) / 7 \approx 46.3\%$

$\sigma^2 = \Sigma(x_i - \bar{x})^2 / n \approx 204.3 \Rightarrow \sigma \approx 14.3$ percentage points

Coefficient of variation $= \sigma / \bar{x} \approx 30.9\%$

Finding: A coefficient of variation of roughly 31% indicates very high dispersion in academic outcomes across public universities. Strikingly, the two largest and most heavily subsidized institutions — TU and Nepal Sanskrit University — post the *lowest* pass rates (~30%), while smaller, specialized institutions (Agriculture and Forestry University, Lumbini Boudha University) post the *highest* (66–68%). This inverse relationship between institutional scale/enrollment share and completion outcomes is consistent with the congestion (adverse student-faculty ratio) effect identified in Section 4.5: the institution absorbing roughly three-quarters of national enrollment and graduate output is also the one whose academic throughput is least efficient.

The domestic-outbound financing gap

In 2023, Nepali students and families spent an estimated NPR 67 billion on foreign study in a single year (tuition, fees, and associated costs for the roughly 110,000 students who

obtained NOCs that year), while the entire public budget for domestic higher education in FY 2023/24 was NPR 17.5 billion.

Outbound-to-domestic financing ratio = 67 / 17.5 ≈ 3.8

Finding: Nepali households now privately finance nearly four times as much annual spending on sending students abroad as the state invests in its entire domestic higher education system. This is a striking revealed-preference statistic: a large share of the nation's human and financial capital dedicated to higher education is now flowing outward rather than being captured by domestic institutions, even as those institutions receive rising nominal public subsidy.

A second ratio reinforces this: cumulative NOC issuances over five years (2019–2024) totaled approximately 404,139 students, equivalent to about 64% of the entire current domestic higher education enrollment stock (633,053):

$$404{,}139 / 633{,}053 \approx 0.638$$

Composite yield estimate: from enrollment to graduation

Independent reporting indicates that approximately 50% of students enrolled in Bachelor's/Master's programs in major cities drop out before their final semester. Combining this (illustratively, as an order-of-magnitude approximation rather than a precise cohort-tracked figure) with the mean pass rate from Section 4.6:

Gross completion yield ≈ $(1 - 0.50) \times 46.3\% \approx 23.1\%$

Finding (illustrative): Under these two independently sourced, order-of-magnitude assumptions, for every 100 students who enroll in a domestic higher education program, only on the order of 23 may be expected to complete their degree on schedule and pass their final examinations. This figure should be treated as a rough composite estimate — the dropout and pass-rate statistics are not drawn from the same tracked cohort — but the direction and magnitude of the implied "leakage" between enrollment and completion is large enough to be a first-order policy concern independent of the exact number.

Discussion of Findings

Four mathematical results, taken together, tell a consistent structural story:

1. Funding is growing faster than enrollment (Section 4.1–4.2). An elasticity of 0.71–0.80 shows that Nepal's higher education financing is not purchasing proportional access growth

— additional rupees are increasingly absorbed by rising unit costs rather than translating into a rising number of educated citizens per rupee spent.

2. Relative prioritization is falling even as nominal spending rises (Section 4.4). A near-halving of education's share of the total government budget since 2006, and a roughly 23% decline in its share of GDP since the 2017 peak, indicates that other sectors (very plausibly federalism-related administrative and infrastructure spending) have captured a growing share of fiscal space at education's relative expense.

3. Quality is uneven and inversely related to scale (Sections 4.5–4.6). The dominant institution, TU, which receives the lion's share of public constituent-campus funding and enrolls three-quarters of the system, has both the most crowded staffing ratios and the lowest pass rates — a textbook congestion effect.

4. Private outbound financing dwarfs public domestic financing (Section 4.7). At roughly 3.8 times the size of the entire domestic HEI budget, the outbound flow of privately financed higher education spending represents a parallel, unregulated "shadow" higher education economy that current public financing policy has done little to redirect.

The composite picture is one of a system where nominal public investment is rising, but three separate and independently measurable indicators — elasticity, relative budget share, and outcome dispersion — all point toward declining unit efficiency and declining relative national commitment, occurring at precisely the moment when private households are voting with their wallets for foreign alternatives at a scale roughly four times the domestic public budget.

Policy Implications

• Efficiency before volume. Because the expenditure elasticity of enrollment is below 1, policy should prioritize per-student cost containment and efficiency (e.g., addressing TU's outsized, low-completion footprint) rather than simply increasing block grants, which the data suggest are not converting proportionally into access gains.

• Close the EMIS data gap for community/private campuses. Since 62% of enrolled students are in campuses with no mandatory full-time faculty reporting, policymakers are effectively managing the system with visibility into only a minority of enrolled students' actual learning conditions.

• Reverse the relative de-prioritization trend. Restoring education's share of total government expenditure toward its historical (2006) level of ~25%, or at minimum halting the decline from ~14%, would require either faster nominal HE budget growth or slower growth in competing sectors.

• Treat the outbound financing gap as a competitiveness signal. A domestic system that cannot retain financing equivalent to even one-third of what leaves the country annually needs either quality-competitive flagship programs or targeted retention incentives (transnational education partnerships, credit-transfer arrangements) rather than only capacity expansion.

• Target completion, not just enrollment. With a gross completion yield on the order of 20–25% (Section 4.8), interventions aimed at reducing dropout and raising pass rates at large institutions like TU likely offer a higher marginal return on public expenditure than further enrollment expansion.

Limitations and Future Research

This paper is constrained by the fact that Nepal does not publish a complete, consistent annual panel across all three variables (expenditure, enrollment, outcomes) at matching levels of granularity. As a result:

• The core elasticity estimate (Section 4.2) rests on essentially two anchor years rather than a full-time series, so it should be read as an approximation of direction and rough magnitude, not a precise econometric parameter.

• The real-terms per-student expenditure adjustment (Section 4.3) uses an assumed average inflation rate rather than an HEI-specific price deflator.

• The composite completion-yield estimate (Section 4.8) combines statistics from different reports and cohorts and should be treated as illustrative.

• Institution-level pass-rate analysis (Section 4.6) uses a sample of seven universities for which comparable EMIS figures were available; a full 22-university panel would refine the dispersion estimates.

Future research should pursue the regression specification proposed in Section 3.2 using a constructed annual panel (FY 2010/11 onward) combining UGC Red Book

allocations, EMIS enrollment and completion figures, and NOC outbound-flow data, ideally with province-level disaggregation given Nepal's federal structure.

Conclusion

Nepal's higher education system has seen genuine nominal growth in both public financing and enrollment over the past decade. However, applying straightforward, transparent mathematical methods — CAGR, elasticity, per-unit expenditure, dispersion statistics, and comparative ratios — to the best available public data reveals a system where funding growth is outpacing access growth, relative fiscal prioritization is declining even as absolute spending rises, quality outcomes are highly uneven and inversely related to institutional scale, and private households are now financing nearly four times as much outbound higher education spending as the state invests domestically. These are not contradictions requiring more funding alone to resolve; they point toward an efficiency, governance, and quality-assurance problem that additional expenditure, absent structural reform, is unlikely to fix on its own.

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