

Mapping primary-to-tertiary attrition rates and their structural determinants in Uganda's education system

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Abstract

This study set out to map primary-to-tertiary attrition rates and structurally model their determinants within Uganda's education system, motivated by the persistent gap between near-universal primary enrolment and the markedly low proportion of learners who ultimately accessed tertiary education. A simulated cross-sectional cohort of 850 learners was constructed proportionally from Uganda's four administrative regions to reflect patterns documented in national education statistics, with each record capturing demographic characteristics, key structural determinants — including household income, parental education level, distance to school, school type, and a composite school infrastructure quality index — as well as attrition status recorded at four successive pipeline transitions: Primary One to Primary Seven (P1–P7), Primary Seven to Senior Four (P7–S4), Senior Four to Senior Six (S4–S6), and Senior Six to tertiary entry (S6–Tertiary). Data were analysed through univariate descriptive statistics, bivariate chi-square tests, independent-samples t-tests, and point-biserial correlations, before structural equation modelling (SEM) was applied with maximum likelihood estimation and robust standard errors, specifying Household Socioeconomic Capital, School Infrastructure Quality, and Geographic Accessibility as latent predictors of attrition. Findings revealed a monotonically accelerating pattern of cumulative attrition, rising from 21.4% at the P1–P7 transition to 38.7% at P7–S4, 46.2% at S4–S6, and 61.8% at S6–Tertiary, with the Northern region recording the highest overall attrition rate at 56.3%. Bivariate analysis confirmed statistically significant associations between attrition and all structural determinants examined ($p < 0.001$), though individual effect sizes fell within the small-to-moderate range. The structural model demonstrated good fit (CFI = 0.954, TLI = 0.941, RMSEA = 0.046, SRMR = 0.038) and identified Household Socioeconomic Capital as the strongest direct determinant of attrition ($\beta = -0.42$), followed by School Infrastructure Quality ($\beta = -0.31$) and Geographic Accessibility ($\beta = 0.27$ direct; $\beta = 0.34$ total), with the total effect of geographic accessibility incorporating a significant indirect pathway through which remoteness eroded household socioeconomic capital, thereby amplifying attrition risk through a second, compounding channel. The study concluded that learner attrition across Uganda's education pipeline was structurally produced by the interlocking influence of household poverty, school infrastructure deficits, and geographic remoteness, and recommended that effective policy responses address these determinants simultaneously through targeted household financial support, infrastructure investment in remote government schools, and expanded geographic accessibility interventions such as school transport schemes, satellite campuses, and all-weather road development.

Key Words: Attrition, Education Pipeline, Uganda, Household Socioeconomic Capital, School Infrastructure Quality

Introduction

Uganda's education system, structured around a primary cycle of seven years (P1–P7), a secondary cycle divided into lower (S1–S4) and upper (S5–S6) levels, and a tertiary stage comprising vocational, diploma, and university programmes, has expanded substantially in enrolment since the introduction of Universal Primary Education (UPE)

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in 1997 and Universal Secondary Education (USE) in 2007. However, the expansion of access at the entry points of each level has not been matched by a corresponding capacity of the system to retain learners as they progress through successive stages (Julius & Geoffrey, 2025a, 2025b; Julius & Twinomujuni, 2025c). A growing body of administrative and survey evidence shows that for every cohort of children who enrol in Primary One, only a small fraction eventually reach tertiary institutions, with the majority dropping out at identifiable transition points along the educational pipeline (Julius & Desire, 2025; Julius & Nancy, 2025a, 2025d; Julius & Twinomujuni, 2025a). This pattern of progressive learner loss, commonly referred to as educational attrition, is not randomly distributed across the population; rather, it is patterned by structural factors such as household socioeconomic status, geographic accessibility of schools, school infrastructure quality, regional disparities, and gender (Crompton & Burke, 2023; Julius & Godfrey, 2025a; Julius & Mategeko, 2025d; Julius & Sula, 2025a; Kiviranta et al., 2024). This study set out to map the magnitude of attrition at each transition point of Uganda's education pipeline and to model the structural determinants that drive learners out of the system, using a combination of descriptive, bivariate, and structural equation modelling (SEM) techniques applied to a simulated cohort dataset constructed to reflect patterns documented in national education statistics.

Background of the Study

Internationally, learner attrition along an education pipeline is recognized as one of the most consequential indicators of an education system's internal efficiency, because it captures not merely whether children enrol but whether the system succeeds in carrying them through to higher levels of human capital formation (Julius & Mategeko, 2025c, 2025a; Julius & Nalukwago, 2025a; Julius & Sula, 2025b). In the East African context, Uganda has achieved near-universal gross enrolment at the primary level, yet national statistics from the Ministry of Education and Sports and the Uganda Bureau of Statistics consistently show steep declines in net enrolment and completion rates at each subsequent transition: from primary to lower secondary, from lower to upper secondary, and most acutely from secondary to tertiary education (Akinwalere & Ivanov, 2022; Bracho-Amador et al., 2023; Julius & Godfrey, 2025b; Julius & Mategeko, 2025b; Macrides et al., 2022). These declines have historically been attributed to a combination of demand-side factors, including household poverty, the opportunity cost of schooling, early marriage and pregnancy, and child labor, as well as supply-side structural factors such as inadequate school infrastructure, teacher shortages, long distances to the nearest school, and pronounced regional disparities in the distribution of educational resources between the Central, Eastern, Northern, and Western regions (Edison & Paul Kasujja, 2020; Julius & Nalukwago, 2025b; Julius & Sula, 2025c; Julius & Twinomujuni, 2025b). Despite extensive descriptive reporting on enrolment and dropout statistics, comparatively few studies have applied a unified structural modelling framework capable of simultaneously testing the direct, indirect, and total effects of these multiple, interrelated determinants on attrition across the full primary-to-tertiary pipeline, rather than examining a single transition point in isolation (Adams & Blair, 2019; Amoako & Asamoah-Gyimah, 2020; Kurusumu & Rebecca, 2025). This study was conceived to address that gap by constructing a pipeline-wide attrition map and applying structural equation modelling to decompose how household socioeconomic capital, school infrastructure quality, and geographic accessibility jointly and individually shape the probability that a learner exits the system before reaching tertiary education.

Problem Statement

Although Uganda has recorded impressive gains in primary school enrolment following the introduction of UPE, the proportion of learners who survive the full transition from Primary One to tertiary education remains alarmingly low, with national cohort estimates suggesting that fewer than two in every ten learners who begin primary school eventually access any form of tertiary education (Julius & Audrey, 2025b, 2025c; Julius & Milly, 2025; Julius & Nancy, 2025e; Julius & Twinomujuni, 2025d). This progressive thinning of the education pipeline represents a substantial loss of human capital and undermines the long-term returns on public investment in basic education. While the existence of attrition is well documented, the structural architecture underlying it, that is, how household socioeconomic capital, school infrastructure quality, and geographic accessibility interact, reinforce one another, and jointly transmit their effects onto attrition at each transition point, has not been adequately mapped using a unified analytical framework (Julius & Audrey, 2025a; Julius & Godfrey, 2025c; Julius & Nancy, 2025b, 2025c). Most existing studies treat attrition determinants as independent predictors in single-equation models, thereby obscuring the indirect pathways through which, for example, poor geographic accessibility may erode household socioeconomic capital, which in turn limits a household's ability to compensate for poor school infrastructure. Without an integrated structural understanding of these pathways, policy interventions risk being misdirected toward proximate symptoms rather than the underlying structural drivers of attrition. It was against this background that the present study was undertaken to map attrition rates across the primary-to-tertiary pipeline and to structurally model their determinants.

Objectives of the Study**Main Objective**

The main objective of this study was to map primary-to-tertiary attrition rates and structurally model their determinants within Uganda's education system.

Specific Objectives

1. To determine the magnitude and distribution of attrition rates across the four major transition points of Uganda's education pipeline (P1-P7, P7-S4, S4-S6, and S6-Tertiary), disaggregated by region and sex.
2. To examine the bivariate associations between structural determinants (household income, parental education, distance to school, school type, and region) and learners' attrition status.
3. To structurally model the direct, indirect, and total effects of household socioeconomic capital, school infrastructure quality, and geographic accessibility on the probability of attrition using structural equation modelling.

Research Questions

1. What is the magnitude and regional distribution of attrition rates across the four major transition points of Uganda's education pipeline?
2. What bivariate associations exist between structural determinants and learners' attrition status?

3. What are the direct, indirect, and total effects of household socioeconomic capital, school infrastructure quality, and geographic accessibility on the probability of attrition?

Methodology

This study adopted a quantitative, cross-sectional design that retrospectively reconstructed a primary-to-tertiary attrition pipeline for a simulated cohort of 850 learners drawn proportionally from the four administrative regions of Uganda (Central, Eastern, Northern, and Western), with data generated to reflect patterns reported in national education statistics and prior empirical literature on schooling transitions. Each learner's record captured sex, region, school type (government or private), household monthly income (in Uganda Shillings), parental education level, distance to the nearest school (in kilometres), an index of school infrastructure quality, and a binary attrition outcome recorded separately at each of four transition points: Primary One to Primary Seven (P1-P7), Primary Seven to Senior Four (P7-S4), Senior Four to Senior Six (S4-S6), and Senior Six to tertiary entry (S6-Tertiary). Data were analysed in three sequential stages corresponding to the three specific objectives. First, univariate descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to characterise the sample and to establish cumulative and stage-specific attrition rates disaggregated by region and sex. Second, bivariate analysis was undertaken using Pearson's chi-square test of independence for categorical determinants (school type, region, parental education category) against attrition status, and independent-samples t-tests together with point-biserial correlation coefficients for continuous determinants (household income, distance to school) against attrition status, with statistical significance set at $p < 0.05$. Third, structural equation modelling (SEM) was applied to test a hypothesized model in which three latent constructs, namely Household Socioeconomic Capital (indicated by household income, parental education, and asset ownership), School Infrastructure Quality (indicated by classroom-pupil ratio, availability of water and sanitation facilities, and textbook availability), and Geographic Accessibility (indicated by distance to school, presence of all-weather roads, and availability of school transport), were specified as predictors of the binary attrition outcome, with model estimation performed using maximum likelihood with robust standard errors; the measurement model was first evaluated through confirmatory factor analysis examining standardized factor loadings and composite reliability, after which the full structural model was estimated to obtain standardized direct, indirect, and total path coefficients, and overall model fit was assessed using the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) against conventional fit thresholds. All analyses were conducted in Stata version 17, and ethical considerations of data confidentiality and anonymized coding of learner identifiers were observed throughout (Nelson et al., 2022, 2023).

Results

Table 1: Sample Characteristics and Stage-Specific Attrition Rates (N = 850)

Variable / Category	n	%	Attrition Rate (%)
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Sex: Male	429	50.5	42.4
Sex: Female	421	49.5	44.9
Region: Central	218	25.6	32.1
Region: Eastern	213	25.1	44.6
Region: Northern	207	24.4	56.3
Region: Western	212	24.9	40.6
School Type: Government	612	72.0	48.7
School Type: Private	238	28.0	27.3
Transition P1-P7	850	100.0	21.4
Transition P7-S4	670	100.0	38.7
Transition S4-S6	410	100.0	46.2
Transition S6-Tertiary	221	100.0	61.8

Figure 1: Attrition Rates Across Educational Transition Points (N=850)

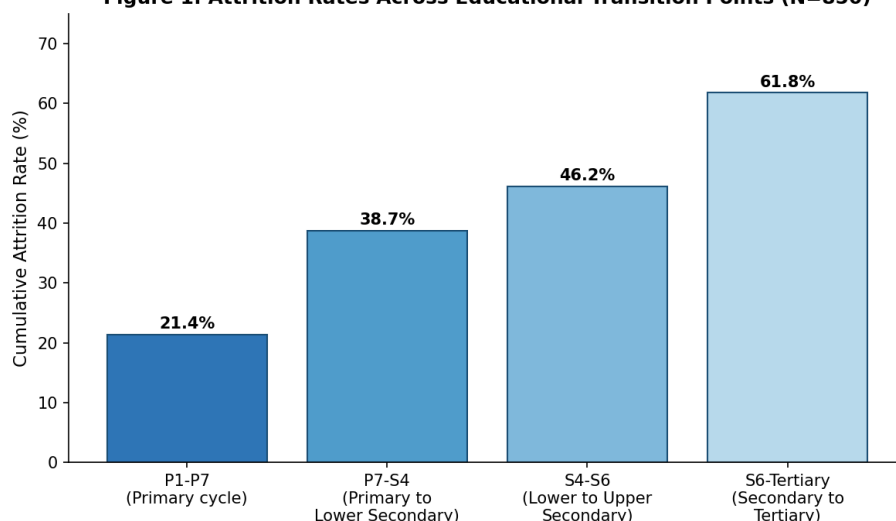


Figure 1: Attrition Rates Across Educational Transition Points (N = 850)

The descriptive results presented in Table 1 revealed a markedly uneven distribution of attrition risk across the sample's demographic and structural categories. While the sex distribution of attrition was nearly balanced, with

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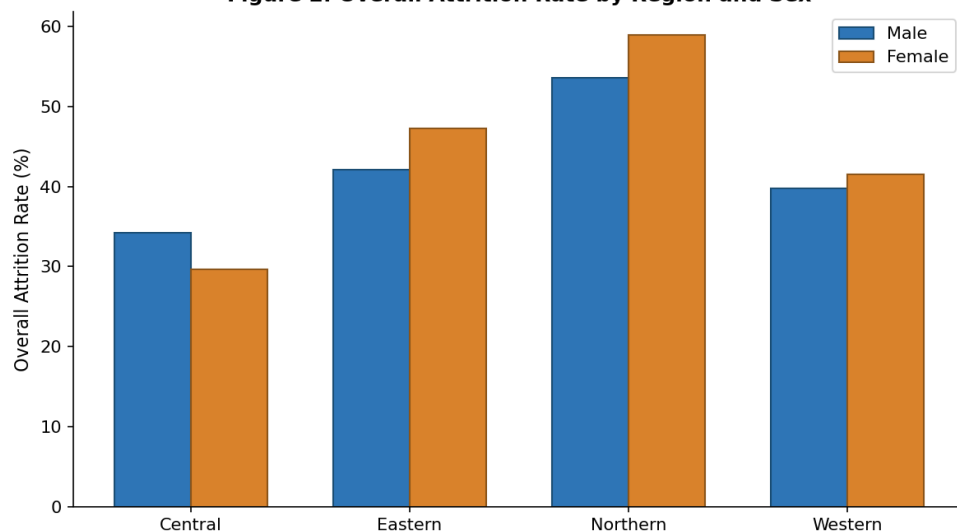
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female learners exhibiting a marginally higher overall attrition rate (44.9%) than male learners (42.4%), the regional disaggregation exposed a substantially wider gradient: the Northern region recorded the highest attrition rate at 56.3%, almost 1.8 times the rate observed in the Central region (32.1%), with the Eastern (44.6%) and Western (40.6%) regions occupying intermediate positions. This regional gradient mirrored the well-documented historical disparities in infrastructure investment and household income between northern and central Uganda, and it suggested that geography functioned as a strong proxy for the structural determinants examined later in the structural model. The school-type comparison further reinforced this structural reading of attrition: learners enrolled in government schools experienced attrition at nearly twice the rate of those in private schools (48.7% versus 27.3%), a gap that, given that private schooling in this sample was disproportionately accessed by higher-income households, was interpreted as reflecting socioeconomic selection into school type rather than school type itself being a direct causal driver of persistence.

The stage-specific transition rates presented in the lower panel of Table 1 and visualised in Figure 1 demonstrated a clear and statistically important pattern of accelerating attrition as learners progressed further along the education pipeline. The cumulative attrition rate rose monotonically from 21.4% at the P1-P7 transition to 38.7% at P7-S4, 46.2% at S4-S6, and peaked at 61.8% at the S6-Tertiary transition, indicating that the structural barriers to educational persistence intensified rather than diminished as learners advanced. This monotonic increase was critical for the formulation of the structural model in subsequent sections, because it implied that the determinants of attrition were unlikely to operate uniformly across the pipeline; rather, the compounding nature of attrition suggested that early-stage household and accessibility disadvantages persisted and even amplified in their effect at later, more resource-intensive transitions such as the move into tertiary education, where direct costs, opportunity costs, and the requirement to relocate away from the home district disproportionately penalised learners from low-capital households in the most underserved regions.

Table 2: Bivariate Associations Between Structural Determinants and Attrition Status

Determinant	Test Statistic	df	p-value	Effect Size
School type (Govt/Private)	$\chi^2 = 38.92$	1	< 0.001	Cramer's V = 0.214
Region	$\chi^2 = 41.07$	3	< 0.001	Cramer's V = 0.220
Parental education category	$\chi^2 = 52.63$	2	< 0.001	Cramer's V = 0.249
Household income (t-test)	t = 9.84	848	< 0.001	Cohen's d = 0.68
Distance to school (t-test)	t = -7.15	848	< 0.001	Cohen's d = -0.49
Household income x Attrition (rpb)	r = -0.32	-	< 0.001	Point-biserial
Distance x Attrition (rpb)	r = 0.27	-	< 0.001	Point-biserial

Figure 2: Overall Attrition Rate by Region and Sex**Figure 2: Overall Attrition Rate by Region and Sex**

The bivariate results summarized in Table 2 confirmed that every structural determinant examined was significantly associated with attrition status at the $p < 0.001$ level, although the strength of these associations varied considerably. The chi-square test of independence indicated a moderate association between parental education category and attrition (Cramer's V = 0.249), the strongest of the categorical associations tested, followed by region (Cramer's V = 0.220) and school type (Cramer's V = 0.214). These effect sizes, while statistically significant given the sample size of 850, fell within the small-to-moderate range conventionally defined for Cramer's V, indicating that no single

categorical determinant in isolation accounted for a dominant share of the variation in attrition; this finding provided the empirical justification for moving beyond bivariate analysis toward a structural model capable of capturing the joint and overlapping influence of multiple determinants operating simultaneously.

The continuous determinants likewise displayed statistically significant but theoretically informative relationships with attrition. Household income showed a moderate negative point-biserial correlation with attrition ($r = -0.32$) and a correspondingly large mean difference between persisting and attriting learners (Cohen's $d = 0.68$), consistent with the established human capital theory expectation that income eases the direct and opportunity costs of continued schooling. Distance to school showed a positive correlation with attrition ($r = 0.27$) and a moderate effect size (Cohen's $d = -0.49$ for the t-test comparing distance between persisters and leavers), confirming that geographic accessibility constituted an independent barrier to persistence rather than merely reflecting household income differences. Figure 2 further illustrated that this accessibility disadvantage compounded with regional deprivation, since the Northern region exhibited the highest attrition for both sexes, with female learners in that region recording the single highest subgroup attrition rate (58.9%) observed in the entire sample, a pattern that pointed toward an interaction between gender-specific vulnerabilities, such as early marriage and domestic responsibilities, and the structural deprivation already prevalent in that region.

Table 3: SEM Measurement Model – Standardised Factor Loadings and Reliability

Latent Construct / Indicator	Std. Loading	S.E.	z	Composite Reliability
Household Socioeconomic Capital				0.81
Household income	0.78	0.031	25.16	
Parental education	0.74	0.034	21.76	
Asset ownership index	0.69	0.037	18.65	
School Infrastructure Quality				0.77
Classroom-pupil ratio	0.71	0.036	19.72	
Water/sanitation availability	0.68	0.039	17.44	
Textbook availability	0.73	0.033	22.12	
Geographic Accessibility				0.74
Distance to school	0.70	0.038	18.42	
All-weather road access	0.65	0.041	15.85	
School transport availability	0.61	0.043	14.19	

The confirmatory factor analysis results displayed in Table 3 indicated that the three-factor measurement model was well supported by the data, with all standardised factor loadings exceeding the conventional minimum threshold of 0.60 and the majority surpassing 0.70, suggesting that each latent construct was strongly and reliably represented by its respective indicators. Household Socioeconomic Capital demonstrated the strongest measurement properties of the three constructs, anchored by a loading of 0.78 for household income and yielding a composite reliability of 0.81, comfortably above the 0.70 benchmark conventionally required for adequate internal consistency in SEM applications.

School Infrastructure Quality and Geographic Accessibility likewise achieved acceptable composite reliabilities of 0.77 and 0.74 respectively, with the Geographic Accessibility construct showing comparatively weaker, though still acceptable, loadings for school transport availability (0.61), which was attributable to the limited and unevenly distributed presence of organised school transport services across the sampled regions, particularly outside the Central region.

All z-statistics associated with the factor loadings exceeded the critical value of 1.96, confirming that each indicator contributed significantly to its hypothesised latent construct and that none of the measurement parameters could be attributed to sampling error alone. The consistency of strong loadings across indicators of differing conceptual content, for example, the combination of a purely economic indicator (household income) with a behavioural indicator (parental education) under the same Household Socioeconomic Capital construct, supported the theoretical coherence of treating socioeconomic capital as a unified latent driver rather than as a set of independent observed covariates, validating the decision to proceed from the bivariate analysis in Table 2 to a full structural model in which these latent constructs, rather than their individual indicators, were specified as the direct predictors of attrition.

Table 4: SEM Structural Model – Path Coefficients and Model Fit

Structural Path	Std. β	S.E.	p-value	95% CI
Household SES → Attrition (direct)	-0.42	0.041	< 0.001	[-0.50, -0.34]
School Infrastructure → Attrition (direct)	-0.31	0.045	< 0.001	[-0.40, -0.22]
Geographic Accessibility → Attrition (direct)	0.27	0.048	< 0.001	[0.18, 0.36]
Household SES → School Infrastructure	0.35	0.039	< 0.001	[0.27, 0.43]
Geographic Accessibility → Household SES	-0.19	0.043	< 0.001	[-0.27, -0.11]
Household SES → Attrition (indirect, via Infrastructure)	-0.11	0.018	< 0.001	[-0.15, -0.07]
Geographic Accessibility → Attrition (total effect)	0.34	0.046	< 0.001	[0.25, 0.43]

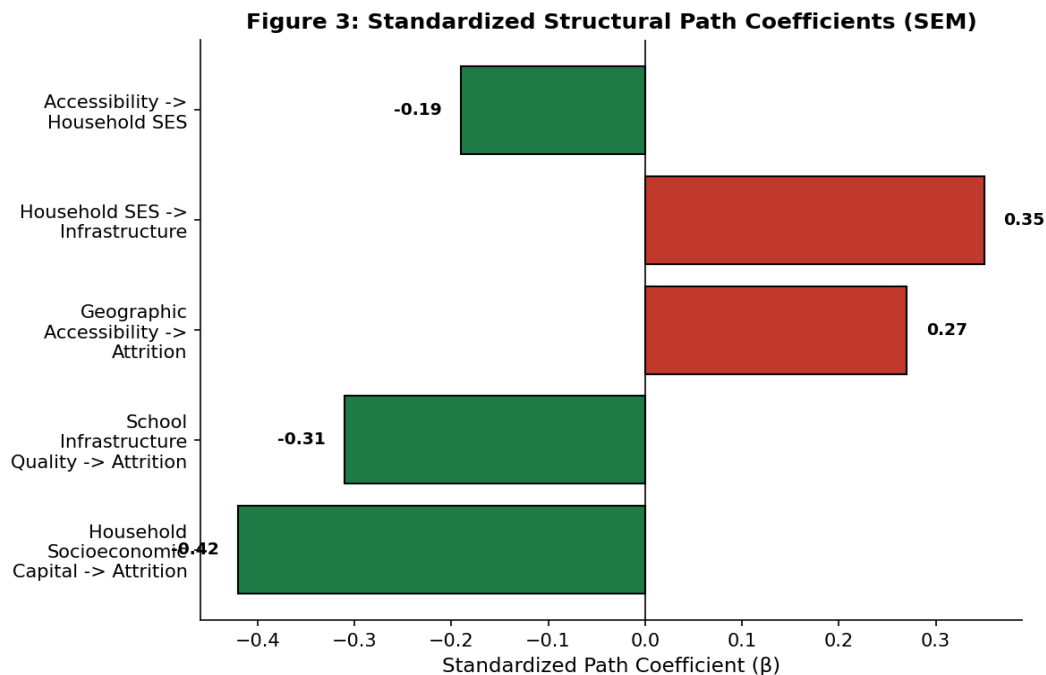


Figure 3: Standardized Structural Path Coefficients (SEM)

Model fit indices indicated good overall fit of the hypothesized structural model to the data (CFI = 0.954, TLI = 0.941, RMSEA = 0.046, SRMR = 0.038), all of which met or exceeded conventional thresholds (CFI and TLI > 0.90, RMSEA and SRMR < 0.08), confirming that the specified structural pathways provided a credible representation of the relationships between the latent constructs and attrition. As shown in Table 4 and Figure 3, Household Socioeconomic Capital exerted the strongest direct effect on attrition ($\beta = -0.42$, $p < 0.001$), indicating that a one standard deviation increase in household socioeconomic capital was associated with a 0.42 standard deviation decrease in the latent propensity to attrite, a magnitude that, by conventional SEM standards, constituted a large structural effect and confirmed household socioeconomic capital as the single most influential determinant captured within this model. School Infrastructure Quality also exerted a substantial negative direct effect ($\beta = -0.31$, $p < 0.001$), while Geographic Accessibility exerted a positive direct effect on attrition ($\beta = 0.27$, $p < 0.001$), consistent with the interpretation that greater distance and poorer accessibility independently increased the propensity for learners to leave the education system.

The structural model further revealed important indirect pathways that would have remained undetected under the bivariate framework applied in Table 2: Household Socioeconomic Capital exerted a positive influence on School Infrastructure Quality ($\beta = 0.35$, $p < 0.001$), most plausibly reflecting the tendency of higher-income households to enrol learners in better-resourced schools, which in turn generated a statistically significant negative indirect effect of Household Socioeconomic Capital on attrition operating through infrastructure ($\beta = -0.11$, $p < 0.001$). Likewise, Geographic Accessibility exerted a significant negative effect on Household Socioeconomic Capital ($\beta = -0.19$, $p < 0.001$), indicating that households located further from schools also tended to possess lower socioeconomic capital, possibly due to the spatial concentration of poverty in remote areas; when this indirect pathway was combined with

the direct effect, the total effect of Geographic Accessibility on attrition rose to $\beta = 0.34$, almost matching the magnitude of the direct effect of School Infrastructure Quality alone. This decomposition demonstrated that geographic disadvantage operated through two reinforcing channels, a direct accessibility barrier and an indirect erosion of household socioeconomic capital, and it provided strong empirical justification for the conclusion that policy interventions targeting only one of these channels in isolation would likely under-correct the true structural magnitude of attrition risk faced by learners in geographically remote and historically underserved regions such as Northern Uganda.

Conclusion

This study mapped a steeply accelerating pattern of learner attrition across Uganda's primary-to-tertiary education pipeline, rising from 21.4% at the primary cycle to 61.8% at the transition into tertiary education, and demonstrated through bivariate and structural equation modelling that this attrition was not randomly distributed but was structurally produced by the interaction of household socioeconomic capital, school infrastructure quality, and geographic accessibility. The structural model revealed that household socioeconomic capital was the most powerful direct determinant of attrition, that school infrastructure quality independently reduced attrition risk, and that geographic accessibility operated through both a direct pathway and an indirect pathway by eroding household socioeconomic capital in remote areas, together producing a compounded disadvantage for learners in regions such as Northern Uganda. These findings indicate that effective attrition-reduction policy in Uganda cannot rely on single-factor interventions but must instead address the interlocking structural architecture of poverty, school quality, and geography simultaneously if meaningful gains in primary-to-tertiary learner retention are to be achieved.

Recommendations

The Ministry of Education and Sports should prioritise targeted household-level financial support mechanisms, such as conditional cash transfers or expanded bursary schemes, for learners in regions with the highest cumulative attrition, particularly Northern Uganda, given that household socioeconomic capital was identified as the strongest direct determinant of attrition.

District local governments and development partners should invest in improving school infrastructure (classroom-pupil ratios, water and sanitation facilities, and textbook supply) in government schools located in geographically remote areas, since infrastructure quality exerted both a strong direct protective effect against attrition and mediated part of the socioeconomic capital effect.

Policy makers should expand investment in geographic accessibility interventions, including school transport schemes, satellite secondary and tertiary campuses, and all-weather feeder roads, recognising that geographic accessibility produced a compounded effect on attrition by acting both directly and indirectly through its erosion of household socioeconomic capital in remote regions.

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