

A model for predicting academic success at lower primary school level: The significance of nursery school attendance

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Abstract

The aim of this study was to develop a model to predict academic success, particularly for lower primary school level. Moving descriptive statistics, cross-tabulation and ordered logistic regression, the study found that, with respect to learner (pupil) characteristics, nursery school attendance was a significant predictor, with increased odds of academic success [OR=1.79, p=0.00]. Regarding school characteristics, studying in an urban centre, Kampala Capital City [OR=1.77, p=0.00] and the rest of urban areas [OR=2.00, p=0.00] had increased odds of a pupil's academic success. Similarly, studying in a privately owned school [OR=4.59, p=0.00] had increased odds for a pupil's academic success.

Therefore, the study recommends that all should attend nursery school before joining formal education. Accordingly, responsible authorities should develop necessary infrastructure to promote nursery school attendance. Also, parity between rural and urban educational practice should be pursued by responsible authorities. For likely academic success, publically owned schools should be run on business model, just on the same model that privately owned schools do.

Keywords: academic success model, kindergarten school, ordered logit regression, Uganda

1. Introduction

1.1 Background Information

This study aimed to develop a model for predicting academic success, particularly for lower primary school level. The interviewees in the study ranged from 5-23 year olds; which age range mostly fall within the pre-operational stage (approximately 2-7 year olds), the concrete operational stage (approximately 8-11 year olds) and the formal operational stage (approximately 15-20 year olds) of human development as articulated by the psychologist Jean Piaget (1896-1980) in the theory on the nature and development of human intelligence^[48-57].

At the pre-operational stage (2-7 year olds) a child begins to learn to speak, develop cognitive capabilities though does not yet understand concrete logic and cannot mentally manipulate information^[48-50]. Thinking in this stage is still egocentric, implying that the child has difficulty seeing the viewpoint of others. The pre-operational stage is usually split into two sub-stages: the symbolic function sub-stage in which a child is able to understand, represent, remember, and picture objects in his/her mind without having the object in front of him/her, and the intuitive thought sub-stage in which a child tends to pose the questions "why?" and "how come?" This is the stage in which a child wants to understand everything^[51]. During concrete operational stage (8-11 year olds), a child's thought processes become more mature and "adult like". A child starts solving problems in a more logical way though abstract approach still lacks and the child can only solve problems that apply to concrete events or objects. At this stage, the child is able to incorporate inductive reasoning involving drawing inferences from observations in order to make generalization but struggles with deductive reasoning involving a generalized principle in order to try to predict the outcome of an event^[52, 53]. At formal operational stage (approximately 15-20 years of

age), adolescence sets in. Adolescence is a period of accelerated physical development in a person's life though generally girls tend to develop faster than boys. At this stage, the young person also experiences cognitive, social, emotional and interpersonal changes as well and outside factors such as the environment, culture, religion, school, and media^[54]. Adolescence may be sub-divided into three stages: early adolescence, in which the individual improves in speech, seeks self-identity, tends to be moody and leans towards peers^[55]; middle adolescence, in which the person, according to^[56], is characterised by unrealistically high expectations and poor self-concept, examination of inner experiences and striving to make new friends; and at late adolescence the individual gains firmer identity, capability to think ideas through and to express ideas in words, emotional control and pride in own work^[57].

This study used secondary data collected in the year 2015 by the National Assessment of Progress in Education (NAPE) of the Uganda National Examinations Board (UNEB). The variables of interest in the dataset were age, gender, nursery school attendance, school location, region where school is found in Uganda and school ownership.

1.2 Literature Review

A wealth of studies has consistently reported that a child's early ability or inability is a strong predictor of his or her future academic success or failure^[1-11]. Considering predictors of academic success, some scholars prioritize cognitive (that is, basic language, mathematics and reasoning) over non-cognitive abilities^[12]; contending that cognitive skills are more significant for predicting later learning. To this point, after controlling for an extensive set of child, family, and contextual influences,^[13] found out that cognitive skills from kindergarten were strong predictors of later academic achievement while on the contrary socio-emotional abilities were not. In fact, in an

exploration of the association between early mathematics, reading, attention, and socio-emotional skills and later reading and mathematics achievement, [13] demonstrated that kindergarten mathematics skills were significantly associated with later achievement for both mathematics and reading. To augment, the findings by [13, 14] showed that early math abilities in kindergarten predicted later academic success strongest while social skills were negligible predictors.

The ensuing discourse notwithstanding, renowned educational philosophers have for ages extolled the merits of holism for the promotion of a healthy mind in a healthy body, contending that academic success and social and emotional aspects of development are inextricably linked [15, 16]. Notably, notions of the 'whole child' are pivotal in many traditions and pedagogies [17]. No wonder, current kindergarten and nursery school curricula ardently emphasize play-based learning in many domains of child development to embrace physical education, citizenship education, civics, arts and music and social clubs [18]. Hence, formal primary school education necessitates a pupil to engage not only in cognitive exercises but also in physical and social programs. To eventually succeed academically, children are deemed to require a comprehensive set of skills that complement each other: cognitive, social, physical, and emotional skills [19]. According to [20], children who are socially adaptable and flexible, as well as physically mature and emotionally stable, have been found to better follow instructions, ask questions, cooperate with peers, work effectively both independently and in groups, curb disruptive behaviours, respect other people and their property, be physically comfortable and communicate effectively. Consequently, such children have been considered apt to succeed academically.

Indeed, a fund of literature on the influence of nursery (preschool) attendance on short-term cognitive development has identified noticeable benefits in several educational settings such as of Bangladesh [21], Uruguay [22], Argentina [23], North India [24], rural Mozambique [25], East Africa [26], Cambodia [27], Malawi [28] and Botswana [29]. Also, a wealth of research in low-, medium-, and high-income countries (especially the USA and UK) has identified positive effects of nursery (preschool) attendance on short-term cognitive and non-cognitive skills development [30-32]. While some of these positive impacts persist into later life, such as increased high school graduation, increased college attendance, reduced risky behaviours and higher earnings [33], many of the cognitive gains attenuate or even dissipate within a few years [34]. A study in Turkey, documented that nursery (preschool) attendance had positive effects on children's school attainment, achievement, and social adjustment at age 10 and 12 but that these effects had dissipated by age 13 and 15 [35]. In fact, studies by [36, 37] have shown positive short-term effects on cognitive skills that tend to diminish over time, as children enter primary or secondary grades. Besides, studies examining the effects of private centre-based or family-based child care programs tend to find smaller or nonsignificant short-term effects when compared with publically funded programs [38]. However, studies by [39, 40] revealed that privately owned outperform public schools.

Relating to age, findings of the effects of relative age on learning achievement suggest that, in developed countries, older pupils in class generally outperform their younger counterparts while the converse is mostly the case in

developing countries (such as Uganda) [41]. To augment the findings by [40, 41] observed that younger pupils of about 8-9 years at primary three class and 10-11 years at primary six class performed better academically compared to their older counterparts; due to the probability that, rather than giving ample time to academics, older pupils get distracted by non-academic affairs that militate against academic success [40]. In fact, findings on the importance of chronological age in relation to academic success are apparently mixed [42].

On assessing regional differences in academic achievement, recourse may be made to the concept of education production function. In essence, the concept posits that academic success is an outcome of a production process where students are considered as input [43]. School is treated as factory with teachers and staff being workers and physical endowments capital. Consequentially, academic success is an output from this production process [44-47]. According to [43], a cursory examination of statistics reveal urban-rural disparities: learners in urban areas performed better than their rural counterparts: since there are considerable disparities in educational resources between these two locations, with learners in urban areas enjoying more educational resources, having higher socioeconomic status and better access to computers at home than rural area learners; parents of urban area learners are better educated compared to parents of learners in rural areas and; schools in rural areas have larger shares of government funding relative to their annual income.

Consensus on a child's early ability or inability being a strong predictor of his or her future academic success or failure may be taken to have been arrived at by scholars [1-11]. However, focussing on specific domain abilities such as cognitive or non-cognitive, the consensus apparently does not hold [12, 13, 15, 16, 19].

1.3 Conceptual Framework

A child's early ability or inability is a strong predictor of his or her future academic success or failure [1-14, 21-32]. Notable scholars prioritize cognitive (that is, basic language, mathematics and reasoning) over non-cognitive abilities [12, 13]. Controlling for an extensive set of child, family, and contextual influences, [13] noted that cognitive skills from kindergarten were consistent and strong predictors of later academic achievement while, on the contrary, socio-emotional abilities had few consistently strong predictors. In fact, [13] demonstrated that kindergarten mathematics skills were associated the strongest with later achievement for both mathematics and reading.

Regarding later academic success, nursery (preschool) attendance has registered salient benefits in several educational settings such as of Bangladesh [21], Uruguay [22], Argentina [23], North India [24], rural Mozambique [25], East Africa [26], Cambodia [27], Malawi [28] and Botswana [29]. However, while some of these positive impacts persist into later life, many of the cognitive gains attenuate or even dissipate within a few years [33, 34]. Relating to age, research findings show that, in developed countries, older pupils in class generally outperform their younger counterparts while the converse is mostly the case in developing countries [35, 41], especially among the eight-to-nine year olds at lower primary (primary three class), whether boy or girl [40].

Several studies also demonstrate that region of the country in which school is found, location of school in either urban or

rural [40, 43] and school ownership, whether public or private [39, 40] are significant factors in determining academic success or failure.

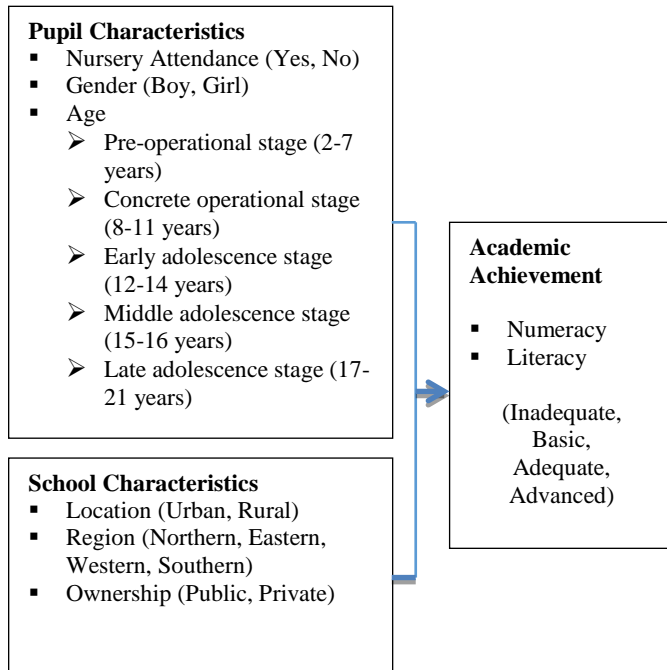


Fig 1: Conceptual framework for predictors of academic achievement at lower primary level

1.4 Objectives of the Study

The aim of this study was to develop a model for predicting academic success. Specifically, the study sought to investigate whether (i) learner characteristics predict academic success, (ii) whether school characteristics predict academic success and (iii) to find the determinants of academic achievement among pupils in lower primary.

2. Materials and Methods

The materials and methods moved to accomplish the objectives of the study encompassed data acquisition and data analysis, as follows.

2.1 Data Source

The study used secondary data on progress in education, collected in the year 2015 by the National Assessment of Progress in Education (NAPE) of the Uganda National Examinations Board (UNEB). The dataset on primary three pupils, contained 24,043 data points on variables of interest including age (in completed years), gender (boy, girl), nursery school attendance (yes, no), school location (urban, rural), region where school is found in Uganda (Northern, Eastern, Western, Southern, Kampala Capital City) and school ownership (public, private).

2.2 Data Analysis

In determining academic achievement of the study respondents (i.e. primary three pupils), the study averaged pupil score in numeracy (mathematics) and literacy (English language) and came up with the following classification of academic achievement: score of 0-25 percent as inadequate, 26-45 percent as basic, 46-74 percent as adequate and 75-100 percent as advanced.

At univariate level, a descriptive summary of pupil and school characteristics using frequency distributions was done. Then, at bivariate level, academic achievement by pupil and school characteristics was assessed using cross tabular analysis and associations were investigated using Pearson’s chi-square test. Pearson’s chi-square test is given by equation (1).

$$\chi^2 = \sum_{i=1}^2 \sum_{j=1}^2 \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \tag{1}$$

Where, O_{ij} is the number of individuals observed in the i^{th} row and j^{th} column cell, E_{ij} is the number of individuals expected in the i^{th} row and j^{th} column cell,

The variables that were significant at the bivariate level were considered for further analysis. At multivariate level, since the dependent variable, academic achievement was an ordinal outcome, the ordered logistic regression model was fitted to assess the effect of pupil and school characteristics on academic achievement; based on equation (2).

$$\log \left(\frac{\Pr(y_i=j)}{\Pr(y_i=1)} \right) = \alpha_j + \beta_1 \text{region}_{\text{east}} + \beta_2 \text{region}_{\text{kampala}} + \beta_3 \text{region}_{\text{north}} + \beta_4 \text{region}_{\text{west}} + \beta_5 \text{location}_{\text{urban}} + \beta_6 \text{owner}_{\text{private}} + \beta_7 \text{nursery}_{\text{attend}} + \beta_8 \text{age}_{2-7 \text{ years}} + \beta_9 \text{age}_{8-11 \text{ years}} + \beta_{10} \text{age}_{12-14 \text{ years}} + \beta_{11} \text{age}_{15-16 \text{ years}} + \beta_{11} \text{age}_{17-21 \text{ years}} + \epsilon_i$$

Where, $\alpha_1 < \alpha_2 < \dots < \alpha_{k-1}$, $\beta_1 \dots \beta_{11}$ are regression coefficients and ϵ_i the error term which follows a logistic distribution with mean 0 and variance $\pi^2/3$. (2)

3. Results

This section presents findings of the study, grouped as: description of interviewees, association between plausible independent variables and academic achievement and, determinants of academic achievement (where the model for predicting academic success at lower primary school level is shown).

3.1 Description of Interviewees

The Table 1 that follows describes the pupils interviewed with reference to the nature of school which they attended and their (pupil’s) nursery attendance, academic achievement, gender, age group, location and region.

Table 1: Description of interviewees

Variable	Category	Freq.	%
Attended nursery	No	9,823	45.25
	Yes	11,885	54.75
Academic achievement	Inadequate	584	2.43
	Basic	4,734	19.73
	Adequate	10,193	42.48
	Advanced	8,481	35.35
Gender	Boy	12,445	51.76
	Girl	11,597	48.24
Age group	2-7 years	328	1.36
	8-11 years	17,665	73.48
	12-14 years	5,821	24.21
	15-16 years	202	0.84
	17-21 years	26	0.11
School ownership	Public	19,836	82.51
	Private	4,206	17.49
Location	Rural	20,303	84.45
	Urban	3,739	15.55
Region	Central	4,816	20.03
	East	6,830	28.41
	Kampala	463	1.93
	North	6,166	25.65
	West	5,767	23.99

From Table 1, the majority (84.45%) of the pupils were studying in rural areas while only few (15.55%) were studying in urban centres; the majority (82.51%) were studying in government owned schools whereas (17.49%) were so doing in privately owned schools; slightly above average (54.73%) had attended nursery school but the rest (42.25%) had not; less than half of the pupils (42.48%) attained adequate level of expected academic achievement and those who attained advanced, that is, the highest level of expected academic achievement were few (35.35%) while on the other side of the

spectrum a few (19.73%) managed to attain the basic expected but worse than basic were some (2.42%) at inadequate level.

3.2 Plausible Independent Variables and Academic Achievement

Analysis of the relationships of the potential factors with academic achievement shown in Table 2 indicates that all the factors had a significant association ($p < 0.05$) with academic achievement among lower primary pupils.

Table 2: Association between plausible independent variables and academic achievement.

Variable		Academic achievement			
		In-adequate (%)	Basic (%)	Adequate (%)	Advanced (%)
Region	Central	0.52	8.15	36.00	55.32
	East	4.53	28.32	41.51	25.64
	Kampala	0.43	1.30	10.80	87.47
	North	3.25	28.02	49.75	18.99
	West	0.85	11.89	43.83	43.43
Pearson chi2 (12) = 3.2e+03 Pr = 0.000					
Location	Rural	2.65	21.47	45.18	30.7
	Urban	1.26	10.33	27.88	60.53
Pearson chi2 (3) = 1.2e+03 Pr = 0.000					
School owner-ship	Public	2.92	22.85	46.35	27.88
	Private	0.14	5.05	24.26	70.55
Pearson chi2 (3) = 2.8e+03 Pr = 0.000					
Age group	2-7 years	5.18	16.46	32.01	46.34
	8-11 years	2.56	20.05	40.46	36.94
	12-14 years	1.88	18.88	49.11	30.13
	15-16 years	1.98	21.29	48.02	28.71
	17-21 years	11.54	26.92	23.08	38.46
Pearson chi2 (12) = 193.9476 Pr = 0.000					
Attended nursery	No	3.45	24.99	49.76	21.8
	Yes	0.95	12.37	36.97	49.71
Pearson chi2 (3) = 2.0e+03 Pr = 0.000					
Gender	Boy	2.02	19.88	43.92	34.18
	Girl	2.88	19.57	40.94	36.61
Pearson chi2 (3) = 40.8280 Pr = 0.000					

From Table 2, the highest proportion attaining advanced academic achievement were pupils who had attended nursery school (49.71%), girls (36.61%) and the 2-7 year olds (pre-operational stage) - (46.34%) whereas the highest proportion with inadequate academic achievement was among; pupils who never attended nursery (3.45%), girls (2.88%) and the 17-21 year olds (late adolescence stage) - (11.54%).

The highest proportion attaining advanced academic achievement were schools located in urban areas (60.53%), Kampala, the capital city of Uganda (87.47%) and privately

owned schools (70.55%) whereas the highest proportion with inadequate academic achievement was among schools located in rural areas (2.62%): Eastern region (4.53%) and government owned (2.92%).

3.3 Determinants of Academic Achievement among Pupils in Lower Primary

The Table 3.3 which follows presents determinants of academic achievement among pupils in lower primary school.

Table 3: Determinants of academic achievement among pupils in lower primary

Variable	Odds Ratio	Std. Err.	Z	P> z	95% Conf. Interval		
Region	Central	1.00					
	Eastern	0.25	0.01	-32.90	0.00	0.23	0.28
	Kampala	1.77	0.29	3.47	0.00	1.28	2.44
	Northern	0.26	0.01	-31.13	0.00	0.24	0.29
	Western	0.72	0.03	-7.88	0.00	0.66	0.78
Location	Rural	1.00					
	Urban	2.00	0.09	16.14	0.00	1.84	2.17
School ownership	Public	1.00					
	Private	4.59	0.19	36.14	0.00	4.23	4.99
Age group	2-7 years	1.00					
	8-11 years	1.16	0.15	1.21	0.23	0.91	1.49
	12-14 years	1.27	0.16	1.87	0.06	0.99	1.63
	15-16 years	1.22	0.23	1.06	0.29	0.84	1.77
	17-21 years	1.15	0.57	0.28	0.78	0.43	3.06
Attended nursery	No	1.00					
	Yes	1.79	0.05	20.24	0.00	1.70	1.90
Gender	Boy	1.00					
	Girl	0.99	0.03	-0.26	0.80	0.94	1.05

Findings derived from the ordinal logistic model presented in Table 3, show that for the students in the Eastern region, the odds of attaining advanced academic achievement versus the combined adequate, basic and inadequate academic achievement are 0.25 times lower than for students in the Central region if the other variables are held constant. For the students in Kampala, the odds of attaining advanced academic achievement versus the combined adequate, basic and inadequate academic achievement are 1.77 times higher than for students in the Central region if the other variables are held constant.

The odds of attaining advanced academic achievement for the students in the Northern region, versus the combined adequate, basic and inadequate academic achievement are 0.26 times lower than for students in the Central region given the other variables are held constant. For students in the Western region, the odds of attaining advanced academic achievement versus the combined adequate, basic and inadequate academic achievement are 0.72 times lower than for students in the Central region given the other variables are held constant.

The odds of attaining advanced academic achievement for the students in the rural areas versus the combined adequate, basic and inadequate academic achievement are 2 times higher than for students in the urban areas given the other variables are held constant. For students in privately owned schools, the odds of attaining advanced academic achievement versus the combined adequate, basic and inadequate academic achievement are 4.59 times higher than for students in public (government) owned schools given the other variables are held constant.

The odds of attaining advanced academic achievement for the students who attended nursery school, versus the combined adequate, basic and inadequate academic achievement are 1.79 times higher than for students who never attended nursery school given the other variables are held constant.

The academic achievement ordered logistic regression model is thus given below with coefficients reported in place of odds ratios:

$$\log\left(\frac{\Pr(y_i=j)}{\Pr(y_i=1)}\right) = 0.58nursery_{attend} + 0.69location_{urban} + 0.57region_{kampala} - 1.37region_{east} - 1.32region_{north} - 0.33region_{west} + 1.52owner_{private} + \epsilon_i \quad \dots (3)$$

4. Discussion

Relating on pupil characteristics, this study found out that the highest proportion attaining advanced academic achievement were those students who had attended nursery school (49.71%), which is in consonance with observations by [1-14, 21-32]. The model analysis confirmed that nursery school attendance is a statistically significant predictor of academic success [OR=1.79, p=0.00].

Focussing on school characteristics, this study found out that attaining advanced academic achievement was significantly higher among schools located in Kampala (the capital city) and urban areas [OR=1.77, p=0.00]. This is in agreement with the observations by [43] which note that a cursory examination of statistics reveal urban-rural disparities whereby learners in urban areas perform better than their rural counterparts: since there are considerable disparities in educational resources

between these two locations, with learners in urban areas enjoying more educational resources, having higher socioeconomic status and better access to computers at home than rural area learners; parents of urban area learners are better educated compared to parents of learners in rural areas and; schools in rural areas have larger shares of government funding relative to their annual income. Also found to be a strong predictor of academic success was the characteristic of studying in a privately owned school [OR=4.59, p=0.00] which concurs with the studies by ^[39, 40] which demonstrate that private schools do outperform public schools, probably because private schools are mostly run on strict business model.

The following characteristics were not statistically significant predictors of academic success. The characteristic of being girl compared to being a boy and higher age groups compared to lower age groups, unlike findings by ^[53, 54] which report that at early stages of human development, girls tend to mature faster and they then outperform boys were not significant. However, findings by ^[40, 41] note that younger pupils outperform their older counterparts, particularly in developing countries.

5. Conclusion

This focus of this study was to develop a model for predicting academic success among school going children. The specific objectives of the study were to find (i) whether learner characteristics predict academic success, (ii) whether school characteristics predict academic success and (iii) to find the determinants of academic achievement among pupils in lower primary.

Accordingly, the study found out that, with respect to learner (pupil) characteristics, nursery school attendance was a statistically significant predictor of academic success. Regarding school characteristics, the study found out that studying in an urban area, Kampala capital city and the rest of urban areas were significant predictors of academic success. Also, studying in a privately owned school was a very strong predictor of academic success. The study developed a model for predicting academic success.

6. Recommendations

Based on the findings of the study, the following recommendations are advanced.

- i) Nursery school attendance is advisable for all before joining formal education. As such, responsible authorities should develop necessary infrastructure to promote nursery school attendance.
- ii) Parity between rural and urban educational practice should be ensured by responsible authorities.
- iii) For likely academic success, publically owned schools should be run on business model, just on the same model that privately owned schools do.

7. References

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