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ORIGINAL ARTICLE

Pathways to Economics Achievement: Modeling Student and School Attributes Mediated by Abilities

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ABSTRACT

This study models the influence of student and school attributes mediated by effects of numerical and graphical abilities on achievement of students in economics. Factors influencing student achievement are home, student, school, or environment related. Subject content is also an important factor which determines achievement. There are three ways to explain Economic phenomena; words, mathematically, or graphically. Therefore, level of ability in these approaches is an important determinant of student level of achievement. Participants of the research are Senior Secondary School II (SSS 2) students who enrolled in an economics class in Ibadan metropolis of Oyo states, Nigeria. There are 61 students from private and 437 from public school while the average age of the students is 15.29. A path analysis was used in the study following a hypothesized and modified model to ensure model-data fit. This study shows that school type is an important factor either with direct or indirect effect on achievement while class and the age of the student have indirect effect on achievement either through numerical or graphical ability. Also, numerical and graphical ability have a significant direct effect on achievement. This study revealed the need to emulate traditions of certain schools. Students in less mathematically and graph-oriented classes should have more time devoted to strengthening basic knowledge in this area so they can improve their level of knowledge and achievement. A latent model approach in a Bayesian framework is a viable alternative. The researchers recommend the inclusion of other variables in future studies to gain further insights into how these factors may affect economics achievement.

Keywords: Numerical abilities, Graphical abilities, Economics Achievement, School type, Class classification

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INTRODUCTION

There are several definitions given by economists to explain the subject of Economics. A general view refers to Economics as a commercial (social science) subject that studies human beings, their behaviors and interaction with resources (Oleabhiele & Oleabhiele, 2015). Hence the study of Economics includes learning of the forces of interaction between demand and supply of goods and services which is utmost to the living of humans. Economics also explains how humans make rational decisions to maximize utility from resources (Mohammed & Pitan, 2022).

Economics is a major subject for students in commercial class classification of secondary school (equivalent to K-12 education in the United States) in Nigeria. The basic concepts of Economics include wants, scarcity, choice, scale of preference and opportunity cost. These concepts explain basic needs of the individual, insufficiency of resources to satisfy those needs, and how the limited resources can be maximized to meet the daily human needs. This makes Economics one of the essential subjects to be studied or taught in the senior secondary school as it aims to equip students with the prerequisite knowledge and skills needed to understand the workings of the nation, harness the nation's resources to bring about job opportunities and wealth creation, and in return contribute to the overall growth and development of the nation (Akin-Ibidiran et al., 2022; Oleabhiele & Oleabhiele, 2015).

The teaching of Economics cut across topics that involves mathematical concepts which are calculations and graphs, with the ability to accurately present topics using correct grammatical expressions referred to as verbal ability. Topics like demand, supply, elasticity, production, and many more involves complex definitions that makes use of economics terminologies and graphical expression in the explanation of its concepts.

Students' dexterity in the knowledge and application of mathematical rules in economics exams and adequate knowledge of economic terminology is essential to their academic achievement. Economics makes use of terminologies that are mostly particular to the subject, which students should be well-acquainted with in order to perform better in examinations. For example, Demand, a concept in Economics is defined as the desire to buy certain quantities of goods and services, at a particular time with the ability to pay. This definition should be written by students with terminologies to get the total marks allotted for such definition in an examination as it is centered on quantity of goods, price, and ability to pay (Dwivedi, 2004).

Additionally, alongside the definition, there might be a given Economic equation to express the demand in relation to price.

$$q_x^d = f_{i=1\ldots j}\,, \quad (1)$$

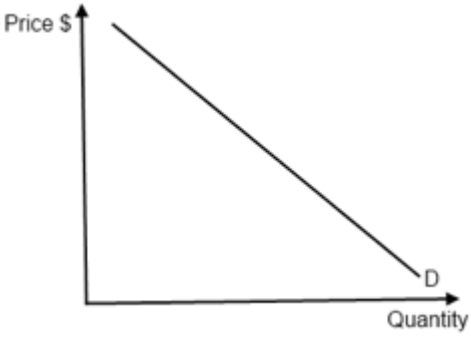
The general demand function can be represented with equation 1 which shows that quantity demanded of product *x* is a function of *j* factors which includes price of the product, the price of related products, income of the

consumer and many other factors. If all other factors are held constant except the price of the product, the following equation can be used;

$$Qd = \alpha - \beta(P), \quad (2)$$

From (2), Qd is the quantity demanded, α infers all other factors affecting quantity demand except the price of the product, β refers to the slope of the demand curve while P refers to the price of the product. Students are expected to plot the graph or curve to illustrate this relationship. For example, the graph below shows a typical demand curve.

Figure 1. *Demand curve*



Therefore, Economics as a subject, requires numerical skills, graphical skills and knowledge of necessary terminology which can be referred to as verbal skills to achieve success by students. These skills are determined by the level of cognitive development of students.

The complexity involved in the subject makes most Economics exams crucial and thus, require utmost learning and effort from the students. Moreover, researchers have found that there had been fluctuating performance of student in most Economics Exams especially the West African Examination Council (WAEC), taken by the SSS Class III students (Alimi et al., 2012; Idika et al., 2018; WAEC 2015-2020). In relation to this, the WAEC examiners from 2015-2022 reported a low performance with the following reasons: the inability of students to solve questions on graphs, draw graphs and analyze graph-related questions accurately; to answer questions with the appropriate economic terminology and to solve mathematical related questions. Lastly, the use of wrong terminologies in providing answers to questions by students was also a reason for low performance. These reasons were presented by the WAEC examiners report (2015-2020) to help teachers and students understand the required areas that should be addressed.

Literature Review

Through various research work, psychologists find out that cognitive development determines student ability which influences academic achievement (Kuncel & Henzlett, 2010). Cognitive ability includes calculative/numerical skill, graphical skill, and verbal skills. Verbal skill refers to the student's ability to use simple and proper grammatical words or languages to communicate in written or oral form the knowledge of a particular concept. It includes every aspect of speaking and writing (Anazia, 2019; Ones et al., 2005).

Numerical ability defines the ability of students to intelligently calculate, involving addition, subtraction, multiplication and divisions in simple mathematics-related work or equations (Koshy et al., 2009). Similarly, graphical ability involves transformation of numerical values to graphical representations or sometimes identification of graphs based on previous knowledge of such graphical representations. It also measures student ability to interpret graphs and convert equations to pictorial expressions in the form of graphs and curves (Cadenas, 1999; Ibrahim & Tollison, 2015).

Researchers also found that cognitive development is not independent of other factors that determine academic achievement. Such factors include demographic and sociological variables like age, sex, school type and environment, class classification, and many others (Abubakar & Oguguo, 2011; Ayodele, 2000). This study focused on school attributes (school type, class classification) and student attributes (sex and age).

There are primarily two school types in the Nigerian educational system, which are the private and public schools. Private schools are owned by individual and private entities established for the purpose of making profit while teaching and learning are considered the basis for the organization of the school system. On the other hand, public schools are owned, manage, directed, and supervised by government and its agencies to provide education at low and subsidized fee to members of the society with the aim of making education open and free for all (Alimi et al., 2012; Aransi, 2018).

Alimi et al. (2012) shows that school type is an important factor to consider by parents or guardians for their children's education due to differences in facilities, structures and atmosphere that might foster healthy learning. Alimi et al. (2012) further reported that private schools are more well-equipped than certain public schools.

Also, the study carried out by Milun et al. (2016) on the impact of age and sex on academic success of students shows that females perform better than male in certain subjects like English language, Economics and Accounting while older students perform better than their younger peers.

Abubakar and Oguguo (2011)'s study shows that biological sex and age have a positive influence on the performance of students. Also, Aransi (2018)'s study on the impact of age and biological sex on the academic performance of students in Economics reported a positive correlation between the chronological age of students with their achievement in Economics and biological sex contributes positively to students' performance in economics. Therefore, in view of these studies, it might be necessary to further consider the interaction between these schools and student attributes as they influence student achievement in Economics .

There are inconsistent and inconclusive results on the effect of age and sex as a factor predicting academic achievement (Buadi 2000; Robbins et al., 2004; Salamonson et al., 2013). Students' sex is identified as a prominent determinant of students' cognitive level, which is not largely established except for certain research work that found striking balance with age and sex (Hanan et al., 2015; Viviline et al., 2013). For instance, John et al. (2015) found that the

chronological age of a student significantly impacted academic performance as the youngest student could score higher than older mate in certain subjects. Also, Abubakar and Adegboyega (2012) found a similar report as there is a positive correlation between age and academic achievement with sex and academic achievement in Mathematics among students. However, age was reported to have a higher effect on student academic achievement. Apparently, age and sex of students have impact on the academic achievement of students; however, these impacts differ as there is no conclusive report, but they serve as evidence of established interwoven factors that determines student performances as they interact with other student attributes.

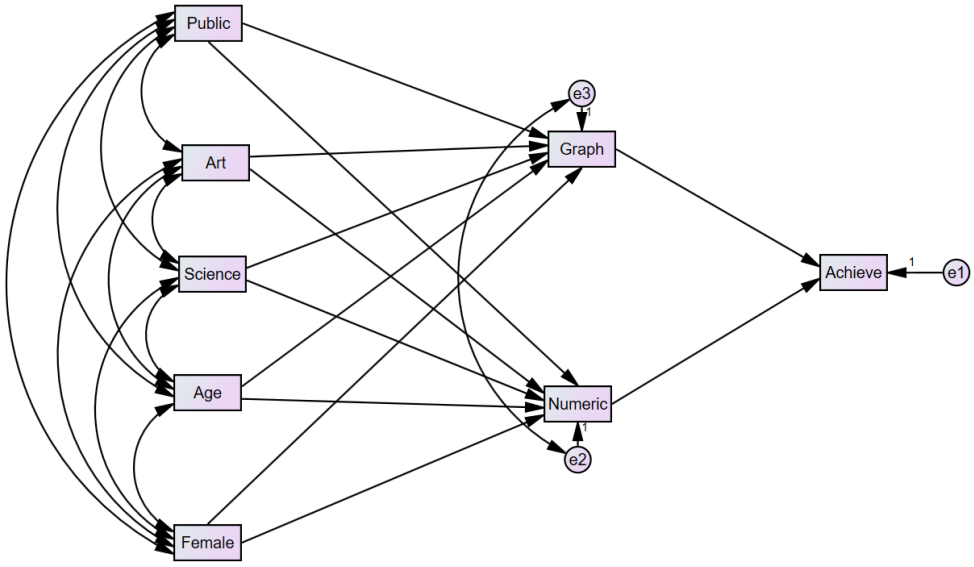
Consequently, school type does not stand alone as a significant factor that determines student academic achievement, class classification is also a contributory factor (Aransi, 2018; Sunday 2014). Class classification plays a significant role in determining the future success of students as they pass through secondary school learning to the higher institutions of learning . In Junior Secondary School (JSS) III (K-9), students are majorly evaluated based on their final examination results to determine the appropriate class to enroll in as they commence the senior secondary class 1 (K-10). Hence, students are grouped into three different classes which include the Sciences with main subjects such as Physics, Chemistry and Biology; the Commercial (Social Sciences) class with main subjects such as Economics, Commerce and Accounting, and the Art (Humanities) class with main subjects such as English literature, Government and History. These classifications are specified in most SSS classes in Nigeria aside from the compulsory subjects, which are primarily Mathematics and English language (Aransi, 2018).

Students whose results show a strong base in mathematics and other related numerical subjects are recommended to enroll in Sciences, while others are channeled into Commercial and Art according to their strength based on the evaluated JSS results. These class classifications provide students with structured learning and streamline the acquisition of knowledge. However, each student is expected to achieve the best in each separated class. The extent to which this is achieved depends on many other factors, irrespective of the division to classes (Aransi, 2018; Philias & Wanjobi, 2011).

Hypothesized path model

Figure 2 depicts the hypothesized path model for this study. Given the understanding of important content of numerical and graphical topics and application, we hypothesize that the exogenous variables in the study should have only an indirect effect on achievement mediated by numerical and graphical ability.

Figure 2. *Study hypothesized model*



Since the exogenous variables are determined outside the model, we hypothesize a possible relationship between them which might interact and influence the relationship with the endogenous variables. For instance, certain types of schools might have specific classes, and students' ages might differ depending on the class they are in. The sex of the students might also affect the class choice and the school type might affect number of students in a class. The proportion of students in science class in relation to total number of students in a private school might be higher than students in science class of a public school. In the study sample, it was found that 32.79% of SS 2 students in private schools were in the Science class, whereas only 18.77% of SS 2 students in public schools were in the Science class.

These variables can influence achievement in the numerical and graphical abilities of students. Research findings show that males perform better in numerical related problems (Adegboyega, 2012), and there has been no consensus on how age relates to achievement (Buadi, 2000,; Robbins et al., 2004; Salamonson et al., 2013). Meanwhile, students in art classes are engaged with less mathematical-oriented subjects unlike science and commercial students. Students in private schools are likely to have higher required standards set for mathematics irrespective of class while those in public schools pay less attention to mathematics especially once class classification is decided and it is not science stream. Finally, we hypothesize that both numerical and graphical abilities have direct effects on economics achievement.

Research Questions

The following questions will guide the study:

1. How does school type (public and private), class (Art, Commercial and Science), and biological sex (male and female) indirectly influence economics achievement among students, considering numerical ability and graphical ability as mediating variables?
2. To what extent do the exogenous variables predict numerical and graphical ability and effect economics achievement?

METHOD

Research Design

This study used a correlation research method. The population of the study comprised of Senior Secondary School 2 students who were enrolled in Economics as a subject in Ibadan, Oyo state. A multistage sampling procedure was used in this study. Four local governments were randomly selected out of the eleven local governments that exist in Ibadan urban and semi-urban communities. Three senior secondary schools were randomly selected in each of the four local governments which make up the total number of 12 schools selected in the local government areas. An intact class of students taking Economics as a subject within the school was purposively selected from each school since schools that do not offer the subject were not eligible for the study.

Setting and Participants

Student (sex and age) and school attributes (school type and class) are exogenous variables in this study, while numerical and graphical ability are the mediating variables and economics achievement score is the endogenous variable. In the study, the exogenous variables except age were transformed into dummy variables to enable meaningful comparisons and interpretations. Specifically, mean age ($\hat{x}_a$) for Sex, Male (n = 221, $\hat{x}_a$ = 15.57) was chosen as the reference group, and Female (n = 277, $\hat{x}_a$ = 15.06) was included in the model to analyze the biological sex differences in economics achievement.

Similarly, for the variable School Type, Private (n = 437, $\hat{x}_a$ = 14.44) was used as the reference group, and Public (n = 61, $\hat{x}_a$ = 15.41) was included in the model. This allowed for an examination of the contrasts between students attending private and public schools regarding their numerical, graphical ability and economics achievement. In terms of the variable Class, Commercial (n = 269, $\hat{x}_a$ = 15.1) was selected as the reference group since economics is an essential subject in any area of their future profession, while Art (n = 102, $\hat{x}_a = 15.69$) and Science (n = 269, $\hat{x}_a = 15.10$) classes were included in the study. This permitted the investigation of the differences in numerical, graphical ability and economics achievement between students in the Commercial class and those in the Art and Science classes.

By employing dummy variables and selecting right reference groups, the study was able to explore the specific effects of each variable while controlling for the influences of the reference categories. This approach provides a comprehensive understanding of the unique contributions of sex, school type, and class on economics achievement, enabling the research to draw more accurate and nuanced conclusions about their impact on students' economic achievement.

Table 1. Descriptive analysis of data used for the study

School	Class	Sex	n	Age	Graphical ability	Numerical ability	Achievement
Private	Art	Male	15	14.6 (1.06)	8.4 (2.90)	10.07 (4.30)	21.13 (6.23)
		Female	20	14.05 (1.23)	8.95 (1.88)	10.65 (3.30)	22.5 (5.24)
	Commercial	Male	1	14	4	3	15
		Female	5	14.2 (0.45)	8 (1.22)	8.8 (4.44)	18.8 (3.83)
	Science	Male	7	15.43 (1.40)	8.43 (1.27)	8.43 (4.23)	20.71 (5.41)
		Female	13	14.46 (1.45)	7.69 (2.10)	7.62 (4.50)	17.38 (4.59)
Public	Art	Male	104	15.47 (1.21)	6.17 (2.41)	7.25 (3.43)	13.53 (4.07)
		Female	130	15.02 (1.18)	6.28 (2.32)	6.83 (3.19)	13.91 (4.26)
	Commercial	Male	45	15.51 (1.59)	5.29 (2.37)	4.62 (2.71)	12.64 (3.85)
		Female	76	15.39 (1.29)	5.86 (2.39)	6.83 (3.05)	12.38 (3.58)
	Science	Male	49	16.20 (1.15)	4.47 (1.79)	4.31 (2.11)	11.78 (3.65)
		Female	33	15.45 (0.87)	5.48 (1.79)	4.39 (2.30)	12.06 (3.72)

Note: The values in the parenthesis represents standard deviation

Software

Open-source software (R) with its Integrated Developed Environment (IDE) RStudio was used while the packages used include Remotes for data import and tidyverse for compact descriptive tables. The Kr-20 function of the Psych package was used for the reliability estimates while Lavaan was used for the path model analysis.

Instruments

Forty items were developed to test basic numerical and graphical knowledge from which 15 were selected after trial testing. The final Numerical Ability Test (NAT) had content validity index (CVI) of 0.83 while Kuder-Richardson 20 (Kr-20) was used to estimate the reliability which was 0.90. The final Graphical Ability Test (GTA) had CVI of 0.75 and Kr-20 of 0.81. The initial test blueprint was developed from the subject curriculum for SS1 and SS2 content since the students are expected to have covered it, then the blueprint was scaled to derive 120 items which was trial tested for the Economics Achievement Test (EAT). After the trial testing and estimating item psychometrics, 40 items were selected, and they had Kr-20 of 0.79. A minimum of forty minutes and maximum of one hour was used by most students to attend

to the items which is a total number of seventy items (NAT: 15, GAT: 15, and EAT: 40).

RESULTS

The following research questions will be addressed in this study:

4.1 Research question 1: How does school type (public and private), class (Art, commercial and science), biological sex (male and female) indirectly influence economics achievement among students, considering numerical ability and graphical ability as moderating variables?

In Table 2, modifications have been proposed to improve the fit of the model by incorporating additional relationships between variables. One notable modification is the inclusion of the direct effect of school type on economics achievement. This modification aligns with theoretical foundations, existing literature, and common sense, making it a more justified and meaningful addition to the model.

Table 2. *Modification indices after the hypothesized model does not fit*

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
61	Achievement	~	Public	73.59	-1.00	-1.00	-0.33	-0.33
52	Achievement	~~	Public	68.19	-0.10	-0.10	-0.37	-0.37
68	Public	~	Achievement	68.19	-0.15	-0.15	-0.47	-0.47
46	Graph	~~	Achievement	38.61	-0.61	-0.61	-0.85	-0.85
60	Graph	~	Achievement	38.61	-0.96	-0.96	-0.96	-0.96
40	Numeric	~~	Achievement	24.57	-0.53	-0.53	-0.73	-0.73
58	Numeric	~	Achievement	24.57	-0.82	-0.82	-0.82	-0.82

The decision to include the direct effect of school type on economics achievement is supported by well-established theories and research in the field of education. Previous studies have consistently highlighted the significant impact of school type on students' academic performance and achievement outcomes. Moreover, existing literature on educational disparities and school quality has consistently shown that school type, whether public or private, can play a crucial role in shaping students' educational experiences and outcomes. Considering this direct effect of school type on economics achievement in the model is essential for capturing the unique contributions of different educational contexts to students' economics achievement.

It is intuitive to assume that the type of educational institution a student attends can influence their academic performance including economics achievements. By incorporating the direct effect of school type on economics achievement, the modified model not only fits data to the model and aligns with established theories and prior research, but also reflects the practical realities of the education system. This strengthened model provides more accurate insights into the factors affecting students' economic achievements.

Table 3. *Model fit estimation before and after considering modification*

Model test User model	Model 1	Model 2
Test statistics	84.084	4.448
Df	5	4
p-value	<0.001	0.349
Baseline model		
Test statistics	907.41	907.41
Df	28	28
p-value	<0.001	<0.001
User V Baseline		
Comparative Fit Index (CFI)	0.910	0.999
Tucker-Lewis Index (TLI)	0.496	0.996
Loglikelihood and Information Criteria		
Loglikelihood user model (H0)	-3672.165	-3632.347
Loglikelihood unrestricted model (H1)	-3630.123	-3630.123
Akaike (AIC)	7422.330	7344.695
Bayesian (BIC)	7586.544	7513.119
Sample-size adjusted Bayesian (SABIC)	7462.756	7386.157
Root Mean Square Error of Approximation	0.178	0.015
(RMSEA)		
90 Percent confidence interval - lower	0.146	0
90 Percent confidence interval - upper	0.213	0.071
P-value H_0: RMSEA <= 0.080	0	0.799
P-value H_0: RMSEA <= 0.080	1	0.022
Standardized Root Mean Square Residual (SRMR)	0.044	0.010

Table 3 presents the results of two models: Model 1 before modification and Model 2 after considering modification indices. Model 2 demonstrates improved fit estimates when compared to the data. This indicates that accounting for the direct effect of school type on economics achievement is crucial and significantly enhances the model's explanatory power.

The overall model fit statistics indicates that the modified path model provides an excellent fit to the data. The non-significant Chi-square test ($\chi^2 = 4.448$, df = 4, p = 0.349) suggests that the model does not exhibit a significant lack of fit, supporting the suitability of the model in explaining the relationships among the variables. The Comparative Fit Index (CFI = 0.999) and the Tucker-Lewis Index (TLI = 0.996) both indicate an outstanding fit of the model, and the low values of Root Mean Square Error of Approximation (RMSEA = 0.015) and Standardized Root Mean Residual (SRMR =

0.01) further confirm the goodness of fit. These fit indices indicate that the proposed model is robust and accurately represents the data.

In other words, the modified Model 2 provides a better representation of the relationships among variables in the data compared to the hypothesized model. The inclusion of the direct effect of school type on economics achievement has strengthened the model's ability to explain the observed patterns in the data.

Overall, these findings emphasize the importance of school type as a significant factor influencing economics achievement. The improved model can serve as a more reliable tool for understanding the complex dynamics that contribute to students' academic success, allowing for more informed decision-making and targeted interventions in educational settings.

Table 4. *Analysis of variance in the model fit*

Model	Df	AIC	BIC	Chi-sq	diff	RMSEA	Df diff	p-value
2	4	7344.7	7513.1	4.4479				
1	5	7422.3	7586.5	84.0838	79.636	0.3974	1	<0.001

The statistical comparison between Model 1 and 2, as presented in Table 4, reveals significant differences in the variance and goodness-of-fit measures. A lower AIC and BIC values for model 2 implies that it is a more parsimonious and effective model in explaining the relationships among the variables. Moreover, the chi-square test statistic for Model 2 is very close to the degree of freedom, which is a promising sign of a good model fit. When the chi-square value is close to the degree of freedom, it suggests that the model is adequately capturing the observed data patterns and is consistent with the expected values.

Together, these findings support the conclusion that Model 2 fits the data more than Model 1 in terms of explaining the variance in the data and providing a more accurate representation of the relationships among the variables. The significant differences observed between the models further emphasize the importance of including the proposed modifications in Model 2, particularly the direct effect of school type on economics achievement. Overall, the statistical evidence and goodness-of-fit measures strongly support the use of Model 2 as a more reliable and robust tool for investigating the factors influencing economics achievement.

Table 5. *Significant level of Direct and Indirect estimates of the exogenous variables on moderating and endogenous variable*

	est	se	z	pvalue	ci.lower	ci.upper
Public						
Achievement	-1.00	0.12	-8.12	<0.001	-1.25	-0.76
Numeric	-0.24	0.06	-4.03	<0.001	-0.37	-0.13

Graph	-0.22	0.05	-4.58	<0.001	-0.31	-0.13
Total – Ind	-0.46	0.08	-5.62	<0.001	-0.62	-0.31
Ground total	-1.46	0.14	-10.10	<0.001	-1.75	-1.18
Female						
Numeric	0.03	0.03	1.07	0.28	-0.02	0.08
Graph	0.02	0.02	1.15	0.25	-0.01	0.07
Total	0.05	0.04	1.30	0.19	-0.02	0.14
Art						
Numeric	-0.03	0.01	-2.70	<0.01	-0.05	-0.01
Graph	-0.03	0.01	-3.69	<0.001	-0.05	-0.02
Total	-0.06	0.02	-3.94	<0.001	-0.09	-0.03
Science						
Numeric	0.13	0.03	3.87	<0.001	0.07	0.21
Graph	0.06	0.03	2.35	<0.05	0.02	0.11
Total	0.19	0.05	4.01	<0.001	0.11	0.30
Age						
Numeric	-0.03	0.01	-2.70	<0.01	-0.05	-0.01
Graph	-0.03	0.01	-3.69	<0.001	-0.05	-0.02
Total	-0.06	0.02	-3.94	<0.001	-0.09	-0.03

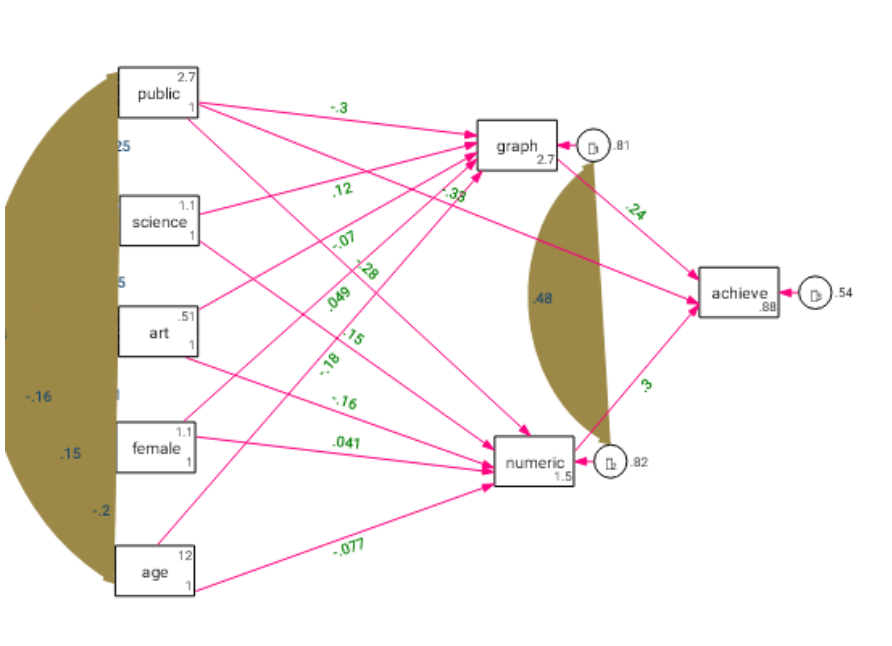
The direct and indirect effects of the variables were also estimated using bootstrap estimation of standard error to assess the significance of direct and indirect effects of various exogenous variables on Economics Achievement within the path model analysis. The bootstrap replication and confidence intervals provide a robust statistical framework for interpreting the results and understanding the uncertainty associated with these effects.

Public school students, when mediated through numerical (-0.24) and graphical (-0.22) ability, have a significantly lower indirect and direct (-1) effect on economics achievement when compared to their counterparts in the private schools. Also, age has a significant negative effect on economics when mediated through numerical (-0.03) and graphical (-0.03) abilities. Hence, older students score lower in economics test. There is a similar result with class classification for students in the art, having a significantly lower achievement in numerical (-0.03) and graphical (-0.03) ability when compared with students in the commercial class.

However, students in the science class have significantly higher achievement in economics when mediated by numerical (0.13) and graphical (0.06) ability when compared with students in the commercial class. Similarly, female participants have significantly higher economics achievement using numerical (0.03) and graphical (0.02) abilities as mediation variable when compared with the male counterparts.

4.2 Research Question 2: To what extent do exogenous variables predict numerical and graphical ability and in effect economics achievement?

Figure 3. *Final fitting model*



Considering the standardized estimates from figure 2, age has a negative estimate on numerical ability (-0.18) and graphical ability (-0.077). This finding implies that, in average, older students may have slightly lower cognitive abilities in both domains. While this result is consistent with typical developmental trajectories, it is crucial to consider individual differences and provide appropriate educational strategies to support students' cognitive growth across different age groups.

Public school has negative estimates on graphical (-0.30), numerical (-0.28) abilities and economics achievement (-0.33). These results indicate that students attending public schools are likely to score lower than those in private schools. Students in the science classes are more likely to score higher than those in commercial class on graphical (0.12) and numerical (0.15) items. However, those in art class might score lower in graphical (-0.07) and numerical (-0.16) items than those in commercial classes. The result shows that female students have higher scores in graphical (0.049) and numerical (0.041) test than their male counterparts.

The model indicates that approximately 17.9% of the total variance in numeric ability is explained by the exogenous and covariance with graphical ability in the model. This suggests that the model explains a moderate amount of variance in numeric ability, while the remaining 82.1% of variability remains unaccounted for. It also signifies that the

model explains about 18.8% of the total variance in graphical ability, while most of the variability in graphical scores (81.2%) is not captured by the included exogenous and covariance of numerical ability. The model accounts for a moderate proportion of the variance in graphical ability. Finally, economics achievement scores have an R^2 value of 0.455, indicating that the model explains approximately 45.5% of the total variance in economics achievement. This value is relatively higher compared to numeric and graphical ability, suggesting that the model accounts for a substantial proportion of the variance in overall achievement.

DISCUSSION

The results provide valuable insights into the factors that contribute to students' economic performance and shed light on the effectiveness of the proposed model.

Findings suggest that both numerical ability and graphical ability play significant roles in predicting Economics Achievement. These mediating variables demonstrated positive standardized estimates indicating that higher levels of numerical and graphical skills are associated with better economic performance. This result aligns with Rohde and Thompson (2007) and Ian et al. (2006)' studies highlighting the importance of cognitive abilities in academic achievement and their potential to influence domain-specific outcomes, such as economics. However, Odimayo et al. (2022)'s study found that numerical ability has no significant influence on physical chemistry achievement.

Interestingly, the exogenous variables, including school type, sex, class in school, and age, exhibited varying degrees of influence on numerical and graphical abilities. School type also had a significant direct effect on economics achievement. This suggests that the type of school attended significantly impacts economic performance, with certain private school environments potentially providing better opportunities or resources for fostering economic knowledge and skills.

Results from the modified model show being female have a positive but non-significant indirect effect on economics achievement through numerical and graphical abilities. This suggests that biological sex, despite influencing achievement, is not really a major factor which indirectly affects economics achievement. The findings in this study show some sign of reduction in mathematical related gap always reported between male and female for many decades now. This suggests there is some change in stride of studies from previous decades which showed male students having numerical ability as the result of the study shows that females are likely to have higher numerical and graphical abilities. Hence, sex has a minimal impact on graphical performance. This result aligns with Aransi (2018) and Abubakar and Adegboyega (2012)'s findings regarding sex having positive contribution to achievement. Milun et al. (2016)'s study also shows that females perform better than males in some SSS subjects which include Economics.

The negative direct effect on economics achievement indicates that students attending public schools differ significantly in their economic achievement when compared to those in private schools. The estimate for school type indicated that students attending public schools had lower numeric scores compared to those in private schools**.** Also, graphical ability path suggests that the students attending public schools had lower graphical scores compared to those in private schools. This finding highlights the importance of considering school type as a potential factor influencing academic achievement. This also suggests that it affects overall economics achievement. Given the modified model, school type plays a major role on the level of student achievement in economics either directly or through the mediating variables.

In a similar manner, Cansız et al. (2019) found that school type has significant impact on student achievement in Turkiye. Being a private school student instead of a public one leads to 87 points increase (29.6%) on average in score. It was found that school type has a larger effect in Turkiye compared to other countries. However, Harry (2016)'s study concludes that there is no meaningful difference in academic achievement between students in assisted (private) schools versus students in government schools.

While the estimate for the art stream indicated that students in this stream tended to have lower numeric scores compared to those in the commercial stream. Conversely, the science stream students had higher numeric scores compared to students in the commercial stream. These differences were statistically significant, suggesting that the choice of stream could have an influence on academic performance in numeric tests. However, it is worth noting that art stream students could still score lower even if the difference is not statistically significant. Meanwhile, the estimate for the students in science stream indicated that students in this stream tended to have higher graphical scores compared to students in the commercial stream. The effect size was statistically significant, suggesting that the choice of the science stream could have a meaningful impact on graphical performance when compared to students in commercial stream. The moderate relationship between numerical and graphical ability in the model equally indicates a likeliness of similar differences in class classification on student graphical ability.

The findings of this study do not conform with a section of Aransi (2017)'s study which found that there are no differences in the achievement based on class classification in mathematics; however, found that science and art stream students are better than commercial students in English language. This finding could be due to lower emphasis of the art stream curriculum on numerical or graphical related content. However, science related stream is heavily dependent on knowledge relating to numerical and graphical abilities based on curriculum (NERDC, 2008).

Age has a negative indirect effect on economics achievement through numerical and graphical factors. This indicates that higher age may influence academic performance indirectly through numerical and graphical abilities, leading

to differences in economic achievement among students of different age groups. Older students may have slightly lower graphical scores, as indicated by the negative estimate. Additionally, the estimate for age showed that there is no significant difference in numeric scores based on the age of the students. However, this estimate is relatively weak compared to other variables, suggesting that age had a minor impact on academic performance.

In line with John et al. (2015)'s study, the chronological age of students had a significant impact on academic performance which aligns with the findings of this study. However, unlike Abubakar and Adegboyega (2012), who found positive but not significant relationship between age and achievement, this study found a negative relationship with both numerical and graphical ability of the students. Additionally, Aransi's study (2018) shows that age does not have an effect on academic achievement in both mathematics and English language. Moreover, Nnamani and Oyibe (2016) found higher achievement in some subjects for females compared to males. However, Ariz and Farah (2017) reported a mixed outcome in performance regarding the age of post-graduate management students.

The effect size, being relatively moderate, suggests a meaningful association between numeric ability and economics achievement. Also, the estimate for graphical ability indicates that higher graphical scores are associated with an increase in economics achievement scores. This suggests that students who excel in graphical tasks also tend to perform better overall. While the effect size is moderate compared to numeric ability, it still highlights the substantial impact of graphical ability on students' overall economics achievement.

Limitations of the Study

It is essential to acknowledge the limitations of this study, such as the sample of students from private school has been small when compared to those from public school. It might affect the result part which uses school type, especially having only one male from commercial class of private school. Furthermore, one-point data collection limits our knowledge of trend over time. Also, this study is limited in knowledge of what happens in other classes and experience class classification which might provide other findings that can complement the results from this study.

Future research should aim to replicate and expand upon these findings to gain a more comprehensive understanding of the complex interplay between cognitive abilities and academic achievement in economics. Considering that summed scores were used for this study without accounting for the measurement errors at the item levels, those errors might have implications for the results reported.

Implications

This study highlights the importance of cognitive abilities, particularly numerical and graphical ability, in predicting economics achievement. Additionally, the influence of exogenous variables such as school type, sex, class

classification, and age on cognitive abilities and their subsequent impact on economics achievement. Findings might provide valuable insights for educators, policymakers, and researchers. Understanding these relationships can guide the development of targeted interventions and educational programs to enhance students' cognitive skills and academic performances in the field of economics.

The results of this study indicate that school type, numerical scores, and graphical scores significantly influence students' economics achievement scores. Attending public school is associated with lower achievement scores compared to private schools. Additionally, strong performance in both numeric and graphical tasks is positively correlated with higher economics scores. These findings provide valuable insights into the factors that contribute to students' academic success and might have implications for educational strategies and interventions.

CONCLUSION AND RECOMMENDATIONS

These findings highlight the importance of considering not only the direct effects of variables on economics achievement but also the indirect pathways through which those factors exert influence. The significance of these indirect effects emphasizes the role of specific skills and educational choices in shaping students' economic success. This knowledge can inform targeted interventions and educational policies to enhance academic performance and economic outcomes among students. However, for variables with non-significant indirect effects, the study suggests that their influence on economics achievement is likely to be more direct or not as strongly mediated through numerical and graphical abilities.

Numerical and graphical knowledge is a useful skill for every individual irrespective of future field of endeavor. Hence, it is important to include subjects which will provide this skill to students especially those in art stream. Also, it might be helpful for government institutions to adapt some systems relating to quantitative expectations of students irrespective of stream used in private schools which was proven to provide a major difference in public schools. Hence, these findings provide useful information to educators and policymakers on prioritizing interventions which improve academic achievement in specific domains, considering the varying impacts of different variables on cognitive abilities and overall achievement.

Suggestion for Future Research

Future research could explore other variables and model specifications to further improve the model's ability and to explain the variance in the endogenous variables. Findings from this study require further exploration with more factors which are not considered, such as teacher factor, other students or school related factors, parent related factors and so forth. Other analysis methodologies could be implemented such as Structural Equation Model or inclusion of

Bayesian approach with the use of proper priors.

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