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STUDENT-LEVEL, CLASSROOM-LEVEL AND SCHOOL-LEVEL FACTORS AS PREDICTORS OF UNDERGRADUATE MATHEMATICS STUDENTS' ACHIEVEMENT IN VECTOR ANALYSIS

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ABSTRACT: *This study investigates student-level, classroom-level, and school-level factors that predict students' achievement scores in vector analysis, and determines the achievement score of students using the regression equation. A total of 243 third-year undergraduate mathematics students from a university in Ghana, participated in the study. The study adopted a correlational design with a multiple regression model, to identify significant predictors. For model 1, the student-level factors explained 56.0% of the variance (R^2=.56, F (36,206) =133.06, p < .05), with fourteen significant predictors. For model 2, the student-level and classroom-level factors explained 61.0% of the variance (R^2=.61, F (39,203) =124.92, p <.05), with fifteen significant predictors. For model 3, the student-level, classroom-level and school-level factors explained 62.0% of the variance (R^2=.62, F (41,201) =120.86, p <.05), with sixteen significant predictors. The study concludes that students whose parents' educational level and socio-economic status are high, have a greater chance of improving their mathematics achievement scores.*

KEYWORDS: achievement, predictors, correlational design, variance.

INTRODUCTION

Factors affecting students' academic achievement are numerous and varied (Beaton & Dwyer, 2002; Kellaghan & Madaus, 2002; Kifer, 2002). These factors include but are not limited to gender, teachers' instruction, personal effort, previous schooling, parental educational background, family income, self-motivation, learning preferences, age, and academic preparation. Other factors are students' learning skills, peer influence, teacher quality, learning infrastructure and parents' socio-economic status. These factors affect student mathematics achievement in different settings (Graetz, 1995; Considine & Zapalla, 2002; Bratti, 2002).

LITERATURE REVIEW

The effect of gender on student mathematics achievement is abundant in the literature. At the lower grades, males appear to do better on achievement tests involving problem-solving than females, while females do better on achievement tests involving computation than males. However, no significant difference in student mathematics learning existed between them (Hyde, Fennema, & Lamon 1990). This finding corroborates recent studies which demonstrated that gender differences in student mathematics achievement are narrowing in many countries. As students reach higher grades, males appear to do better in mathematics in several domains of mathematics than females (Mullis, Martin, Fierros, Goldberg, & Stemler, 2000). It appears females tend to learn mathematical concepts by following rules, while males compete and master concepts among their peers (Hopkins, McGillicuddy-De Lisi, & De Lisi, 1997).

Socio-economic status correlates strongly with mathematics achievement (Jeynes, 2002). Several studies have shown that parents with higher socio-economic status are more involved in their children's education than parents of lower socio-economic status. This parental involvement results in the development of positive attitudes of these children toward school, classes, thereby enhancing their mathematics achievement (Lareau, 1987; Stevenson & Baker, 1987). In contrast, parents' low socio-economic status impacts negatively on student academic achievement because it prevents them from accessing various educational materials and resources (Majoribank, 1996; Jeynes, 2002). Many studies have demonstrated that student achievement is correlated highly with their parents' educational level. Students whose parents have lower levels of education obtained lower mathematics grades than those whose parents have higher levels of education (Campbell, Hombo, & Mazzeo, 2000).

Many mathematics curricula emphasise the memorization of facts and not the understanding and application of these facts. Memorization must give way to conceptualization, application and problem-solving for students to successfully apply the concepts. A body of research suggests that a curriculum that considers students to be incapable of metacognitive actions, should be replaced with the one that sees students as capable higher-order thinking and reasoning individuals (Bransford et al., 2000; Schauble et al., 1995; Warren & Rosebery, 1996). There is also enough evidence to suggest that the curricula in which students' knowledge and skills grow are significantly connected to their learning, and therefore their mathematics achievement (Brown & Campione, 1994; Lehrer & Chazan, 1998).

To become successful in mathematics, students should understand their current state of knowledge, build on it, and make changes in the face of conflicts. Therefore, instructional strategies and methods should provide students with learning experiences to enable them to develop and apply higher-order operations to enhance their mathematics achievement. Teachers could provide meaningful and authentic tasks to enable students to construct their understanding and knowledge (Wilson, 1996).

It is worthy to note that teachers' knowledge and beliefs about mathematics are directly connected to their instructional choices and procedures (Brophy, 1990; Brown, 1985; National Council of Teachers of Mathematics, 1989; Thompson, 1992; Wilson, 1990a, b). These teachers need to be skillful and knowledgeable to apply their philosophy in teaching. They need substantially more knowledge to adequately prepare a diverse group of students for challenging work in the schools (Darling-Hammond, 1997). They do not only need knowledge of a particular subject matter, but they also need to have good pedagogical knowledge (Bransford et al., 2000). Their competency in these areas is linked closely to student thinking, understanding and learning in mathematics. Student achievement in mathematics requires teachers who are knowledgeable in the subject they teach (Ball, 1993; Grossman et al., 1989; Rosebery et al., 1992).

For effective mathematics learning, students should be highly motivated to reason, make interpretations and solve problems. They must first learn to critically analyze mathematical problems and produce effective solutions, before they learn to compute. To achieve this, they must possess the knowledge to make sense of complex mathematics concepts and think mathematically (Cobb et al., 1992). In this regard, teachers' role is to prepare students to produce mathematical knowledge competently. The main instructional task for teachers is to create a learning environment for students to engage in mathematical activities through exploration, conjecturing, representation, verification, and reflection (Carr, 1996).

The literature reviewed suggested evidence of factors or predictors influencing student mathematics achievement in several settings and jurisdictions (Fernández-Cezar, Solano-Pinto, & Garrido, 2021). However, studies involving this large number of predictors are readily not available. Therefore, the purpose of this study was two-fold: To investigate student-level, classroom-level, and school-level factors that significantly predict students' achievement scores in vector analysis, and to determine a student's score using the multiple regression equation. The study addressed the following questions: The study addressed the following questions:

1. What student-level, classroom-level, and school-level factors significantly predict students' achievement scores in vector analysis?
2. What is the achievement score of students using the regression equation?

METHODOLOGY

Research Design and Conceptual Framework

This study adopted a correlational research design to investigate the relationships among the fifteen predictors and determined their effects on students' scores. The factor of interest in this study was students' achievement scores in Vector Analysis. The conceptual framework examined the student-level, classroom-level and school-level factors that predicted students' achievement scores in vector analysis (Fig. 1). Student-level factors consisted of gender, ethnicity, religious affiliation, region of birth, parental educational level, parents' socio-economic status, mathematics self-concept, attitude towards mathematics, computational ability, and motivation. Classroom-level factors consisted of curriculum, instructional strategies and methods, and teacher competency

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in mathematics. School-level factors consisted of school resources and class attendance. Factors, their type and categories, are indicated in table 1.

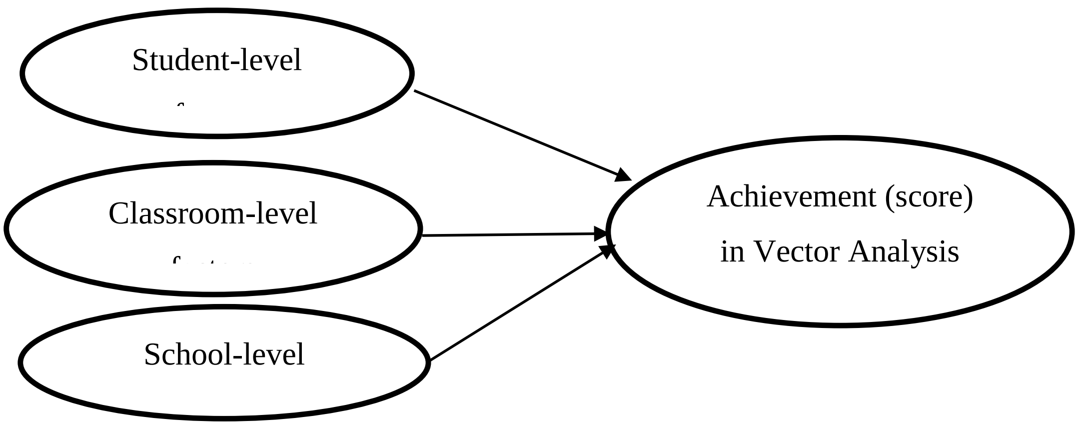

Fig.1. Conceptual framework for examining factors affecting achievement in undergraduate vector analysis

Table 1. Factors affecting achievement in vector analysis

Factor	Type	Categories
Gender	Categorical	Female, Male
Ethnicity	Categorical	Asanti, Fanti, Ga, Ewe, Others
Religious Affiliation	Categorical	Christianity, Islam, African Traditional Religion, Others
Region of Birth	Categorical	Ahafo, Ashanti, Bono, Bono East, Central, Eastern, Greater Accra, North East, Northern, Oti, Savannah, Upper East, Upper West, Volta, Western, Western North
Parental Education Level	Categorical	None, JHS, SHS, Diploma, HND, Bachelors, Masters, Doctorate
Parents' Socio-economic Status	Categorical	High, Middle, Low
Mathematics Self-concept	Continuous	Nil
Mathematics Attitude	Continuous	Nil
Computation Ability	Continuous	Nil
Motivation	Continuous	Nil
Curriculum	Continuous	Nil
Instructional Strategies and Methods	Continuous	Nil
Teacher Competency in Mathematics	Continuous	Nil
School Resources	Continuous	Nil
Class Attendance	Continuous	Nil

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Mathematical Model for the Regression Analysis

A multiple linear regression analyses the effect of two or more predictors on a dependent variable (Freedman, 2009). The multiple regression equation is represented as follows:

$Y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_\varphi x_{i\varphi} + \epsilon$, where,
Y_I = Achievement score in vector analysis
x_i = Predictor variables (Factors in table 1)
β_0 = y-intercept (constant term)
β_φ= Regression coefficients for each predictor variable
ϵ = Model's error term (residuals)

Participants and Setting

Two hundred and forty-three (243) Level 300 undergraduate mathematics students, comprising one hundred and ninety-five (195) males and forty-eight (48) females from a public university in Ghana, participated in the study. They were selected purposively from four (4) intact classes. They had completed an undergraduate course in Vector Analysis and written their end of semester examination. Their religious affiliation, ethnicity, region of birth, parental educational level, social economic status, were gathered. The average age of the students was twenty-one years and five (5) months. Table 2 indicates the demographic characteristics of the students.

Table 2 Students' Demographic Characteristics

Demographic Characteristics	Category	Number of Students	Percentage
Religious Affiliation	Christianity	145	59.7
	Islam	75	30.9
	African Traditional Religion	16	6.6
	Others	7	2.9
	Total	243	100
Gender	Male	195	80.2
	Female	48	19.8
	Total	243	100
Ethnicity	Ashanti	56	23.0
	Fanti	49	20.2
	Ga	39	16.0
	Ewe	44	18.1
	Others	55	22.6
	Total	243	100
Region of Birth	Ahafo	6	2.5
	Ahanti	39	16.0
	Bono	7	2.9
	Bono East	4	1.6
	Central	26	10.7
	Eastern	23	9.5
	Greater Accra	28	11.5
	North East	7	2.9

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Demographic Characteristics	Category	Number of Students	Percentage
	Northern	35	14.4
	Oti	7	2.9
	Savannah	11	4.5
	Upper East	9	3.7
	Upper West	8	3.3
	Volta	14	5.8
	Western	12	4.9
	Western North	7	2.9
	Total	243	100
Socio Economic Status	High	45	18.5
	Middle	93	38.3
	Low	105	43.2
	Total	243	100
Parents' Educational Level	None	7	2.9
	Junior High School (JHS)	40	16.5
	Senior High School (SHS)	45	18.5
	Diploma	33	13.5
	Higher National Diploma (HND)	30	12.3
	Bachelors	52	21.4
	Masters	32	13.2
	Doctorate	4	1.6
	Total	243	100

Assumptions

The multicollinearity assumption was satisfied because the correlation coefficients among the variables were below .60, and no correlation coefficient was above .80. Further, the VIF scores were below 10 (Myers, 1990; Bowerman & O'Connell, 1990), and the tolerance scores above .2 (Menard, 1995), as indicated in the regression table. There were correlations between the dependent variable and the predictor variables as shown in table 2. Few correlations were, however, quite significant. The values of the residuals were independent since the Durbin-Watson statistic obtained was close to 2 (Durbin-Watson = 1.90), and the variance of the residuals was constant. The plot of standardized residuals versus standardized predicted values showed no apparent signs of funnelling, suggesting that the assumption of homoscedasticity was satisfied. The Cook's Distance values were all under 1, indicating that individual cases did not influence the models.

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Table 3 Correlation Coefficients Between Score and the Predictors

Scale Predictor		Score
Math Self concept	Pearson Correlation	.49
	Sig. (2-tailed)	.00
	N	243
Math Attitude	Pearson Correlation	.48
	Sig. (2-tailed)	.00
	N	243
Computational Ability	Pearson Correlation	.46
	Sig. (2-tailed)	.00
	N	243
Motivation	Pearson Correlation	.42
	Sig. (2-tailed)	.00
	N	243
Curriculum	Pearson Correlation	.43
	Sig. (2-tailed)	.00
	N	243
Instructional Strategies and Methods	Pearson Correlation	.23
	Sig. (2-tailed)	.00
	N	243
Teacher Competency in Math	Pearson Correlation	.10
	Sig. (2-tailed)	.11
	N	243
School Resources	Pearson Correlation	.50
	Sig. (2-tailed)	.00
	N	243
Class Attendance	Pearson Correlation	-.06
	Sig. (2-tailed)	.35
	N	243
Religion Dependent		.51
Score Dependent		.20
Gender Dependent		.40
Score Dependent		.03
Ethnicity Dependent		.44
Score Dependent		.38
Parents' Educational Level		.49
Score Dependent		.47
SES Dependent		.47
Score Dependent		.44
Region of Birth Dependent		.41
Score Dependent		.40

RESULTS

The ANOVA table in table 2, provides a test of the statistical significance of the regression models using a one-way between-subjects ANOVA. The regression models have thirty-six, thirty-nine, and forty-one degrees of freedom because these were the number of predictors in the models. The total degrees of freedom were equal to $N - 1$ or 242, for each of the models, leaving 206, 203, and 201 for the error terms. The models accounted for significant amount of dependent variable variance, F (36,206) = 133.09, $p < .05$, for model 1, F (39, 203) = 124.92, $p < .05$, for model 2, and F (41, 201)

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= 120.86, *p* < .05, for model 3. The entre method for the regression was used in this study.

Table 4 ANOVA Table for the Regression Models

Model		Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
1	Regression	3114.41	36	86.51	133.09	.00[b]
	Residual	133.73	206	.65		
	Total	3248.15	242			
2	Regression	3117.93	39	79.95	124.92	.00[c]
	Residual	130.21	203	.64		
	Total	3248.15	242			
3	Regression	3121.82	41	76.14	120.86	.00[d]
	Residual	126.32	201	.63		
	Total	3248.15	242			

a. Dependent Variable: Score

b. Predictors: (Constant), Asanti, Gender, Oti, Bono, Ahafo, Volta, North East, Western, Upper West, Doctorate, Upper East, Eastern, Junior High school, Savannah, Islam, Ga, Diploma, Greater Accra, Higher National Diploma, Mathematics Attitude, Fanti, Northern, Motivation, Central, Ewe, Mathematics Self-concept, Computational Ability, African Traditional Religion, Middle, Masters, Senior High School, Ashanti, High, Bachelors, Christianity

c. Predictors: (Constant), Asanti, Gender, Oti, Bono, Ahafo, Volta, North East, Western, Upper West, Doctorate, Upper East, Eastern, Junior High school, Savannah, Islam, Ga, Diploma, Greater Accra, Higher National Diploma, Mathematics Attitude, Fanti, Northern, Motivation, Central, Ewe, Mathematics Self-concept, Computational Ability, African Traditional Religion, Middle, Masters, Senior High School, Ashanti, High, Bachelors, Christianity, Teacher Competency in Mathematics, Curriculum, Instructional strategies and Methods

d. Predictors: (Constant), Asanti, Gender, Oti, Bono, Ahafo, Volta, North East, Western, Upper West, Doctorate, Upper East, Eastern, Junior High school, Savannah, Islam, Ga, Diploma, Greater Accra, Higher National Diploma, Mathematics Attitude, Fanti, Northern, Motivation, Central, Ewe, Mathematics Self-concept, Arithmetic Ability, African Traditional Religion, Middle, Masters, Senior High School, Ashanti, High, Bachelors, Christianity, Teacher Competency in Mathematics, Curriculum, Instructional strategies and Methods, Class Attendance, School Resources

Multiple regression analysis was used to test if the student-level factors significantly predicted students' achievement scores in vector analysis. For model 1, the results of the regression indicated that thirty-six predictors explained 56.0% of the variance (R^2=.56, F (36,206) =133.06, p<.05), with fourteen, being very significant. The following factors were the significant predictors of students' achievement scores: Christianity (β = .90, p<.05); Bono East (β = -1.01, p<.05); Savannah (β = -.88, p<.05); High SES (β = 1.79, p<.05); JHS (β = 3.92, p<.05); SHS (β = 7.35, p<.05); Diploma (β

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= 8.85, p<.05); HND (β = 9.28, p<.05); Bachelors (β = 10.92, p<.05); Masters (β = 12.45, p<.05); Doctorate (β = 14.56, p<.05); Mathematics self-concept (β = -.28, p<.05); Computational ability (β = .24, p<.05); and Motivation (β = -.90, p<.05) (see table 5).
For model 1, the following regression equation would enable us compute a student's achievement score:
Achievement score = 55.42 + .13 Gender + .90 Christianity + -.78 Islam - .42 African Traditional Religion – .23 Fanti - .10 Asanti - .07 Ga - .00 Ewe + .34 Ashanti - .50 Ahafo + .51 Bono – 1.01 Bono East -.17 Central + .31 Eastern + .03 Greater Accra - .12 North East - .35 Northern - .49 Oti - .88 Savannah - .37 Upper East + .16 Upper West - .09 Volta + .05 Western + 1.79 High + .37 Middle + 3.92 JHS + 7.35 SHS + 8.85 Diploma + 9.28 HND + 10.92 Bachelors + 12.45 Masters + 14.56 Doctorate + .15 Math self-concept - .28 Mathematics Attitude + .24 Computational ability + .08 Motivation.

For a student who is a male, (gender = 1), a Christian, an Ewe, from Bono, High SES of parents, Parents have Bachelors, Math self-concept =4, Math attitude=4, Computational ability=3, and Motivation=3, the equation becomes: Achievement score = 55.42 + .13 (1) + .90(1) - .00(1) + .51(1) + 1.79 (1) + 10.92 (1) + .15(4) - .28(4) +.24(3) +.08(3) = 70.11.

Considering the contributions of the significant factors on students' achievement in vector analysis. On average, students who were Christians obtained achievement score of .90 higher than students from other religions. On average, students from Bono East obtained achievement scores of 1.01 lower than students from Western North. Generally, parents' educational level significantly contributed positively to the students' achievement scores. For instance, students whose parents had bachelor's degree increased their achievement scores by 10.92 more than students whose parents had no education. For motivation, a one unit increase in motivation, increases students' achievement score by .08.

Table 5 Multiple Regression Results for model 1

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	55.42	1.04		53.21	.00	53.37	57.47		
Gender	.13	.14	.02	.95	.34	-.14	.41	.86	1.16
Christianity	.90	.40	.12	2.24*	.03	-1.69	-.11	.27	8.35
Islam	-.78	.40	-.10	-1.96	.05	-1.56	.01	.28	7.53

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Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
African Traditional Religion	-.42	.45	-.03	-.92	.36	-1.3	.47	.22	4.62
Fanti	-.23	.18	-.03	-1.31	.19	-.57	.12	.55	1.83
Asanti	-.10	.19	-.01	-.52	.61	-.47	.27	.44	2.27
Ga	-.07	.19	-.01	-.34	.73	-.45	.32	.53	1.88
Ewe	-.00	.19	.00	-.01	.99	-.38	.38	.50	2.02
Ashanti	.34	.36	.03	.93	.35	-.38	1.06	.25	6.65
Ahafo	-.50	.50	-.02	-.99	.32	-1.48	.49	.45	2.23
Bono	.51	.49	.02	1.04	.30	-.46	1.48	.40	2.51
Bono East	-1.01	.59	-.04	-2.88*	.03	-2.52	.05	.49	2.06
Central	-.17	.38	-.01	-.44	.66	-.93	.59	.29	5.24
Eastern	.31	.38	.03	.82	.41	-.44	1.07	.21	4.67
Greater Accra	.03	.38	.00	.09	.93	-.72	.78	.28	5.51
North East	-.12	.49	-.01	-.25	.80	-1.08	.84	.40	2.48
Northern	.35	.37	.03	.96	.34	-.37	1.08	.36	6.20
Oti	-.49	.48	-.02	-1.04	.30	-1.43	.45	.42	2.37
Savannah	-.88	.44	-.05	-2.99*	.02	-1.74	-.01	.32	3.11
Upper East	-.37	.46	-.02	-.80	.42	-1.28	.54	.35	2.84
Upper West	.16	.54	.01	.29	.77	-.91	1.23	.29	3.50
Volta	-.09	.44	-.01	-.21	.83	-.95	.77	.27	3.64
Western	.05	.41	.00	.12	.91	-.77	.86	.34	2.99
High	1.79	.43	.19	4.17*	.00	.94	2.63	.30	6.29
Middle	.37	.28	.05	1.29	.20	-.19	.93	.34	7.02

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Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Junior High School	3.92	.45	.40	8.73*	.00	3.03	4.80	.30	8.30
Senior High School	7.35	.45	.78	16.38*	.00	6.47	8.24	.29	8.32
Diploma	8.85	.43	.83	20.39*	.00	7.99	9.71	.22	8.23
Higher National Diploma	9.28	.46	.83	19.74*	.00	8.36	10.19	.32	8.69
Bachelors	10.92	.45	1.22	24.45*	.00	10.03	11.80	.38	8.30
Masters	12.45	.50	1.15	24.92*	.00	11.46	13.43	.39	7.62
Doctorate	14.56	.62	.51	23.46*	.00	13.34	15.78	.43	2.32
Math Self Concept	.15	.11	.03	1.29	.20	-.08	.37	.45	2.23
Math Attitude	-.28	.13	-.04	-3.19*	.03	-.53	-.03	.53	1.88
Computational Ability	.24	.12	.04	3.98*	.04	.00	.49	.47	2.14
Motivation	.08	.13	.01	4.60*	.04	-.17	.32	.49	2.03

R = .75, R^2 = .56, $\Delta R^2 = .52, * p \leq .05$

For model 2, the student-level and classroom-level factors indicated that thirty-nine predictors explained 61.0% of the variance (R^2=.61, F (39,203) =124.92, p<.05), with fifteen, being very significant. The following factors were the significant predictors of students' achievement scores: Christianity (β = .87, p<.05); Bono East (β = -1.11, p<.05); Savannah (β = -.88, p<.05); High SES (β = 1.64, p<.05); JHS (β = 3.89, p<.05); SHS (β = 7.30, p<.05); Diploma (β = 8.86, p<.05); HND (β = 9.36, p<.05); Bachelors (β = 10.98, p<.05); Masters (β = 12.47, p<.05); Doctorate (β = 14.45, p<.05); Mathematics attitude (β = -.36, p<.05); Computational ability (β = .25, p<.05); and Motivation (β = -.03, p<.05); and Curriculum (β = .25, p<.05). (See table 6).
For model 2, the following regression equation would enable us compute a student's achievement score:
Achievement score = 55.13 + .15 Gender + .87 Christianity + -.77 Islam - .35 African Traditional Religion – .15 Fanti - .11 Asanti - .01 Ga - .01 Ewe + .31 Ashanti - .53 Ahafo + .48 Bono – 1.11 Bono East -.21 Central + .36 Eastern - .09 Greater Accra - .17 North East + .30 Northern - .61 Oti - .88 Savannah - .46 Upper East - .04 Upper West - .10 Volta + .02 Western + 1.64 High + .26 Middle + 3.89 JHS + 7.30 SHS + 8.86 Diploma + 9.36 HND + 10.98 Bachelors + 12.47 Masters + 14.45 Doctorate + .13 Math

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self-concept - .36 Mathematics Attitude + .25 Computational ability + .03 Motivation + .24 Curriculum + .10 Instructional strategies and methods - .14 Teacher competency in Math

For a student who is a female, (gender = 0), an Islam, a Ga, from Greater Accra, Middle SES of parents, Parents have Diploma, Math self-concept =3, Math attitude=3, Computational ability=4, and Motivation = 4, Curriculum = 4, Instructional strategies and methods = 3, Teacher competency in Math = 4, the equation becomes: Achievement score = 55.13 + .15 (0) - .77(1) - .01(1) - .09(1) + .26 (1) + 8.86 (1) + .13(3) - .36(3) +.25(4) +.03(3) + .24(4) + .10(3) - .14(4) = 64.48.

Similar interpretation applies to significant factors in this model, albeit with values slightly different from those in model 1. For a one unit increase in Curriculum, students' achievement scores increased by .24 unit.

Table 6 Multiple Regression Results for model 2

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Collinearity Statistics	
Model 2	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	55.13	1.25		44.30	.00	52.68	57.59		
Gender	.15	.14	.02	1.04	.30	-.13	.42	.86	1.17
Christianity	.87	.40	.12	4.17*	.03	-1.66	-.08	.27	8.50
Islam	-.77	.40	-.10	-1.94	.05	-1.55	.02	.28	7.62
African Traditional Religion	-.35	.45	-.02	-.77	.44	-1.23	.54	.22	4.66
Fanti	-.15	.18	-.02	-.86	.39	-.50	.20	.53	1.90
Asanti	-.11	.19	-.01	-.59	.56	-.48	.26	.44	2.30
Ga	-.01	.19	-.00	-.03	.98	-.39	.38	.52	1.92
Ewe	-.01	.19	-.00	-.08	.94	-.39	.36	.49	2.03
Ashanti	.31	.36	.03	.84	.40	-.41	1.02	.35	6.71
Ahafo	-.53	.50	-.02	-1.05	.29	-1.51	.46	.44	2.26
Bono	.48	.50	.02	.98	.33	-.49	1.46	.39	2.58
Bono East	-1.11	.58	-.04	-3.91*	.04	-2.26	.04	.48	2.08

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Model 2	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound	Collinearity Statistics Tolerance	Collinearity Statistics VIF
Central	-.21	.38	-.02	-.53	.60	-.96	.55	.29	5.31
Eastern	.36	.38	.03	.94	.35	-.39	1.11	.23	4.69
Greater Accra	-.09	.38	-.01	-.23	.82	-.84	.67	.38	5.66
North East	-.17	.49	-.01	-.34	.73	-1.13	.79	.40	2.50
Northern	.30	.37	.03	.82	.41	-.42	1.02	.26	6.28
Oti	-.61	.48	-.03	-1.26	.21	-1.55	.34	.41	2.43
Savannah	-.88	.44	-.05	-3.98*	.03	-1.75	-.01	.32	3.18
Upper East	-.46	.47	-.02	-.99	.32	-1.38	.46	.34	2.92
Upper West	-.04	.55	-.00	-.07	.94	-1.13	1.04	.28	3.63
Volta	-.10	.44	-.01	-.24	.81	-.97	.76	.27	3.68
Western	.02	.41	.00	.04	.97	-.80	.83	.33	2.99
High	1.64	.43	.17	3.79*	.00	.78	2.49	.39	8.61
Middle	.26	.29	.03	.89	.37	-.31	.82	.24	7.23
Junior High School	3.89	.45	.39	8.69*	.00	3.00	4.77	.30	8.36
Senior High School	7.30	.45	.78	16.26*	.00	6.41	8.19	.29	7.46
Diploma	8.86	.44	.83	20.39*	.00	8.01	9.72	.22	8.36
Higher National Diploma	9.36	.47	.84	20.12*	.00	8.44	10.27	.21	8.81
Bachelors	10.98	.45	1.22	24.48*	.00	10.09	11.86	.28	8.56
Masters	12.47	.50	1.15	25.04*	.00	11.48	13.45	.29	7.68
Doctorate	14.45	.63	.50	23.13*	.00	13.22	15.68	.42	2.38
Math Self Concept	.13	.11	.03	1.83	.24	-.09	.36	.44	2.25
Math Attitude	-.36	.13	-.05	-4.58*	.01	-.59	-.08	.50	1.99

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Model 2	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
Computational Ability	.25	.12	.04	4.04*	.04	.01	.50	.45	2.21
Motivation	.03	.13	.01	4.24*	.04	-.22	.29	.48	2.10
Curriculum	.24	.12	.04	5.95*	.04	-.00	.48	.45	2.21
Instructional Strategies and Methods	.10	.11	.01	.90	.37	-.12	.33	.80	1.25
Teacher Competency in Math	-.14	.11	-.02	-1.19	.23	-.36	.09	.84	1.20

R = .78, R^2 = .61, $\Delta R^2 = .03, *p \leq .05$

For model 3, the student-level, classroom-level and school-level factors indicated that forty-one predictors explained 62.0% of the variance (R^2=.62, F (41,201) =120.86, p<.05), with sixteen, being very significant. The following factors were the significant predictors of students' achievement scores: Christianity (β = .59, p<.05); Bono East (β = -1.10, p<.05); Savannah (β = -.74, p<.05); High SES (β = 1.60, p<.05); JHS (β = 3.75, p<.05); SHS (β = 7.16, p<.05); Diploma (β = 8.68, p<.05); HND (β = 9.12, p<.05); Bachelors (β = 10.70, p<.05); Masters (β = 12.06, p<.05); Doctorate (β = 13.98, p<.05); Mathematics attitude (β = -.34, p<.05); Computational ability (β = .24, p<.05); and Motivation (β = -.02, p<.05); Curriculum (β = .27, p<.05); and School resources (β = .25, p<.05) (See table 7).

For model 3, the following regression equation would enable us compute a student's achievement score:

Achievement score = 55.32 + .12 Gender + .59 Christianity + -.51 Islam - .22 African Traditional Religion – .19 Fanti - .14 Asanti - .05 Ga - .06 Ewe + .32 Ashanti - .59 Ahafo + .45 Bono – 1.10 Bono East -.16 Central + .35 Eastern - .09 Greater Accra - .14 North East + .34 Northern - .58 Oti - .74 Savannah - .66 Upper East - .08 Upper West - .08 Volta + .02 Western + 1.60 High + .35 Middle + 3.75 JHS + 7.16 SHS + 8.68 Diploma + 9.12 HND + 10.70 Bachelors + 12.06 Masters + 13.98 Doctorate + .11 Math self-concept - .34 Mathematics Attitude + .24 Computational ability + .02 Motivation + .27 Curriculum + .13 Instructional strategies and methods - .13 Teacher competency in Math +.25 School resources + .03 Class attendance

For a student who is a female, (gender = 0), an Islam, an Asanti, from Greater Accra, Middle SES of parents, Parents have Masters, Math self-concept =3, Math attitude=3,

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Computational ability=4, and Motivation=4, Curriculum = 4, Instructional strategies and methods = 3, Teacher competency in Math = 4, School resources = 4, Class attendance =3, the equation becomes: Achievement score = 55.32 + .12 (0) - .51(1) - .14(1) - .09(1) + .35 (1) + 12.06 (1) + .11(3) - .34(3) +.24(4) +.02(3) + .27(4) + .13(3) - .13(4) + .25(4) + .03 (3) = 68.36.

Similar interpretation applies to significant factors in this model, albeit with values slightly different from those in models 1 and 2. For a one unit increase in school resources, students' achievement scores increased by .25 unit.

Table 7 Multiple Regression Results for model 3

Model 3	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound	Collinearity statistics Tolerance	Collinearity statistics VIF
(Constant)	54.32	1.28		42.62	.00	51.81	56.84		
Gender	.12	.14	.01	.87	.39	-.15	.39	.85	1.18
Christianity	.59	.42	-08	1.42	.10	-1.41	.23	.26	8.88
Islam	-.51	.41	-.07	-1.25	.21	-1.32	.30	.27	7.81
African Traditional Religion	-.22	.45	-.012	-.50	.62	-1.11	.66	.21	4.74
Fanti	-.19	.18	-.02	-1.09	.28	-.54	.16	.52	1.92
Asanti	-.14	.19	-.02	-.77	.44	-.51	.22	.43	2.33
Ga	-.05	.19	-.01	-.25	.81	-.43	.33	.52	1.94
Ewe	-.06	.19	-.01	-.34	.74	-.44	.31	.49	2.06
Ashanti	.32	.36	.03	.89	.38	-.39	1.03	.35	6.72
Ahafo	-.59	.51	-.03	-1.16	.25	-1.61	.42	.41	2.45
Bono	.45	.49	.02	.92	.36	-.52	1.42	.39	2.59
Bono East	-1.10	.58	-.04	-4.91*	.04	-2.24	.04	.48	2.08
Central	-.16	.38	-.01	-.42	.67	-.91	.59	.39	5.33
Eastern	.35	.38	.03	.94	.35	-.39	1.10	.21	4.71
Greater Accra	-.09	.38	-.01	-.24	.81	-.84	.66	.28	5.66
North East	-.14	.48	-.01	-.30	.77	-1.09	.81	.39	2.51
Northern	.34	.36	.03	.93	.36	-.38	1.06	.26	6.30
Oti	-.58	.47	-.03	-1.21	.23	-1.51	.36	.41	2.44
Savannah	-.74	.44	-.04	-1.67*	.03	-1.61	.13	.31	3.23
Upper East	-.36	.46	-.02	-.77	.44	-1.27	.56	.34	2.95
Upper West	-.08	.55	-.00	-.15	.88	-1.16	.99	.28	3.64
Volta	-.08	.44	-.01	-.19	.86	-.94	.78	.27	3.69
Western	.02	.41	.00	.06	.95	-.78	.83	.33	2.99
High	1.60	.43	.17	4.72*	.00	.75	2.44	.29	8.67
Middle	.35	.29	.05	1.22	.23	-.22	.91	.24	7.39
Junior High School	3.75	.45	.38	8.41*	.00	2.87	4.63	.22	7.52
Senior High School	7.16	.45	.76	15.98*	.00	6.28	8.05	.29	7.64
Diploma	8.68	.44	.81	19.87*	.00	7.82	9.54	.22	8.61

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Model 3	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound	Collinearity statistics Tolerance	Collinearity statistics VIF
Higher National Diploma	9.12	.47	.82	19.42*	.00	8.20	10.05	.21	9.19
Bachelors	10.70	.46	1.19	23.39*	.00	9.80	11.61	.28	7.35
Masters	12.06	.52	1.12	23.15*	.00	11.03	13.08	.38	8.92
Doctorate	13.98	.65	.49	21.59*	.00	12.70	15.26	.38	2.61
Math Self Concept	.11	.11	.02	.94	.35	-.12	.33	.44	2.28
Math Attitude	-.34	.13	-.05	-4.62*	.01	-.59	-.08	.50	2.02
Computational Ability	.24	.12	.04	4.94*	.03	-.00	.48	.45	2.22
Motivation	.02	.13	.00	4.18*	.02	-.22	.27	.48	2.10
Curriculum	.27	.12	.05	3.22*	.03	.03	.51	.45	2.25
Instructional Strategies and Methods	.13	.11	.02	1.15	.25	--.09	.36	.78	1.28
Teacher Competency in Math	-.13	.11	-.02	-1.18	.24	-.35	.09	.83	1.20
School Resources	.25	.11	.05	5.23*	.03	.03	.47	.43	2.34
Class Attendance	.03	.02	.02	1.16	.25	-.02	.07	.76	1.32

$R = .79$, $R^2 = .62$, $\Delta R^2 = .01$, $* p \leq .05$

DISCUSSION

In this study, the effect of gender, ethnicity, religious affiliation, region of birth, parental education level, parents' socio-economic status, mathematics self-concept, mathematics attitude, computational ability, motivation, curriculum, instructional strategies and methods, teacher competency in mathematics, school resources, and class attendance on mathematics achievement in vector analysis were investigated.

In contrast to studies by Campbell (1995), Gray (1996) and Kimball (1989), gender was not a significant factor predicting student mathematics achievement scores in vector analysis. This finding corroborates earlier findings by Beaton et al. (1996) and Mullis et al. (1997), which indicated the same levels of mathematics achievement between males and females. Parental education level was a significant predictor of student mathematics achievement. Thus, parents with higher educational levels could become role models for their children to accomplish high mathematics achievement levels. Such parents motivate their children to cultivate a culture of learning and provide them with the resources to achieve a higher level of excellence. Similar to Eamon (2005), Jeynes (2002), Hochschild (2003) and McNeal (2001), socio-economic status was a significant predictor of student mathematics achievement. Parents with high socio-economic status

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have the financial muscle to provide the resources for their children to excel academically.

Instructional strategies and methods did not significantly predict student mathematics achievement scores. To become significant predictors, they should be selected and implemented in such a way to allow students to apply higher-order operations (Wilson, 1996). Teacher competency did not also significantly predict student mathematics achievement. This finding does not support studies that demonstrate teachers who have a good understanding of the subject matter improve student mathematics achievement (Ball, 1993; Grossman et al., 1989; Rosebery et al., 1992). Computational ability significantly predicted student mathematics achievement. This ability includes manipulating mathematical knowledge and concepts in ways that transform their meaning and implications. It allows students to interpret, analyze, synthesize, generalize, or hypothesize the facts and ideas of mathematics.

Ethnicity was not a significant predictor of student mathematics achievement. While ethnicity played a role in predicting student mathematics achievement in some research activities, the gap has shrunk over the past three decades, making it an almost negligible factor in recent times (McGraw, Lubienski, & Strutchens, 2006). For the region of birth, Bono East and Savannah were significant predictors in reducing student mathematics achievement in vector analysis. These regions' environments could not have supported and promoted learning. As a result, students were less motivated, engaged, and had a lower learning outcome, than students from other regions. These students did not learn to achieve good mathematics scores because they might have viewed the learning environment as not positive and supportive. For religious affiliation, Christianity was a significant predictor of student mathematics achievement. Research indicates that religious beliefs amongst students correlated with high achievement (Furinghetti & Pehkonen, 2000). For Christians, this could border on maintaining good virtues and helping students understand themselves and others.

Contrary to previous studies which found that a positive mathematics self-concept facilitates student mathematics achievement (Marsh et al., 2005; Skaalvik & Valås, 1999), it did not significantly predict student mathematics achievement in this study. However, research has witnessed a consistent positive relationship between student self-concept and academic achievement (Kung, 2009; Ercikan et al., 2005; Marsh et al., 2005; Ross, Scott, & Bruce, 2012; Sarouphim & Chartouny, 2017). Mathematics attitude was a predictor of student mathematics achievement in vector analysis. This finding corroborates earlier studies which indicated that mathematics attitude is a predictor of higher mathematics achievement (Mohamed & Waheed, 2011; Mata, Monteiro & Peixoto, 2012; Ngussa & Mbuti, 2017). Attitudes can change and develop over time. Thus, students' mathematics achievement could improve when they build a positive attitude (Syyeda, 2016; Mutai, 2011). On the flip side, a negative attitude could hinder effective learning and affects their achievement outcomes (Joseph, 2013).

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IMPLICATIONS

Policymakers and the Ministry of Education should be motivated by these findings to embark on nationwide research to ascertain if these predictors apply to students of the entire country. This research would enable the ministry to roll out a comprehensive education programme to train teachers to focus on specific factors to improve student mathematics achievement. Thus, for future research, a more representative sample comprising students in public universities could make the findings generalizable to the public universities in the country.

CONCLUSION

The predictors of student mathematics achievement are numerous and varied. Some of these predictors depend on the areas and settings where the research takes place. However, parental education level, parents' educational level, parent socio-economic status, mathematics self-concept, computational, and motivation have often proven to be significant predictors of student mathematics achievement.

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