

Students' Perception and Its Impact on Ghanaian Students' Interest in Mathematics: Multivariate Statistical Analytical Approach

Yarhands Dissou Arthur^{1*}, Samuel Asiedu-Addo² and Charles Assuah²

¹Department of Interdisciplinary Studies, College of Technology Education, University of Education, Winneba, Kumasi Campus, Ghana.

²Department of Mathematics Education, Faculty of Science Education, University of Education, Winneba, Ghana.

Authors' contributions

This work was produced through collaboration between all authors. Author YDA gathered all literature materials and designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors SAA and CA initiated the study design and supervised the statistical analysis as well as given valuable inputs into analysis. All authors read and approved the final manuscript.

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Abstract

The study aims at addressing the effect of students' perception and its impact on student interest in Mathematics using multivariate statistical techniques. One Thousand Two Hundred and Sixty Three (1263) students were drawn from ten (10) Senior High Schools in the Ashanti region of Ghana using structured questionnaires to investigate the effect and impact of student perception on their interest in Mathematics. The study used multivariate techniques to investigate and further predict the effect and impact of student perception on student interest in Mathematics. The study concluded that, negative perception of student about Mathematics significantly influence their interest in Mathematics negatively however, students perception explains almost 9% ($P < 0.001$) of students interest in Mathematics. The study recommended for practice teaching methods that inculcates motivations to help reduce bad perception to optimize interest.

*Corresponding author: E-mail: day1981boy@yahoo.com;

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1 Introduction

The perception of students' about Mathematics remains crucial in educational stakeholders' quest for finding lasting solution to the problem of poor performance and lack of interest in Mathematics. These perceptions of learners about Mathematics may be as a results of experiences learners have gone through at their early stages in their educational life [1,2]. The experiences learners go through in their academic life comes together in forming factors that contribute to disliking of Mathematics as a subject [3]. The general lack of interest in Mathematics which in most cases leads to total avoidance of Mathematics in many African countries remain crucial in the for investigations [4–6]. The perceptions held by many students may be that Mathematics is a subject which is more of ability than effort. This view can further be implied that efforts may not matter in performance in Mathematics with admission that lack of Mathematics achievement is mainly beyond students' control. The perceptions held by students in Mathematics have in many cases prevented learners from reaching their desired academic height [7,8]. The fears of bad performance in Mathematics are among other negative perceptions student hold about Mathematics and these negative perceptions resist learning and enquires since learning and enquires depended on perceptions and beliefs [9]. The roles of teachers in shaping the perceptions of students are an important component of eradicating negative perceptions about mathematics [10–12]. The teacher's role of eradicating negative perception about Mathematics may be to learn about their students and their perceptions that they hold in order to help tackle this perception. The teachers' ability to acquire knowledge about their students' perception of Mathematics may improve strategies that will contribute in developing instructional strategies in teaching and learning of mathematics.

1.1 Students perception, performance and interest

There have been claims by several researchers that students beliefs about Mathematics are formed from a history of experiences [13]. However, changing such beliefs might be a herculean task for instructors, educational policy makers and even parents. But such changes in student's belief seems possible by consistent application of effective teaching activities as suggested in the equilibrium model which would definitely result in changes in the cognitive as well as the behavioural dimensions of Mathematics attitude in the long run. Conversely, modifying these negative beliefs requires more than just effective teaching. It has been suggested that activities with elements affecting cognition and emotions would yield more results with respect to modifying students grave beliefs and perceptions towards the learning of Mathematics and success [14].

Students with higher cognitive abilities tend to have a higher Mathematics academic self-concept. Moreover, students in general and technical sections of education tend to have a lower Mathematics academic self-concept compared to students in the classical study section. In addition the results from [14] supports the big-fish-little-pond effect, postulated by [15], with respects to self-concept and academic achievement. As supported by [15] equally able students have higher academic self-concept in groups where the average abilities are low.

Therefore, high mean cognitive abilities of the class group had a negative effect on the Mathematics academic self-concept, taking into account cognitive abilities of the individual [14]. Different authors [16–20] have studies that shows positive correlation between student's attitude and perception towards Mathematics and academic achievement of students. Specific attitudes such as problem solving in terms of patience, confidence and willingness have positive relation with students' Mathematics achievement [16,21]. There have been a lot of misconception by students of the difficult nature of mathematics which have scared many students in the course of their educational career. These misconceptions being negative perception held by students have landed many students to have low self-concept in Mathematics [3,22]. The students' misconception of mathematics seem to extend to the teachers of the subject, the time of day in which the subject is taught, the amount of formula in mathematics, lack of students involvement during

lessons as well as the perceptions that only bright student can perform in Mathematics [10,14,23]. There are studies that posit that, the perceptions of student about mathematics do not only lie in the teachers and students attitude but also the environment in which studies take place play a significant role [7,11,24].

The bad perception of students and people who dislike Mathematics has created quite unfortunate and bad public image of Mathematics in Ghana and other parts of the globe describing Mathematics as difficult, cold, abstract, theoretical and uninterested subject [9,25–27]. This problem of misconception and bad perception need to be dealt with in order to secure students interest in the learning of Mathematics all levels of our education curricular.

1.2 Research objectives

The study after extensive review of relevant literature arrived at the following research objectives.

- i. To investigate the extent to which negative perceptions of students affects their interest in Mathematics.
- ii. To examine the effect of time in which Mathematics is taught as well as students' perception that only bright student can perform in Mathematics on students' interest in Mathematics.
- iii. To conduct principal component analysis for the students' perception construct by determining how these constructs meet the assumptions for PCA.
- iv. To determine the effect of students perception and the extent to which students' perception predicts students' interest in Mathematics.

1.3 Research questions

The study adopted the following research questions to help arrive at the needed solution for the problem this study seeks to solve.

- i. To what extent do students hold negatives and bad perception about Mathematics?
- ii. Does the time of the day in which mathematics is taught affect students' interest in Mathematics?
- iii. To what extent does the students perception constructs predicts students interest in Mathematics?

1.4 Research hypotheses

The study presents two null hypotheses as stated below

- H1: Student perception does not significantly influence their interest in Mathematics.
H2: There is no significant correlation between the measurements of perception construct.

2 Research Methodology

The study used students from both gender from ten senior high schools in the Ashanti Region of Ghana. Structured questionnaires were administered to the participating students through the help of their teachers as they consented to participate in the study. The study randomly selected 150 participants on average from the 10 participating schools. There were 1263 participant who were involved in the study. The instrument used in this study was self-constructed items as part of a bigger study. The student's perception subscale consists of 10 items for measuring students perception based on five point Likert scale. The students were made to respond to the student perception statement on teaching and learning of mathematics. The students were made to respond to the statement whether they strongly agree, agree, neutral disagree or strongly disagree. The instrument contained statement such as; Negative perception of student from basic schools affects student interest in Mathematics; Misconception of about Mathematics affects student interest in

Mathematics; the time of the day in which Mathematics is taught affects student interest in Mathematics, etc. The instrument for measuring students interest consisted of four measurement which included question such as; I love learning Mathematics; Learning Mathematics is frustrating; The hours I spend doing Mathematics are the ones I enjoy most and finally ,I am highly motivated to learn Mathematics were the statements used to measure students interest in mathematics. These statements were also responded to using the five point likert scale.

The study was purely quantitative approach to help explore and describe the students' factors of high school students' perception in Mathematics. The survey method was used for the data collection.

3 Data Analysis and Results

This section presents data analysis and reports on the results obtained by both descriptive and inferential approaches used in the data analysis. The study began with descriptive statistical results from the measures of students perception construct. The paragraphs below present the results.

The study found out how the perception students held from basic schools influence their interest in Mathematics. The study establish that, 58.1% of the total respondent agreed cumulatively that, students' negative perception of Mathematics from the basic school has strong influence on their interest in Mathematics as they move forward in their educational ladder. However 20.4% of the total participants cumulatively disagreed to the fact that negative perception of Mathematics by students from basic schools affects their interest in Mathematics. The study found negative perception of students from basic schools to have an average rating of 3.6 and standard deviation of 1.33 but the study further found the relative importance index of 0.74 as the overall rating of the participants' importance.

The study also investigated how certain misconceptions held by students about Mathematics affects students interest in Mathematics. The study used an item " Misconception about Mathematics affects student interest in Mathematics" 'The study concluded that 58.4% of the total participants agreed with the statement Misconception about Mathematics affects student interest in Mathematics but 14.4% of the total participants disagreed with 27.2% of the total participants neutral of the statement that Misconception about Mathematics affects student interest in Mathematics. The study found the average response of the participant to be 3.7 with standard deviation of 1.17 but relative importance index was found to be 0.74.

The study also investigated the students' perception about the time of the day in which Mathematics is taught and how it affects the students' interest in Mathematics. The study found that 51.8% of the total participants agreed with the views that, the time of the day in which Mathematics is taught affects student interest in Mathematics; however this was disagreed by 16.3% of the total participants that, the time of the day in which Mathematics is taught affects student interest in Mathematics. The study also found 31.9% of the total participants were without decision to whether the time of day in which Mathematics is taught affects their interest in Mathematics. The study found the time of day in which Mathematics is taught as variable to with mean 3.65 and standard deviation of 1.22 but a relative importance index was found to be 0.73.

The study examined how bad perception about Mathematics by students affects their interest in Mathematics .The study found that 60% of the total participants were found to agree with the statement that, Students with bad perception about Mathematics negatively affects student interest in Mathematics, conversely, 14.2% of the total participants were found to disagree with the statement that, Students with bad perception about Mathematics negatively affects student interest in Mathematics. The statement however had a mean ranting of 3.8 and standard deviation of 1.19 with relative importance index of 0.75.

The students' perception that, there are so many formulas in Mathematics was investigated with reference to the impact it has on the students interest Mathematics. The study made participants to rank the statement: There are so many formulas in Mathematics and that affect student interest in Mathematics. The found 45% of the total participant to agree with the statement while 24.3% and 30.6% of the total participants disagreed and neutral to the statement respectively. The average ranking of the statement was 3.37 and standard deviation of 1.24 with relative importance index of 0.67.

The study investigated the statement that Mathematics is complex and the perceived complex nature of Mathematics affects student interest in Mathematics. The study found the student level of agreement or disagreement to the statement: The complex nature of Mathematics affects student interest in Mathematics. The study result found that, 51.9% of the total participants were agreed while 18.2% of the total participant disagreed to the statement that, the complex nature of Mathematics affects student interest in Mathematics. The study however found almost 30% of the study participants neutral to the statement. The study found the statement under investigation with mean and standard deviation of 3.5 and 1.2 respectively with relative importance index of 0.70.

The study investigated the students' perception that Mathematics in not enjoying and how this perception affect student interest in Mathematics. The study found 53.3% of the total participant agreed to the perception that Mathematics is not enjoying affects students' interest in Mathematics while 13.3% of the total participants disagreed. The study however found 23.4% of the total participants were found to neither agree nor disagree with the fact that Mathematics is not enjoying affects students interest in Mathematics. The study also found the statement to have average ranking of 3.5 and a standard deviation 1.2 while the relative important index of 0.70.

The study also examined the students' perception that teachers do not involve them in the teaching and learning of Mathematics. The study investigated the statement that: students feel they are not involved in the teaching and learning process. It was found that less than 25% of the participants agreed while 37.7% of the participants disagreed with the statement that students are not involved in the teaching and learning of Mathematics. In effect the participants were undecided on the statement and were indifferent and were more skewed to disagreement than they agree. The study however found that student ability to attach a personal significance to the course of study was also found to have some level of importance to the students' interest in Mathematics.

The study further investigated the perception that only bright students can perform in Mathematics and found that 51.4% of the total participants agreed to the fact that, student's perception that only bright students' can perform well in Mathematics affects students' interest in Mathematics while 24.4% of the total participants were not disagreed. The study however found 24.2% of the total participants to neither agree nor disagree to the statement with mean and standard deviation of 3.49 and 1.29 respectively.

3.1 Principal component analysis (PCA) results

The study used exploratory factor analytical approach to investigate the extent to which the ten (10) items of the students perception construct performed on the data of 1263 participants from ten (10) Ghanaian senior high schools. Before the application of PCA, the data were screened by examining the descriptive statistics on each item as indicated in Table 1. The study further checked possible assumption violations and how the data were suitable for PCA and further analysis. The study found from the initial assessment that the data were adequate due to the adequate sample size used for the study. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.87 which is an indication that the data were adequate for PCA [28,29]. The study further investigated how sufficient were the variables corrected using the Bartlett's test of sphericity. The result of the test indicated a significant ($p < 0.001$) which provided the clearance for the analysis of the PCA.

The study extracted three factors which had eigenvalues greater than 1.00 which account for 63.4% of the total variance. The students' perception is said to have three dimensions, Perceived misconception (PM),

Complex formula (CF) and Personal significance (PS). The perceived misconception by student explained 40.52% of the total variance, the second component named complex formula (CF) explained 12.23% while the third component named personal significance explained 10.53% of the total variance. The study further proceeded to investigate the effect of these extracted factors on the student interest in Mathematics and the extent to which they predicts student interest. The analyses of the extracted constructs were found to correlate significantly with student Mathematics interest. The study predicted student interest in Mathematic significantly. The model explained approximately 9% of the total variation in students' interest in Mathematics although the second and the third constructs namely complex formula and personal significance do not significantly contribute to the prediction of student interest in Mathematic. The study found student perceived misconception about Mathematics to predict significantly predicts almost 8% of the students' interest in Mathematics.

Table 1. Descriptive statistical analyses of students' perception construct

Factors	SD	D	N	A	SA	RII	M	SD
Negative perception of student from basic schools affects student interest in Mathematics	11.2%	9.2%	21.6%	24.6%	33.5%	0.72	3.6	1.33
Misconception of about Mathematics affects student interest in Mathematics	5.6%	8.8%	27.2%	26.6%	31.8%	0.74	3.7	1.17
The time of the day in which Mathematics is taught affects student interest in Mathematics	5.7%	10.6%	31.9%	16.4%	35.4%	0.73	3.65	1.22
Students with bad perception about Mathematics affects student interest in Mathematics	5.6%	8.6%	25.8%	24.2%	35.8%	0.75	3.76	1.19
There are so many formulas in Mathematics and that affect student interest in Mathematics	8.1%	16.2%	30.6%	20.6%	24.4%	0.67	3.37	1.24
The complex nature of Mathematics affects student interest in Mathematics	8.4%	9.8%	29.9%	27.7%	24.2%	0.70	3.5	1.20
The students perception that Mathematics is not enjoying affects student interest in Mathematics	5.9%	17.4%	23.4%	27.8%	25.5%	0.70	3.5	1.21
Students feel they are not involved in the teaching and learning process	10.2%	27.2%	27.8%	21.3%	13.5%	0.60	3.01	1.20
Student attaches personal significance to the study of Mathematics	8.4%	16.1%	35%	26.9%	13.6%	0.64	3.21	1.13
The students perception that only bright student can perform well in Mathematics affects student interest in Mathematics	8.1%	16.3%	24.2%	21.1%	30.3%	0.70	3.49	1.29

Table 2. KMO and Bartlett's test of sampling adequacy

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.865
Bartlett's Test of Sphericity	Approx. chi-square	3511
	Df	45
	Sig.	0

Table 3. Total variance explained

Component	Total variance explained					
	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.052	40.517	40.517	4.052	40.517	40.517
2	1.226	12.259	52.776	1.226	12.259	52.776
3	1.053	10.531	63.307	1.053	10.531	63.307
4	0.828	8.28	71.587			
5	0.627	6.271	77.858			
6	0.568	5.68	83.538			
7	0.48	4.796	88.334			
8	0.455	4.553	92.887			
9	0.408	4.082	96.969			
10	0.303	3.031	100			

Table 4. Three-component rotated structure matrix

	Rotated component matrix		
	Component		
	1	2	3
Negative impression student from basic schools affects students interest in Mathematics	0.847		
Misconception about Mathematics affects students interest in Mathematics	0.83		
The time of the day in which Mathematics is taught affect student interest in Mathematics	0.676		
Students with bad perception about Mathematics affects student interest in Mathematics	0.758		
There are so many formulas in Mathematics and that affects student interest in Mathematics		0.776	
The complex nature of Mathematics affects students interest in Mathematics		0.715	
The students perception that Mathematics is not enjoying affects students interest in Mathematics	0.523		
Students feel they are not involved in the teaching and learning process		0.505	
Student attaches personal significance to the study of Mathematics			0.801
The students perception that only bright student can perform well in Mathematics affects student interest in Mathematics			0.703

Table 5. Summary statistics for regression model

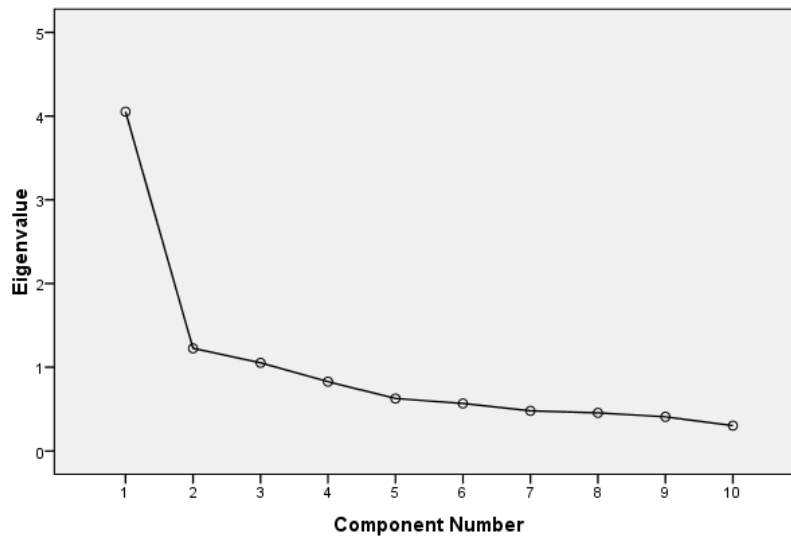
Model summary					
R	R square	Adjusted R square	Std. error of the estimate	Change statistics	F change
.303	0.092	0.089	0.90149	0.092	42.295

Table 6. Analysis of variance test for model adequacy

ANOVA					
	Sum of squares	Df	Mean square	F	Sig.
Regression	103.118	3	34.373	42.295	.000
Residual	1023.176	1259	0.813		
Total	1126.294	1262			

Table 7. Test of model coefficients

	Coefficients			T	Sig.
	Unstandardized coefficients	Std. error	Standardized coefficients		
			Beta		
(Constant)	2.571	0.122		21.136	0.00
PM	0.302	0.032	0.307	9.466	0.00
CF	-0.001	0.034	-0.001	-0.039	0.969
PS	-0.01	0.028	-0.01	-0.35	0.726

Scree Plot**Fig. 1. Scree plot rotated structure component for students perception construct**

4 Discussion of Results

The negative perception of students about mathematics according the findings from the study influences student interest in mathematics. With perception viewed as a form of attitude could negatively influence interest and by extension could directly affect performance. These misconceptions are attributed without empirical source by both students and section of the public. These findings were consistent to some extent with the studies by [9,25–27].

The time of day in which Mathematics is taught was found not to be an issue of great concern by students even though to most student mathematics is perceived without any empirical basis that it should be taught in the morning. This may be attributed to the fact that if the instructor has the qualities needed for the teaching and the content knowledge is great then, it does not matter the time of day in which Mathematics is taught.

The perception of students that only bright student can perform better in mathematics, dominated their perception of learning Mathematics. This perception might be founded on the fact that the approach used in teaching Mathematics favors only brilliant students without considering those with special attention and needs with respect to numeracy and computation to attain equal levels [30,31]. These perceptions may be

corrected by adopting strategies that will involve students to construct their own ideas in Mathematics. This finding is somewhat consistent with the studies by authors [11,32,31].

The results from the regression model predict approximately 9% of students' interest in Mathematics. The result confirms the importance of students' perception on mathematics interest building process [23,33,34]. Thus, the more positive student perceives Mathematics, the more likely they are to develop higher interest in the subject. The perceived misconception constructs which consist of factors such as students' negative impression from basic schools, the time of day in which Mathematics is taught, students' general bad perception about Mathematics as subject as well as the perception that Mathematics is not enjoyable positively. The result of the study confirms further that students' perceptions significantly affect students' interest in Mathematics.

5 Conclusion and Recommendations

The study investigated the effect of students' perception on interest in Mathematics and came out with the following conclusion:

- i. Students' with negative perceptions about Mathematics negatively influence students' interest in Mathematics.
- ii. The perception about the time in the day in which Mathematics is being taught was really an issue of most students although some students were indifferent about it.
- iii. The greater majority of the participants believe that student interest in mathematics is influenced by student perception that only bright student can perform well in Mathematics.
- iv. The students' Mathematics perception construct (MPC) can be put into three principal components namely: Perceived Misconception (PM), Complex formula (CF) and Personal significance (PS). These three components explained almost 63% of total variance.
- v. The student perception significantly predicts students' interest in Mathematics and explains approximately 9% of the variability in students' interest in Mathematics.

The study recommended that, educational leadership should take notice of the effect of misconception of Mathematics on the students' interest, which will negatively influence the students' interest. If parents and educational leadership eradicate misconception in Mathematics among students' this will positively affect their interest. The teachers of Mathematics should give equal attention to students from different economic, cultural and academic background to help erase some perceptual views of students' which does not benefit the students in terms of performance. The study further recommended for further studies the use of other methodological approaches to expand the body of knowledge of perception and how it contributes to building students interest and performance.

Competing Interests

Authors have declared that no competing interests exist.

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