The contribution of attitudes of students and teachers to junior high school students' achievement in mathematics

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Abstract

This study investigated the extent to which Ghanaian junior high school students' attitude towards mathematics and the attitude of their teachers contribute to students' achievement in mathematics. In all, 400 junior high school students in their third year (i.e., the ninth grade), comprising 230 boys and 170 girls, randomly selected from twenty junior high schools in the Central Region of Ghana, participated in the study. The results of the study indicated that, in general, each of the two independent variables, students' attitude towards mathematics and their teachers' attitude towards mathematics, contributes significantly to junior high school student's achievement in mathematics in Ghana. The study recommended, among other things, that both in-service and pre-service junior high school mathematics teachers should be made aware of the impact of their attitudes on students' achievement in mathematics.

Keywords students' attitude, teachers' attitude, mathematics achievement

Introduction

Mathematics is considered to be the back-bone of scientific and technological advancement. Its usage permeates almost every field of study including physics, geology, engineering, biology and medicine. It is accepted universally that a strong foundation in mathematics is a pre-requisite for many careers and professions in today's growing technological society. The implication for any country, especially a developing country like Ghana, is that progress in industrial and technological development calls for a workforce that is well-grounded in mathematics.

For the individual's own personal advancement Isenberg and Altizer-Tuning (1984) have posited that, in order to be prepared for potential success in the world today and in the future, knowledge of mathematics and science is important. But the irony is that while mathematics is becoming increasingly important, there is evidence for a decreasing trend in average students' performance in the subject (especially on tasks that require deep understanding of mathematics), accompanied by a significant decline of student's interest in mathematics during the course of high school (Jones, 1998; Reynolds & Walberg, 1992).

Many researchers have investigated factors that influence students' achievement in mathematics (see for example, Good & Grouws, 1977; Hines, Cruickshank and Kennedy, 1985; Csikszentmihaly & Nakamura, 1989; Csikszentmihaly, Rathunde & Whalen, 1993). Such studies have identified factors such as teaching methods, quality of instruction, home factors (e.g., parental influence, socio-economic status, etc.), school environment and students' characteristics.

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Other research findings have also shown that factors such as motivation, attitude, anxiety, personality, interest etc. influence learning and achievement in mathematics (see for instance, Gilleslpie & Bonnie, 1983; Aikens, 1976; Selkirk, 1974; Neale, Gill and Tismer, 1970; Abrego, 1966). Abrego (1966), for instance, contended that of these student variables, attitude is perhaps the most important. Abrego (1966), therefore, argued that without the right attitude the child's full potential of growth in knowledge and achievement cannot be realized. Selkirk (1974) found that there is a decrease in the number of students enrolling in mathematics classes at the high school and college level. He stated that one of the reasons for this is a general negative student attitude towards mathematics. Aikens (1976) found a significant positive correlation between attitude towards mathematics and achievement in mathematics.

Neale, Gill and Tismer (1970) also found a significant positive correlation between attitude towards mathematics and achievement among junior secondary school pupils. Based on findings on the importance of the attitudes of students towards mathematics and its relation with student achievement many recommendations have emphasized the importance of motivating students (by getting them more interested in mathematics) as a means to overcome the deficit in mathematics achievement (see for instance, Jones, 1988, p. 329).

In Ghana, studies on attitudes of students towards mathematics at the Senior and Junior High School (SHS and JHS) levels indicate that female students have as fairly high positive attitude towards mathematics as their male counterparts (see for instance, Appiah-Ofori, 1993; Nkani, 1993; Okpodjah, 1991). For instance, researching on the then General Certificate of Education, Ordinary and Advanced level (GCE "O" & "A" levels) students, Nkani (1993) found that both males and females in mixed and single-sex secondary schools (at the 'O' and 'A' levels) have a positive attitude towards mathematics. Appiah-Ofori (1993) found similar results in a study that involved students from rural and urban junior secondary schools (now called Junior High Schools). Thus, it appears that in Ghana, students in both urban and rural junior and senior high schools have a positive attitude towards mathematics irrespective of gender.

In terms of students' achievement in mathematics, there are no conclusive findings from studies conducted in Ghana (see for example Eshun, 1987; Kpemlie, 1993; Wilmot 2001). For instance, Kpemlie (1993) investigated gender differences in achievement at the then junior secondary school (JSS) level and found that at the JSS level girls perform equally well as boys in mathematics. One would have expected that if differences in gender achievement were not significant at the junior secondary school level, similar trend would be observed throughout the primary school level. However, this trend of performance was not consistently observed by Wilmot (2001). Wilmot (2001) found that while at the lower primary grade levels (primary classes 1 to 3) there is no significant difference between the achievement of boys and girls, by primary class six (i.e., the sixth grade), significant differences in achievement, begin to be observed in favour of boys. At the senior secondary schools (SSS) level, Eshun

(1987) had earlier found that, in general, boys in single-sex achieved higher than their females counterparts in mathematics. However, when the results were analyzed by school type Eshun (1987) observed that, the achievement of females in single-sex SSS in mathematics was significantly better than that of boys in the mixed schools (co-educational institutions).

Also in Ghana, apart from Nkani (1993), whose study considered the relationship between the attitudes of students toward mathematics and their achievement in mathematics at the Senior Secondary School (SSS) level, all other studies have dealt with either attitude of students toward mathematics or achievement in mathematics separately. Nkani (1993) found a significant correlation ($r = 0.546$) between the attitude of the then senior secondary school students towards mathematics and their achievement in mathematics.

No studies have been done in Ghana in terms of investigating the impact of both students' attitude towards mathematics and those of their teachers on students' achievement in mathematics. The need for such studies cannot be overemphasized. It is in the light of this that this study was designed to investigate the possible contribution of the attitudes of students and their teachers on students' achievement in mathematics at the junior high school level.

Method

The sample for the study comprised 400 third year junior high school students. Of these, 230 were boys and 170 were girls. The 400 participants were randomly selected from twenty schools in two districts in the Central Region of Ghana. These were the Cape Coast and Mfantsiman districts. Ten schools were initially selected at random from each of the two districts. And from each of the selected schools twenty students were randomly selected from the JHS 3 class to participate in the study. The Cape Coast and Mfantsiman districts were chosen for the study due to the accessibility and familiarity of the area to the researchers.

Two reasons accounted for the use of JHS3 students for this study. First, by the end of the third year of the junior high school (i.e. JHS3), students are expected to have either fully covered the content of JHS mathematics syllabus or a greater part of it. Since one of the instruments used for the study was an achievement test based on the JHS syllabus, it was considered that the JHS 3 students were the cohort of students more likely to be able to answer the questions on the achievement test. Second, research suggests that the period of time from the seventh grade to the ninth grade (JHS1 to JHSS3) is critical in the development of students' attitude towards mathematics (Aikens, 1985; Bauer, 1985). As a result, it was anticipated in this study that by the third term of JHS3, students' potential for specific programmes at the senior high school (SHS) or an equivalent level would have developed or at least begun to develop. Consequently, such students would have developed various attitudes toward each of the school subjects, including mathematics, by the time they are in the third year of junior high school.

Research Instruments

Three instruments were used to collect data for the study. These were an attitude questionnaire for students, an achievement test for students and an attitude questionnaire for teachers. Both of the attitude questionnaires were the Likert-type and comprised two sections. The first sections elicited background information respectively about the students and teachers, as well as their schools, while the second sections was made up of attitude statements about mathematics to which respondents indicated their degree of agreement or disagreement. The latter contained statements such as, "Mathematics is very interesting", "I have always been afraid of mathematics", "I would have stopped mathematics in Junior High School 2 (JHS 2) if it had been allowed" etc. To find out about respondents' attitude towards mathematics, they were requested to indicate whether they strongly agreed, agreed, disagreed, strongly disagreed or were undecided with each statement. The second instrument, the achievement test, on the other hand, consisted of 40 multiple choice items, each with five options. The items were based on the junior high school mathematics content.

The two student instruments were piloted on 40 JHS 3 students in schools similar to those that participated in the study and refined using the pilot data before being used in the study. The Cronbach's alpha reliability coefficient calculated for the reliability of the questionnaire yielded a reliability coefficient of 0.80 while the split half reliability coefficient of 0.82 was also obtained from the piloting of the achievement instrument. In the same way, the teachers' instrument was also piloted on teachers in schools similar to those that participated in the study. The reliability coefficient (also Cronbach's alpha) of the teachers' instrument was found to be 0.79.

Data Collection Procedure

The study was conducted about one and a half months to students writing of the Basic Education Certificate Examinations (BECE). Initial visits were made to the selected schools one week prior to the administration of the instruments. These meetings provided opportunity for the rationale of the study to be explained to the school administrators, teachers and the students and to arrange for convenient days to administer the instruments. In each school, the administrators, mathematics teachers and the JHS 3 students agreed to participate and considered the achievement test as a warm-up test that had the potential of exposing students to areas that they needed to further improve prior to their main BECE.

In each school, the two students' instruments were administered on the same day in the students' own classroom. The questionnaires were administered to the students in the morning hours between 9am and 12noon while the achievement test was administered one hour later (between 1pm and 2pm) to allow for an hour break after the questionnaire administration. The teachers' questionnaire was administered at the same time as the students' questionnaire. Thus, while the students were in their classrooms completing their questionnaire, their teachers were in the staff common

room completing theirs. By this arrangement, students were free to indicate their true attitudes without the pressure which would otherwise have been on them had their teachers been present. To ensure that other selected schools did not get access to the achievement test papers prior their appointment dates, all the test papers were collected together with the answer sheets. To maintain anonymity of participants, each respondent was given an identification number to use for both the questionnaire and the achievement test.

Data analysis

As already mentioned, this study collected data on junior high school students' attitude and their teachers' attitude towards mathematics, as well as the achievement of the students in mathematics. It was guided by the research question "to what extent do junior high school students' attitude towards mathematics and the attitude of their teachers contribute to students' achievement in mathematics?"

To answer this research question a multiple regression model involving the mean scores the attitude of students and that of their teachers, and the students' achievement was developed. Multiple Regression was used for two main reasons. First, multiple regression has an advantage over correlation because it can be used to determine the relationship between one dependent variable (criterion), which in this case was the mean students' achievement in mathematics, and the best combination of two or more independent variables (predictors), which in this case were mean scores of the attitudes of the students toward mathematics and those of their teachers. In addition, with Multiple Regression, it is possible to determine not only whether variables are related, but also the degree to which they are related (Gay, 1987). Consequently, Multiple Regression can be used to investigate the joint and relative contributions of the independent variables to the dependent variable.

The model tested was of the form, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$, where,

Y = the dependent variable representing the mean student achievement,

X_1 = the independent variable representing the mean students' attitude,

X_2 = the independent variable representing the mean teachers' attitude,

β_0 = students' mean achievement when the independent variables are each equal 0.

β_1 = the change in students mean achievement for one unit increase in students' attitude, X_1, holding all other independent variables constant.

β_2 = the change in students mean achievement for one unit increase in teachers' attitude, X_2, holding all other independent variables constant.

e = the error for the students' mean achievement (e's are assumed to be independently and identically normal distributed with a mean of 0 and variance, σ^2).

Results of the study

To estimate this multiple regression model, values of coefficients of the independent variables and the constant term were used. Table 2, presents these coefficients.

Table 1 Coefficients of the multiple regression model

Variable	Unstandardized Coefficients		t	p-value
	β	Std. Error		
Constant	9.940	3.877	2.56	0.011
Students' Attitude	0.271	0.037	7.37	0.000
Teachers' Attitude	0.398	0.101	-3.94	0.000

Table 1 indicates that the co-efficient of each of the two independent variables, students' attitude and teachers' attitude (i.e. 0.271 and 0.398 respectively) in the regression equation are significant (p-value < 0.025, two tail). This implies that each of the two independent variables, students' attitude towards mathematics and their teachers' attitude towards mathematics, contributes significantly to student's achievement in mathematics.

Using these coefficients, the multiple regression model that was estimated in this study was as shown below;

$\boldsymbol{Y = 9.940 + 0.271X_1 + 0.398X_2 + e}$, where,

Y = the dependent variable representing the mean student achievement,

X_1 = the independent variable representing the mean students' attitude,

X_2 = the independent variable representing the mean teachers' attitude,

9.940 = students' mean achievement when the independent variables are each equal 0.

0.271 = the change in students mean achievement for one unit increase in students' attitude, X_1, holding all other independent variables constant.

0.398 = the change in students mean achievement for one unit increase in teachers' attitude, X2, holding all other independent variables constant.

e = the error for the students' mean achievement

Also, the Multiple Regression analysis was used to determine what proportion of the variability in the students' achievement was explained by the model. Table 2, below, reveals such a summary.

Table 2 Multiple regression model summary

R	R Square	Std. Error
0.3688	.136	**11.59**

The "R-square" value in the model is the coefficient of determination. It is indicative of how much of the variability in the dependent variable (mean students' achievement) is explained by the model. Thus, Table 2 reveals that about 13.6% of the variability in the mean students' achievement could be explained by the model.

Conclusions

From the foregoing, the multiple regression model used to estimate the extent to which Ghanaian junior high school students' attitude towards mathematics (X1) and

the attitude of their teachers (X2) contribute to the students' achievement in mathematics (Y) as shown below.

$$Y = 9.940 + 0.271X_1 + 0.398X_2 + e$$

Thus, in terms of answering the question that guided this study, it was concluded that a linear relationship estimated by the equation above existed between Ghanaian junior high school students' achievement in mathematics, their attitude towards mathematics and the attitude of their teachers. The positive coefficient of X1, the mean students' attitude, in the regression model implies that, granted that all possible confounding variables have been included in the model, a unit increase in students' attitude towards mathematics would correspond to an increase in mean student achievement (by a factor of .0.271). Similarly, the positive coefficient of X2, the mean teachers' attitude in the regression model implies that, granted that all possible confounding variables have been included in the model, a unit increase in teachers' attitude would correspond to an increase in mean student achievement (by a factor of 0.398). In addition, from the p-values (refer to Table 1) it can be seen that as far as the participating schools are concerned each of these independent variables contributes to students' achievement significantly.

It can be, thus, be concluded that teachers' and students' attitude towards mathematics are significantly related to students' achievement at the junior high school level. These two independent variables (i.e., teachers' and students' attitude towards mathematics) can therefore not be ignored when discussing or talking about factors that contribute to student's achievement in mathematics at the junior high school level in Ghana.

Recommendations

A number of recommendations are suggested from the findings of this study. First, it is recommended that teachers at the pre-service and in-service level be made aware of the significant contribution of their attitudes on the achievement of their students, especially at the junior high school level.

Also, the findings from this study implies that it is necessary for attempts to be made at the pre-service level and through professional development programmes to help mathematics teachers develop more positive attitudes towards the subject. In addition, it is recommended that mathematics teacher educators should equip teachers with the right approaches they could use in helping their students develop positive attitudes towards the subject. This is because from this study, it is obvious that teachers who have positive attitudes and are equipped with the right skills to build similar positive attitudes in their students are more likely to improve their students' achievement in mathematics that those who lack these qualities.

In addition, the conclusions drawn from this study have important implications for further studies into students and teachers' attitudes towards mathematics and students achievement in the subject especially in Ghana. The following options are recommended for further studies:

Only 400 junior high school students participated in the study. The limitations imposed on this study due to this small number calls for the need to replicate the study to include more schools across the country. Increasing the participation of more students and teachers could help build a model that could be more stable and more generalizable to the entire country. In addition, such an increase in the number of participants has the potential of making it possible to extend of the focus of future studies to include the issue how the number of years of teaching experience could affect teachers' attitude and the resultant model that gets estimated.

Second, increasing the number of schools in future research could also ensure that representative samples of all school types are allowed to participate in the study. Including various school types in Ghana would in turn permit more analyses to be done (e.g., analyses done across rural and urban schools, single-sex versus co-educational, private versus public school).

It is also recommended that the study be replicated at the primary and senior high school level, as well as other pre-university levels of our educational system. This will help generate data at all pre-university levels of our educational system and provide a comprehensive knowledge of how teachers and students' attitudes affect student performance in mathematics. Such data-base and set of research findings would be helping for teacher educators in finding possible solutions to the negative effect of the two factors studied in this research on students' achievement in mathematics in Ghana.

Finally, it would be informative to research into how the attitudes of teachers get transformed into their instructional practices. In this regard, it is recommended that future studies should include classroom observations of teachers. Including these observations in future studies could help isolate teachers with different types of attitudes and examine how such attitudes influence their pedagogical practices. This will be useful in contributing to the discussion of factors, aside teacher knowledge, that affect how mathematics teachers teach in Ghana.

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