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Original Article

Relationship between Student Anxiety and Achievement in Mathematics among Secondary School Students in Ganze District Kilifi County Kenya

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ABSTRACT

This article is based on a bigger study which sought to establish the relationship between affective factors with students` achievement in mathematics. The article shares findings from the study objective to establish the relationship between student anxiety and achievement in mathematics. Descriptive Survey research design on a sample size of 250 students used a mathematics anxiety rating scale and mathematics achievement test to collect quantitative data. The computational formula of Pearson`s product-moment correlation coefficient (rxy) determined the null hypothesis, "there is no statistically significant relationship between student anxiety and achievement in mathematics". The study found that there was a statistically significant positive correlation coefficient of $rxy = 0.38$ between student anxiety and achievement in mathematics. This implies that student anxiety is indirectly proportional to achievement in mathematics. However, analysis based on gender differences contradicts the stereotype that females are always of higher anxiety levels towards mathematics than males. Males in mixed-boarding and mixed-day secondary schools indicated lower anxiety levels than females, unlike in single-sex boarding secondary schools where both genders indicated similar anxiety levels towards mathematics. The study recommends mathematics teachers have to build up friendly situation that avoids anxiety in a classroom environment for better achievement since student anxiety is indirectly proportional to achievement in mathematics.

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INTRODUCTION

Research on gender differences in student attitudes toward mathematics influenced some researchers to investigate affective variables as mediators of gender differences in mathematics achievement (Casey, 2001). However, little consensus existed among researchers regarding the influence of affective variables on mathematics achievement. Fennema and Sherman (1977) describe the mathematics attitude scale as being composed of attitude, anxiety, and confidence, which are linked to affects (affective) that usually include attitudes, emotions, beliefs, and possibly values. The bigger study operationalised affective factors as emotional behaviours or actions driven by feelings that include attitude, anxiety, and confidence (Hyde et al., 2006). In fact, a major reason for studying affective factors in mathematics education is to find ways to help students learn more mathematics (Adrej, 2015). Another reason to study affective variables is that a positive attitude toward mathematics is an important educational outcome, regardless of achievement level. However, this article did not advocate on positive attitude per se but how anxiety affects the students' achievement in mathematics. Even though Papanastatsiou (2010) noted an extensive foundation of theory and research exists on anxiety, relatively little research about specific mathematics anxiety has been done.

There seems to be some connection between mathematics anxiety and general anxiety; however, this relationship has not been studied in depth. So, students possessing mathematics anxiety feel unease such as worry or fear. Anxiety can be mild or severe in that it contributes to their low achievement in mathematics. The studies reported that compared with males, female students had debilitating causal attribution patterns, perceived mathematics as a male domain, and were anxious about mathematics (Ma & Kishor, 1997; Hyde et al., 2006). However, none of these studies demonstrates a clear cause-effect relationship between mathematics anxiety and achievement in mathematics thus the need for an in-depth discovery study. Therefore, on such bases, this research article looked beyond gender and academic abilities to establish the relationship between student anxiety and achievement in mathematics aimed at managing the problem posed by females' underrepresentation in advanced mathematics careers.

Statement of the Problem

According to a meta-analysis of gender comparisons of mathematics anxiety and affect published by the University of Wisconsin-Madison (Hyde et al., 2006), mathematics has lost its male domain stereotyped anxiety effect size of -0.90. This indicates we cannot relate to gender differences and academic abilities in explaining the substantial underrepresentation of females in advanced mathematics classrooms and mathematics-related careers. Research about the anxiety influence on student achievement failed to explain the females` underrepresentation but focused on classroom environments to infer that teacher-classroom behaviour is a factor associated

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with student anxiety per se (Papanastatsiou, 2010). The studies reported that compared with males, female students had debilitating causal attribution patterns, perceived mathematics as a male domain, and were anxious about mathematics. However, none of these studies demonstrates a clear cause-effect relationship between student anxiety and achievement in mathematics. Therefore, the need to establish the relationship between student anxiety and achievement in mathematics aimed at addressing the problem posed by females' underrepresentation in advanced mathematics careers. The research objective was to establish the relationship between student anxiety and achievement in mathematics.

Research Hypothesis

The null hypothesis of this research article was, "There is no statistically significant relationship between student anxiety and achievement in mathematics".

Research Question

To what extent is anxiety relevant in mathematics achievement as an affective factor?

THEORETICAL FRAMEWORKS

This study considered the Attribution theory developed by Weiner (1974). Weiner defined attribution as a cause of behaviour such as success and failure. Weiner proposed a two-dimensional model with four major causes of success and failure (ability, effort, task difficulty, and luck). The two dimensions are the locus of control and stability. Locus of control relates to whether the cause of success or failure is perceived to result from some factor within or outside of the individual; stability is concerned with whether the cause can change for an individual from one time to another. Since ability is the same from one time to another and is due to a factor within a person, it is categorised as stable and internal. An effort is internal and unstable because the individual has control over effort and may vary the effort expended in different situations. Task difficulty is stable because a given task does not change in difficulty from one situation to another. Task difficulty is also external since a person has no control over it. Luck changes from time to time and is independent of the individual; therefore, it is classified as unstable and external.

The Attribution theory is much relevant to this study because student attitude is rooted in a person's perception of his/her success and failure. When a person perceives the cause of success and failure as stable (ability or task difficulty), the change in expectations will be greater than when unstable factors (effort or luck) are seen as the cause. For example, when success is attributed to the ability or ease of the task, the increase in expectancy for future success in that situation will be larger than if the success had been attributed to good luck. Similarly, when failure is seen as caused by low ability, the drop in expectancy for future performance is greater than when failure is attributed to a lack of effort or bad luck. On average, females and males seem to differ in their patterns of attribution of success and failure. In academic achievement situations, girls are more likely to see success as caused by effort and less likely to see success as caused by ability than boys. In failure situations, girls are more likely than boys to attribute their failure to a lack of ability than a lack of effort. However, these gender differences in attributions are not large and will be more pronounced when the task is gender stereotyped.

Therefore, since attribution theory is a three-stage process: (1) behaviour is observed, (2) behaviour is determined to be deliberate, and (3) behaviour is attributed to internal or external causes (Weiner, 1974); then it can be relatively inferred and conceptualised that student anxiety being the independent variable is behavioural too. The achievement in mathematics being the dependent variable can be attributed to (1) effort, (2) ability, (3) level of task difficulty, or (4) luck, as well as intervening by other learning factors such as entry

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behaviour, resources, teaching techniques, and subject assessment.

RESEARCH METHODOLOGY

The main purpose of this research article was to establish the relationship between student anxiety and achievement in Mathematics. The study was motivated by the underrepresentation of females in advanced mathematics levels and related careers. This study employed a descriptive survey research design. The target population comprised both male and female students from secondary schools in Ganze District, Kilifi County, Kenya. The district had four zones with a total of 1620 male students and 1080 female students within the 20 schools, among which 12 were mixed-day secondary schools, four boarding schools, and four single-sex schools. Proportional stratified random sampling was done to ensure at least 50% of the schools were sampled from every zone. The students were selected through a stratified sampling technique with lower strata representing students' poor in mathematics based on class lists of students` achievements kept by the academic master or mistress in school administrative units. Senior classes (Form 4 and 3) were selected for study since they had been in the school much longer and were more knowledgeable about the school environment than junior classes (Form 1 and 2). The research sample size consisted of 250 students (150 males and 100 females).

The research instruments included Mathematics Anxiety Rating Scale (MARS) and Mathematics Achievement Test (MAT). Mathematics Anxiety Rating Scale (MARS) was adapted from the Fennema and Sherman Mathematics Attitude Scale (1977). This is an instrument developed to measure student attitude towards mathematics that consists of a group of nine instruments: Attitude towards Success in Mathematics Scale, Mathematics as a Male Domain Scale, Mother or Father Scales, Teacher Scale, Confidence in Learning Mathematics Scale, Efficacy and Motivation Scales in mathematics, Mathematics Anxiety Scale, and Mathematics Usefulness Scale. The Mathematics Anxiety Rating Scale (MARS) for students consisted of thirteen statements indicated by students through ticking appropriately as of not at all (NAA), a little fair (AL), a fair amount (AFA), much (M), and very much (VM). The Mathematics Achievement Test (MAT) for students was in the form of a common Continuous Assessment Test (CAT) that consisted of seven problems totalling twenty marks expected they solved within half an hour.

At the piloting stage, the content validity of the research instruments was established through test-retest by addressing the match between the rating statements and what was intended to assess. It involved administering the improved questions to the same student respondents for the validity of the research instruments. The reliability of the research instruments was established using the split-half method. The split-half method was done by coding the questionnaire items using odd or even numbering before calculating using:

$$rxx = \frac{[2r½½]}{[1 + r½ ½]}$$

Where; r_{xx} = whole test reliability, $r_{½ ½}$ = half-test reliability.

Through the split-half, in the test-retest method, the reliability of all the instruments clicked at $p<0.001$ (Mugenda & Mugenda, 2003).

The instrumentation was done by administering the rating scale and mathematics test to the sampled students. The students were supposed to indicate their mathematics anxiety by ticking appropriately after identifying their respective classes, gender, and type of schools. The student's achievement in the mathematics test was obtained directly from the sampled students in the form of a common Continuous Assessment Test (CAT) administered, marked, and scored by the researcher mainly for the

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study purpose without being documented within school administration units.

The data were analysed by using the computational formula of the Pearson Product Moment Correlation coefficient (r_{xy}). The mode of analysis mainly involved Correlational Analysis of Pearson Product moment correlation coefficient (r_{xy}) indicating the statistically significant correlation value for either accepting or rejecting the null hypothesis, "there is no statistically significant relationship between student anxiety and achievement in mathematics". The correlation coefficient, r_{xy}, varies between −1.00 and +1.00. A value of −1.00 indicates a perfect negative relationship, 0.00 means no relationship, and +1.00 means a perfect positive relationship. So, values in between were judged low to high negative or positive relationships depending on their size. Correlation Analysis was computed with the objective of establishing the relationship between the independent (student anxiety) and dependent (achievement in mathematics) variables. For non-numerical data, the indicator variables were coded as 0 or 1. The indicator variable was coded 0 for any case that did not match the variable name and 1 for any case that did match the variable name from the baseline chosen. The neutral situation of student anxiety formed the baseline. This resulted in a low anxiety level for cases coded 1 that did match the anxiety rating scale item and a high anxiety level for cases coded 0 that did not match the anxiety rating scale item.

PRESENTATION OF FINDINGS AND DISCUSSION

The study sought to establish the relationship between student anxiety and achievement in mathematics. The results of student anxiety levels analysed in cumulative percentages per their mathematics test mean scores are presented in *Table 1*.

Table 1: Anxiety and Mathematics Achievement

Type of Schools	Gender	High Anxiety		Low Anxiety	
		% (n)	Mean	% (n)	Mean
Mixed Day Secondary Schools	Male (n=100)	76.92 (n=77)	42.5	23.08 (n=23)	71.67
	Female (n=70)	69.23 (n=48)	41.67	30.77 (n=22)	63.33
	Average (n=170)	73.08 (n=125)	42.09	26.93 (n=45)	67.5
Mixed Boarding Secondary Schools	Male (n=20)	66.67 (n=13)	87.5	33.33 (n=7)	88.75
	Female (n=13)	50 (n=6)	92.5	50 (n=7)	92.00
	Average (n=33)	58.34 (n=19)	90	41.66 (n=14)	90.63
Single Sex Boarding Secondary Schools	Male (n=8)	60 (n=5)	80	40 (n=3)	86.67
	Female (n=9)	60 (n=5)	57.5	40 (n=4)	70.00
	Average (n=17)	60 (n=10)	68.75	40 (n=7)	78.34

Table 1 reveals the dynamic status of student anxiety and achievement in mathematics. Student anxiety is indirectly proportional to achievement in mathematics. This means the increase in students` anxiety towards mathematics results in a decrease in their mathematics achievement. A decrease in students` anxiety towards mathematics results in an increase in their mathematics achievement. As evidenced in mixed-day secondary schools, students with low anxiety of 41.66% towards mathematics recorded a mean score of 90.63 in mathematics achievement higher than those with a high anxiety of 58.34% at 90. For students in mixed boarding with low anxiety of 26.93% recorded a mean score of 67.5, higher than those with high anxiety of 73.08% at 42.09. Single-sex boarding students with a low anxiety of 40% recorded a mean score of 78.34, higher than those with the high anxiety of 60% at 68.75. However, analysis based on gender differences contradicts the stereotype that

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females always have high anxiety levels toward mathematics than males (Hyde et al., 2006), which is not the case in this study. Males in mixed-boarding and mixed-day secondary schools indicated lower anxiety levels than females, unlike in single-sex boarding secondary schools where both genders indicated similar anxiety levels towards mathematics. The slight gender disparity in student anxiety and mathematics achievement in half of the schools where the study was carried out expounded due to both the principal and the deputy principal being of the same gender and students lacking people to deal with their gender issues.

The relationship between student anxiety and achievement in mathematics was established using the computational formula of the Pearson Product Moment Correlation coefficient (r_{xy}) as shown in *Table 2* below:

$$rxy = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X2 - (\sum X)2]\,[N\sum Y2 - (\sum Y)2]}}$$

Where: X is the average of anxiety levels (%); Y is the average of respective mean scores; N is the number of corresponding data (6); ∑ is the summation symbol; √ is a square root symbol.

Table 2: rxy for Anxiety and Mathematics Achievement

X	Y	X^2	Y^2	XY
26.93	67.5	725.2	4556	1818
41.66	90.63	1736	8214	3776
40	78.34	1600	6137	3134
73.08	42.09	5341	1772	3076
58.34	90	3404	8100	5251
60	68.75	3600	4727	4125
300	400	16406.2	33506	21180

$$rxy = \frac{127080 - 120000}{\sqrt{[98437.2 - 90000]\,[(201036 - 160000]}}$$

$$rxy = \frac{7080}{\sqrt{8437 \times 41036}} = \frac{7080}{\sqrt{346220732}} = \frac{7080}{18607} = 0.38$$

The r_{xy} shown in *Table 2* above indicates a statistically significant correlation of 0.38 between student anxiety and achievement in mathematics. The study revealed a clear cause-effect relationship between mathematics anxiety and achievement in mathematics. This concurs with Ma and Kishor (1997) but contradicts Papanastasiou (2010) that there is no relationship between student anxiety and achievement in mathematics. It can be inferred that the increase and decrease of student anxiety should be at a relevant and manageable level. This is because too low anxiety levels may cause overconfidence which in turn results in students underrating mathematics tests (Morena, 2010). While excessive anxiety levels can cause withdrawals or collapse of students during mathematics tests, which apart from resulting in poor achievement in mathematics is unhealthy for the student's growth and development. The anxiety levels were due to poor mathematics concepts being built in the students` minds under minimal consultations from their teachers. It results the students` achievement in mathematics to be recorded as below average and in turn developing fear towards their next mathematics test. Most students indicated panic, the need of their minds not

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to be destructed as they were about to tackle mathematics tests, and others even dodged mathematics quizzes. These are behavioural indicators of excessive anxiety levels which alter the mind process of thinking, which in turn result in poor mathematics achievement.

CONCLUSION

The results from this study suggest that secondary students know that mathematics is important, and they seem willing to learn mathematics and learn it well. However, their anxiety levels affect their achievement in the subject. In addition, teachers are aware that there are certain aspects of students` learning in mathematics that need to be improved. For example, both teachers and students are limited to theoretical teaching and focused on passing examinations. In this sense, mathematics students do not demonstrate in a more practical way, by which students cannot spontaneously associate mathematics knowledge with the everyday environment. Engagement and exposure will result in students` better perspective of mathematics and their mathematics achievement, which in turn helps students to develop a more positive attitude toward the subject. This promotes learning ability and consequently performs better in mathematics examinations.

A bearable and manageable anxiety level is required as an impetus toward positive action; the opposite same could be detrimental to the student's well-being and may greatly contribute to low mathematics results. Therefore, students should get equipped with knowledge of anxiety and effective management skills for their benefit while in school and elsewhere. Students should take responsibility to seek affective management help from teacher counsellors, other teachers, or the peer counselling clubs within their schools to ensure that their anxiety does not escalate to levels that negatively impact their academic results. Students should realise that individuals can decide how they process the problems they encounter since problems left unprocessed unconsciously become major sources of high anxiety.

It is therefore imperative that the students should desist from apportioning blame and instead proactively seek to find positive solutions to their problems for better adjustment. Students should be encouraged to use all available opportunities to raise issues that cause them to be of low anxiety; so that teacher counsellors to facilitate positive resolutions to the problems. Teachers sought to understand the nature of students' anxiety-causing factors so that they could address the same as part of the affective management skill acquisition process. The developmental process and especially during the teenage poses many anxiety-causing challenges to students. Teacher counsellors should therefore invest a lot of time in imparting knowledge on development to help reduce the pressure that might arise from the growth process experience. Teacher counsellors therefore should help students to learn to take positive responsibility to seek counselling help when need be. Principals play a very vital role in the life of students as they have a monopoly on designing school programs. From this study, the anxiety level has indicated students` high anxiety, as a result, their academic results are lacking. Hence the relationship between student anxiety and achievement in mathematics is beyond gender differences and academic abilities.

The Implication of the Findings for Practice

The findings form a base for addressing the trending low mathematics achievement success based on student anxiety beyond gender differences and academic abilities. Encourage the creation of an equal competitive academic environment among mixed students. Improve content delivery during teaching to enhance the learning of mathematics. It enhances the students` grouping criterion for effective mathematics teaching and learning. The development of knowledge was hoped to be contributed much by the student anxiety on the

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attributes of ability, task difficulty, effort, and luck towards high achievement in mathematics.

Recommendation

Based on the foregoing discussion of the findings and conclusion, the research article recommends that mathematics teachers must build up friendly situation that avoids anxiety in a classroom environment for better achievement. Also, further research should be done on the impact of special teaching methods on students with high anxiety towards mathematics.

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Conflict of Interest

The author declares that there is neither conflict of interest nor affiliation with nor involvement in any organisation or entity with any financial interest such as educational grants or non-financial interests such as personal relationships in the subject matter discussed in this manuscript.

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