Test Anxiety Beliefs as Predictor of Students' Achievement in Chemistry in Public Secondary Schools in Kenya

James Ndege Oluoch[*], Peter J. O. Aloka, Benson Charles Odongo

Jaramogi Oginga Odinga University of Science and Technology, School of Education, Kenya

Abstract   The present study was designed to determine the extent to which test anxiety beliefs predicted achievement in chemistry among students in public secondary schools in Kenya. The study was guided by Eccles-Wigfield's Expectancy-Value theory of motivation. The study adopted concurrent embedded design. A sample of 353 form for students, 10 chemistry and 10 guidance and counseling teachers was selected from 26 public secondary schools from Rachuonyo South Sub County in Homa Bay County using both Stratified random sampling and purposive sampling techniques. Data collection was done using questionnaire and interview schedule. Questionnaire was adapted from Test Anxiety Inventory (TAI) By Spielberger (1980). Quantitative data was analyzed both descriptively and inferentially (Pearson Product Moment Correlation, multiple regression and ANOVA) while qualitative data was analyzed using thematic analysis. Pearson Product Moment revealed that there was statistically significant negative correlation (r= - .432, n=308, P< .05) between test anxiety and Chemistry academic and that test anxiety accounted for 18.7% (R^2=.184) of the variation in performance in chemistry Academic. The study recommended that there is need for curriculum and efforts towards guidance and counseling in schools to include strategies of coping with test anxiety in the guidance and counseling programs alongside the education policies in Kenya relating to guidance and counseling. This is because test anxiety negatively affects chemistry academic achievement and learners who are at risk of developing test anxiety may end up performing poorly in chemistry exam.

Keywords   Test anxiety beliefs, Chemistry academic achievement, Secondary school students, Kenya

1. Introduction

According to Webster (2009), as much as chemistry is a science that underpins most of the science discoveries of 20th century and still doing so in the 21st century, chemistry courses have low rates of students' success which has resulted to limited access to science fields. Academic achievement in chemistry is in worrying trend. In USA (2010) the report on Education in Science, Technology, and Engineering and Mathematics (STEM) subjects showed that students performed poorly on international comparison of mathematical and scientific proficiency. STEM subjects include, biology mathematics, physics and chemistry. On National Assessment of Educational Progress (NAEP) report of the (2010) indicated that there was little improvement in STEM subjects for over a decade. The report further indicated a growing interest in STEM subjects.   The report indicated that one of the major contributors towards Achievement in STEM subjects was motivation. In addition, the Program for International Student Assessment (PISA) indicated that 15 year olds' science literacy scores in USA were below average in 2006 according to National Center for Education Statistics (2010) report. Glynn, Tassoobshirazi and Brickman (2009) study in USA reports that university students with lesser motivation in science courses have lower performance in sciences. According to Shari (2012) study in USA, self-efficacy, Self-regulation, assessment anxiety significantly predicted chemistry achievement.

Educational psychologists, educational experts, curriculum developers, and science teachers have continuously investigated both environmental and personal variables that can be manipulated so as to improve students' academic achievement in chemistry. However, Test anxiety belief which is one of the components of motivational beliefs has received little or no attention in order to determine its contribution to academic achievement in chemistry. Test anxiety refers to psychological state of mind expressed through fear, certain levels of worry and uncertainty before, during and after test. According to Spielberger and Sarason (1989), text-anxiety is a situation –specific trait that refers to conditions of worry during examination. According to

Huberty (2009), test anxiety has relatively permanent features of anxiety with cognitive, behavioral, and physiological signs and symptoms. The cognitive primary symptoms include concentration problems, worry, difficulty in solving problems, cognitive dysfunctions, oversensitivity, and attention problems. Behavioral symptoms include task avoidance, nervousness, lack of participation, task avoidance, seeking easy tasks, withdrawal and irritability. Lastly, physiological signs and symptoms include: rapid heart rate, headaches, vomiting, nausea, perspiration and recurrent localized pain.

Fulton (2016) study in reported that there was a significant negative relationship between test anxiety and academic performance in standardized science test. Chukwu (2014) conducted study in Nigeria and results revealed that there was a moderate positive relationship between test anxiety and academic achievement of students in Geometry. A study in Kenya by Muola, Ndirangu and Nassiuna (2009). The study revealed that there was no significant relationship between test anxiety and academic performance.

In Kenya, more so in Rachuonyo South Sub County in Homa Bay County, Kenya, which is the location of this study, there has been low and declining trend in academic achievement in chemistry subject. Numerous studies which have been conducted in Kenya to find out the causes of poor performance in chemistry have pointed out factors including and not limited to Attitude of learners towards chemistry, students' self-efficacy beliefs, inappropriate learning environment, shortage or total absence of trained chemistry teachers, inadequate learning facilities (Oluoch, 2013; Ogembo, 2013), teachers' personal level of skills and knowledge of the subject matter in chemistry (Chepkorir, Cheptonui & Chemutai, 2012) have also been cited as factors attributed to low academic achievement in chemistry subject. However, there is very little literature on possible correlation between text anxiety beliefs and academic achievement in chemistry in Kenya more so in Rachuonyo South Sub-County.

1.1. Statement of the Problem

Performance in chemistry has continued to be poor in national examination Kenya in spite of the numerous studies which have been conducted with aim of improving the academic achievement in the subject. Statistics reveal that academic achievement in chemistry in Rachuonyo South Sub-County has also been on the declining trend and generally very low. Most of the studies done previously in Kenya have focused on factors like attitude towards Chemistry by students, teachers' attitude towards learners' abilities, insufficient teaching and learning resources, and unsuitable teaching methodologies as factors that influence chemistry academic achievement. A number of the studies in Chemistry learning have paid attention to aspect of student cognition. In learning, cognition is determined and influenced by affective factors. Among the affective factors, test anxiety is an affective factor which also influences

learning. Little attention has been paid to how test anxiety beliefs predict academic achievement in chemistry among secondary school students in Rachuonyo South sub County, Homa Bay County, Kenya. Therefore this study endeavors to fill to fill this gap.

2. Research Methodology

Concurrent embedded design based on the mixed method approach was used in the present study. The study targeted all the 3822 form four students of the year 2017 in the 79 public secondary schools, 101 chemistry teachers and 79 guidance and counseling teachers in Rachuonyo South Sub-county. Using stratified random sampling and purposive sampling techniques, 351 form four students, 10 chemistry teachers and 8 Guidance and counseling teachers were sampled for the study. Data collection instruments included questionnaires, for quantitative data and interview schedules for one to one interview with respondents.

Items to measure test anxiety was adapted from Test Anxiety Inventory (TAI) By Spielberger (1980). In using the TAI for this study, the items were rephrased to specifically to align to Kenyan educational context to ensure that the students participants understand the survey item and respond appropriately and also to suit secondary school chemistry for it was previously used in college chemistry. There were 20 items in the questionnaire based on a five point scale Likert scale ranging from strongly disagree to strongly disagree with ratings as: 1=Strongly Disagree (SD), 2= Disagree (D), 3=Undecided (U), 4=Agree (A) and 5=Strongly Agree (SA). The scoring of this subscale was done by adding scores from each item. Reverse scoring was applied to negative statements in the subscale. The score ranged between 20 and 100, where a score of 20 implied low level of test anxiety and that of 100 indicated high level of test anxiety. Chemistry academic achievement was obtained from Kenya Certificate of Secondary Education (KCSE) results for 2017.

3. Results and Discussion

The study sought to investigate the relationship between test anxiety and students' achievement in chemistry. The level of students' test anxiety was measured using an adapted Test Anxiety Inventory (TAI) By Spielberger (1980). The students' responses are summarized in table 1.

On the students' levels of test anxiety, it was evident from table 1 that that quite a substantial number of students show signs of test anxiety as reflected by their level of worry before, during and after test chemistry exam. This was mirrored by an average by mean average test anxiety index of 2.86 (standard deviation = 0.64). This finding reveals that most chemistry students suffer considerable amount of anxiety level before, during and after chemistry tests. For example, although a respectable proportion 136 (44.2%) of the sampled students held a contrary opinion, nearly a half

152 (49.4%) of them accepted that before taking a test, they rarely feel confident and relaxed. This was translated to test anxiety level of 3.03 (SD=1.50). On the same note, majority of 162 of the students translating to 54.6% of the respondents confirmed that at the beginning of chemistry test, they were always nervous. These findings are in line with Segool et al.

(2013) study in USA which reported that students had more overall test anxiety in relation to high stakes testing. However, the finding was inconsistent with finding of Muola et al. (2009) in Kenya that found no significant relationship between test anxiety and academic achievement.

Table 1. Views of the Students on Chemistry Test Anxiety Beliefs

Item	SD	D	U	A	SA	Mean	SD
I feel unsure and tense while taking chemistry test	90 (29.2%)	81 (26.3%)	16 (5.2%)	56 (18.2%)	65 (21.1%)	2.76	1.55
While taking the test I have uneasy, upset feeling	76 (24.7%)	81 (26.3%)	27 (8.8%)	79 (25.6%)	45 (14.6%)	2.79	1.43
Thinking about the scores I'd get in chemistry interferes with my work on the test	51 (16.6%)	78 (25.3%)	16 (5.2%)	95 (30.8%)	68 (22.1%)	3.17	1.44
I read through the test and feel that I do not know any of the answers.	126 (40.9%)	69 (22.4%)	17 (5.5%)	63 (20.5%)	33 (10.7%)	2.38	1.45
The harder I worked at taking the chemistry test, the more confused I get	134 (43.5%)	74 (24.0%)	21 (6.8%)	50 (16.2%)	29 (9.4%)	2.24	1.39
Thoughts of doing poorly interfere with my concentration on the test	78 (25.3%)	70 (22.7%)	21 (6.8%)	71 (23.1%)	68 (22.1%)	2.94	1.53
Even when I'm well prepared for the chemistry test, I feel very nervous about it	70 (22.7%)	61 (19.8%)	13 (4.2%)	113 (36.7%)	51 (16.6%)	3.05	1.46
During the test I feel so tense that my stomach get upset and I feel "butter flies"	152 (49.4%)	81 (26.3%)	6 (1.9%)	39 (12.7%)	30 (9.7%)	2.07	1.38
I make mistake on easy question to put answers in the wrong places.	72 (23.4%)	65 (21.1%)	15 (4.9%)	102 (33.1%)	54 (17.5%)	3.00	1.48
When I started a test, I am not easily distracted	57 (18.5%)	43 (14.0%)	38 (12.3%)	112 (36.4%)	58 (18.8%)	3.23	1.39
I felt my heart beating very fast during the chemistry test	102 (33.1%)	84 (27.3%)	13 (4.2%)	68(22.1%)	41 (13.3%)	2.55	1.47
After the test is over I try to stop worrying about it, but I just I can't	55 (17.9%)	74 (24.0%)	35 (11.4%)	70 (22.7%)	74 (24.0%)	3.11	1.46
During test, I find myself thinking of the consequences of failing	83 (26.9%)	42 (13.6%)	43 (14.0%)	94 (30.5%)	46 (14.9%)	2.93	1.45
At the beginning of chemistry test, I am not nervous	45 (14.6%)	76 (24.7%)	25 (8.1%)	110 (35.7%)	52 (16.9%)	3.16	1.36
During examination, I get so nervous that I forget facts I really know	80 (26.0%)	90 (29.2%)	18 (5.8%)	64 (20.8%)	56 (18.2%)	2.76	1.49
After taking a test, I don't have feelings that I could have done better than I actually did	85 (27.6%)	69 (22.4%)	24 (7.8%)	89 (28.9%)	41 (13.3%)	2.78	1.45
Before taking a test, I rarely feel confident and relaxed.	71 (23.1%)	65 (21.1%)	20 (6.5%)	88 (28.6%)	64 (20.8%)	3.03	1.50
When I get my exams copy, it takes me time to calm down and begin	90 (29.2%)	51 (16.6%)	24 (7.8%)	95 (30.8%)	48 (15.6%)	2.87	1.50
I do not worry so much before a chemistry exam	68 (22.1%)	42 (13.6%)	25 (8.1%)	97 (31.5%)	76 (22.1%)	3.23	1.51
I do not feel my heart beating very fast during important examinations.	69 (22.4%)	53 (17.2%)	17 (5.5%)	98 (31.8%)	71 (23.1%)	3.16	1.51
Mean average score on test anxiety						2.86	0.64

Key: Strongly Disagree (SD) =1, Disagree (D) =2, Undecided (UD) =3, Agree (A) =4, Strongly Agree (SA) =5 and SD-Standard Deviation

Further, it is observed that only 121 (39.3%) of the students accepted that they feel unsure and tense while taking chemistry test during exams, more than a half 171 (55.5%) of them denied the claim that they feel unsure and tense during chemistry exams. Equally, majority 195 (63.3%) of the students who took part in the survey denied the claim that as they read through the test they always feel that they do not know any of the answers, translating to low anxiety level of 2.38 (SD=1.45). A significant majority of 233 (75.7%) of the students respondents disputed the researcher's assertion that many chemistry students always feel so tense that their stomach get upset and they feel "butter flies" during exams. Only 69 (22.4%) of the students who took part in the survey agreed that they occasionally experience the feeling of stomach upset during exams, which translated to a mean anxiety level of 2.07 (SD=1.38). On the flip flop, about a half 256 (50.6%) of the students who took part in survey attributed their low performance in chemistry exams to mistakes they make on easy question by writing answers in the wrong places.

It also emerged from table 1 that the thought of failing chemistry exams negatively impacts on some students. This was mirrored by the claim by 140 (45.4%) of the students that during exams they always find themselves preoccupied with the thought of the consequences of failing, but some 125 (40.5%) of the students denied that they nurse such a thought. However, although majority held a contrary point of view, a considerable number 120 (39.0%) of the students who took part in the survey said that sometimes they get so nervous during the exams that they forget facts they really know. This echoed test anxiety levels of 2.76, with a standard deviation of 1.49. Equally, another sign of test anxiety (mean =3.16; SD=1.51) among the students was confirmed by many 169 (54.9%) of the students who observed that they usually feel their heart beat very fast during important examinations.

On the other hand, more than three quarters 208 (67.5%) of the sampled students rejected the claim the harder they work at taking the chemistry test, the more confused they get. They believe that if they work very hard they can never get confused. They held a strong belief that adequate preparation for exams is prerequisite to avoid being nervous during exams. This point of view was supported by more than a fifth 70 (22.7%) of students who took part in the survey who strongly rejected allegation advanced by some students that even when they are well prepared for chemistry test, they still felt very nervous about it. However, some 100 (32.5%) of the students observed that when they have started a test they never easily get distracted. This indicates low test anxiety which generally supports high academic achievement.

The findings of the study established that anxiety after exams is equally unbearable among most of the students. For instance, it emerged that 144 (46.7%) of the students revealed that even after the test is over they try to stop worrying about it, but they cannot help worrying, translating to a mean anxiety level of 3.11, with a standard deviation of 1.46. Equally, 143 (46.4%) of students indicated that when they get their exams copy, it takes them time to calm down to begin studying, which is a sign of anxiety. Astonishingly, it emerged that even some students get surprised when they find that they have passed chemistry test. This was confirmed by 130 (42.2%) the students who revealed after taking a test; they do not believe that they could have done better than they actually did.

Further analysis of the qualitative data obtained confirmed that students experienced nervousness before, during and after chemistry test. Nervousness is one of the behavioral symptoms of test anxiety that is experienced by learners due to motor restlessness. The learners interviewed affirmed that they find themselves forgetting facts due excess nervousness and this resulted to them failing in the test. One of the students had this to say:

"*When times of chemistry test come I feel not good at all and I worry how the teachers and my parents will think of my chemistry test results. I'm in a lot of stress always in the exams. Before the times of the chemistry test I feel I can't read and when I read I feel I can't remember anything I have read or revised in chemistry. During the test, I find myself in a bad state and feel like taking many excuses to not do the test so that I can do the test later. Also I feel before the exams I need run to the toilets many times and even during the exam I go many times. My stomach goes bad and moving. After the chemistry test, I could not sleep and I can't stop thinking about the chemistry test.*" (Student, 5).

From the excerpt of student 5, it emerged that the learners showed the physiological (sleeping disorders and headaches), cognitive (worry about teachers and parents attitudes) and the behavioral (feeling of avoiding the test) symptoms before, during and after chemistry test. Excessive test anxiety leads to low achievement in chemistry. In that regard therefore, the results are similar to those of Dahood et al. (2016), Dogan and Murat (2016) Tuncay (2011) Faleye (2010) all that reported significant negative relationship between test anxiety and academic achievement. On the contrary, the finding is in disagreement with that of Chukwu (2014) study which reported a moderate positive relationship between test anxiety and academic achievement.

3.1. Statistical Relationship between Test Anxiety and Chemistry Achievement

To investigate whether there was any statistical significant relationship between test anxiety and student achievement in Chemistry among form four students, a Pearson Product Moment Correlation Coefficient was determined, with scores on test anxiety as the independent variable and academic achievement in chemistry as dependent variable. The hypothesis was stated as follows:

H_0: *There is no statistically significant relationship between test anxiety and student achievement in Chemistry in Rachuonyo South Sub-County, Kenya.*

The level of test anxiety was calculated from the frequency of responses and was converted into continuous scale, where high scale ratings implied high perceived level of test anxiety and vice-versa. Achievement in chemistry was obtained from the 2017 KCSE results. Table 2 shows the correlation analysis results in SPSS output.

Table 2. Relationship between the level of Test Anxiety and Academic Achievement

		Chemistry Achievement	Test Anxiety Inventory
Chemistry Academic Achievement	Pearson Correlation	1	-.432**
	Sig. (2-tailed)		.000
	N	308	308
Test Anxiety Inventory	Pearson Correlation	-.432**	1
	Sig. (2-tailed)	.000	
	N	308	308

**. Correlation is significant at the 0.05 level (2-tailed).

The finding of the study reveals that there was statistically significant negative correlation (r= -.432, n=308, p<.05) between text anxiety and chemistry academic achievement, with high level of test anxiety associated to poor performance in chemistry among the form four students and vice-versa. Given that the relationship was statistically significant, the hypothesis that, "there is no statistically significant relationship between test anxiety and chemistry academic achievement among the form four students" was rejected. Therefore, it was concluded that there is statistically significant negative relationship between Test Anxiety and Chemistry Academic Achievement among form four students. This result was in concurrence and almost similar to that of Ali and Mohsin (2013) that was carried out in Pakistan and found out that there was a significant negative relationship between test anxiety and chemistry academic achievement among nursing students. However, the study was in disagreement with the finding of Maryan et al. (2010) that reported that there was a positive relationship between test anxiety and academic achievement.

To estimate the level of influence of Test Anxiety on students' Chemistry Academic Achievement, a coefficient of determination was computed using of regression analysis and the result was as shown in Table 3.

Table 3. Model Summary on Regression Analysis of Influence of Test Anxiety on Chemistry Academic Achievement

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.432ᵃ	.187	.184	.62012

a. Predictors: (Constant), Test Anxiety Inventory

The model summary reveals that level of test anxiety accounted for 18.7% (R^2=.184) of the variation in performance in chemistry in KCSE exams among the form four students. This finding implies that variation in the level of test anxiety explains 18.7% of the variability in academic achievement in chemistry among the form four students. Numerous studies concur with the present study by reporting a link between test anxiety and academic achievement. Khatoon and Zinat (2017) study in Iran reported a significant negative relationship between mathematics anxiety and academic achievement.

Further, to estimate the actual influence of test anxiety beliefs on chemistry academic achievement, Linear regression was generated and result shown in Table 4.

Table 4. Coefficient Output: Test Anxiety Beliefs and Student Achievement in Chemistry

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	3.659	.347		10.532	.000
Test Anxiety Inventory	-.564	.087	-.337	-6.467	.000

a. Dependent Variable: Student Achievement in Chemistry

$Y = 3.659$ *units* - $.564x_1$ units

Where Y is the student achievement in chemistry and X_1 is the test anxiety beliefs.

It is evident from table 4 that a unit increase level of test anxiety would results in to .564 units drop in student academic achievement in chemistry.

From the qualitative results, the students indicated that they forget a lot during test due to high anxiety. One student had this to say:

I always feel painful after the chemistry test and I think about what will happen if I don't do well in the final test and after the chemistry test things become very bad. I do lose my focus in the chemistry test. Even in case I know the answer, I start to be out of memory and lose my knowledge of everything and struggle to find the thing to write and the correct words to explain my knowledge. When chemistry test is over and I get out of the exam room, it is when I remember everything and every right answer to the questions that I couldn't write (Student, 4).

From the excerpt by student 4, the cognitive symptom of test anxiety of worry and lack of concentration emerged which were associated with low academic achievement. It is evident that severe test anxiety was responsible for low academic achievement in chemistry. This finding is in line with Nadeem et al. (2012) study that reported that there was a negative relationship between test anxiety and academic achievement. However, the finding is in disagreement with that of Chukwu (2014) study which reported a moderate positive relationship between test anxiety and academic achievement.

Further analysis of the qualitative data indicated that learners get so nervous during tests that make them forget things they have learned in class and this supported the above finding as two Students said:

Whenever most of my students sit for chemistry test, they get so nervous and they always feel like they were going to fail the test. They sometimes feel like they haven't studied enough. This usually makes them forget to answer even simple questions correctly (Chemistry teacher, 4).

The excerpt from chemistry teacher 4 is an indicator that the students experience high chemistry test anxiety. They reveal that this makes them feel extremely nervous and this makes them forget even simple concepts in chemistry making them to perform poorly in the chemistry test. The finding is in agreement with the finding of Segool et al. (2013) in USA that reported that students had more overall test anxiety.

The finding is in harmony with finding of Chukwu (2014) study which reported a moderate positive relationship between test anxiety and academic achievement.

Qualitative data obtained from the study confirmed that learners who experience low test anxiety do have high academic achievement as one student said:

My students usually feel at ease and relaxed before and during chemistry test. I am always sure they always pass their test because I believe they usually study and prepare adequately for the chemistry test (Guidance and counseling Teacher, 6).

From the excerpt above, it is evident that when students experience low test anxiety, they feels relaxed and can remember the things studied in the subject. This is achieved through adequate preparation before the test. Low test anxiety leads to high academic achievement. This finding is in line with finding of Maryam et al. (2010) study that reported that there was a significant positive relationship between test anxiety and academic achievement. The finding is not in agreement with that of Muola et al. (2019) in Kenya that reported that there was no significant relationship between test anxiety and academic achievement.

4. Conclusions & Recommendations

It was concluded that there is statistically significant negative relationship between Test Anxiety and Chemistry Academic Achievement among form four students in Rachuonyo South Sub-County based on statistical results which the study obtained from the Pearson Product Moment Correlation coefficient that. It was observed that vast majority of the students experienced the basic symptoms and signs of test anxiety. In a nutshell, the expressions from the students showed that students experienced severe cognitive (memory and difficulty in solving problems), behavioral (task avoidance and failure to complete tasks), and physiological (rapid heart rate and sleeping problems) signs and symptoms due to test anxiety. High test anxiety tellingly leads to low academic achievement in chemistry with high test anxious students performing poorly while low test anxiety sustains high academic achievement. The study recommended Chemistry teachers to adopt and apply various measures to manage test anxiety among students like inculcating confidence among learners, teaching them best strategies for examination preparation, training them on seeking social support and training of relaxation therapy techniques in their classrooms to help the learners deal with feelings of test anxiety and to enable the learners reduce their anxiety levels. School counselors should also develop assessment tools for regular monitoring and identification of high test anxious students and ways of treating them in order to increase their academic achievement. The counselors should also provide timely and effective counseling and therapeutic interventions for secondary school students to address irrational beliefs in chemistry which cause anxiety. This is because test anxiety is a psychological phenomenon that adversely and negatively influences academic achievement.

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