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Relationship between Executive Functioning and Achievement Motivation for Learning Chemistry in Secondary Schools in Kiambu County, Kenya

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Abstract
Most secondary schools in Kiambu County are grappling with low achievement motivation for learning chemistry as evidenced by below average performance in the subject among majority of the students. There is limited research evidence on the predictors of achievement motivation for learning chemistry in this area that may be used to address this issue. This research was carried to examine the relationship between executive functioning and achievement motivation for learning chemistry among secondary school students. The study was informed by information processing theory by Siegler and achievement motivation theory by McClelland. The researcher used convergent parallel mixed research design to examine the relationship between the study variables. The target population was 10528 form three students taking chemistry in 284 public secondary schools in Kiambu County in the year 2020. Purposive sampling was used to select Kiambu County and form three students taking chemistry. Stratified sampling was used to select the schools while simple random sampling was used to select students to participate in the study. The study was conducted in 17 secondary schools using a sample of 402 students. A pilot study was done in one school involving 40 students to establish the validity and reliability of the research instruments. Data were collected using questionnaires and interview schedules and then analyzed using both descriptive and inferential statistics. The results indicated that there was a moderate significant positive correlation between executive functioning and achievement motivation for learning chemistry, $r (336) = .39$, $p < .05$. Multiple regression coefficient was 0.45 which suggests a moderate prediction of achievement motivation for learning chemistry from shifting, initiation, inhibitory control and sustained attention executive functioning skills. R square was 0.21 which means that 21% variance in achievement motivation for learning chemistry can be explained by the predictor variables. Qualitative results also showed that executive functioning was associated with student's achievement motivation for learning chemistry. The study recommends that school counsellors and chemistry teachers should guide and support chemistry students to enhance their executive functioning skills in order to boost the student's achievement motivation for learning chemistry for better learning outcomes in chemistry.
Keywords**: **Executive Functioning, Achievement Motivation, Chemistry

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I. Introduction

A significant number of secondary school students in Kenya have been performing below average in chemistry in national examinations. This has been associated with low level of motivation among the students (Wangui, 2017). The researcher observed that motivation determines the goals students set in the subject and how they strive to achieve them. The level of achievement motivation determines the choices that learners make; either to study chemistry or do something else. The initiative to start learning a chemistry task and persistence to work it out successfully largely depends on achievement motivation of the learner (Wangui, 2017). Based on KNEC statistics on the performance in chemistry in Kenya, achievement motivation for learning chemistry among secondary school students is still an issue of concern.

A number of factors have been directly or indirectly associated with achievement motivation for learning and performance in chemistry among secondary school students. Such factors include learners' attitude, shortage of trained chemistry teachers, teaching methods, motivation and inadequate learning materials (Chepkorir, 2014; Ogembo, 2013; Wangui, 2017). However, there is a scarcity of literature on the cognitive

factors associated with achievement motivation for learning chemistry. The current study focused on the relationship between executive functioning and achievement motivation for learning chemistry among secondary school students.

According to Kaufman (2010), executive functioning refers to the cognitive processes that allow individuals to regulate and maintain their learning activities that lead to long term academic achievement. It is one of the cognitive processes for adaptive functioning that enables learners to adopt goal oriented strategies in learning. Research evidence indicates that executive functioning contributes to learner's motivation and success in education (Neuenschwander, 2012; Pascual et al., 2019). Studies have consistently linked executive functioning skills to both academic and social success (Allan et al., 2014; Sung et al. 2018). It has also been demonstrated that executive functioning skills are associated with mathematics achievement (Rutherford et al., 2018). Executive functioning domains vary but researchers have generally been focusing on initiation, sustained attention, metacognition, shifting and inhibitory control.

Denckla (1994) argues that executive functioning has four control processes namely; initiation, sustained attention, inhibition and shifting. Initiation executive functioning skill refers to a student's ability to independently start a learning task, while sustained attention refers to the ability to use goal directed attention and self-regulation to complete initiated goals. On the other hand, inhibition is described as the ability to maintain attention and disregard prepotent responses (Denckla, 2005). Shifting is characterized by the ability to transition from one task to the other (Kaufman, 2010). The four domains contribute to successful problem solving execution and completion of long term academic goals. Inhibition has been considered to be a main factor in self-regulation (Roth et al., 2005). The concept has been defined differently; Gioia et al. (2000) define it as the ability to control impulses and stop behavior. Barkley (1997) and Tannockand Logan (1993) define it as the deliberate suppression of prepotent responses.

Studies have established that lack of inhibitory control is associated with negative learning outcomes (Wu et al., 2013). In Spain, Gutierrez et al. (2020) established that difficulties in executive functioning skills were associated with procrastination tendencies due to lack of motivation to complete learning tasks. The study established that executive functioning skills were negatively associated with procrastination tendencies. Generally, past research has consistently established that executive functioning is significantly associated with academic achievement (Jacob & Parkinson, 2015). However, there is a scarcity of studies on the relationship between executive functioning and achievement motivation for learning chemistry among secondary school students.

II. Statement of the Problem

There has been a challenge of low achievement motivation for learning chemistry among secondary school students in Kiambu County as evidenced by consistent below average performance in the subject. The KCSE performance posted in the year 2016, 2017, 2018, 2019 and 2020 were as follows; 2.86, 2.76, 3.06, 3.04 and 2.62 respectively. The trend of poor performance in Chemistry in secondary schools has become a major concern due to the fact that Chemistry is an important subject in career development of the students. It is also a key subject in the realization of Kenya's Vision 2030 and SDGs since it equips the students with industrial skills. Therefore, students achievement in this subject and the factors related to its performance is a matter of serious concern that requires empirical inquiry to avert this situation.

A large number of students fail to progress and secure opportunities in science related fields due to poor performance in Chemistry. This may lead to low income among the affected students and shortage of professionals in the key sectors of the economy like health, manufacturing and agriculture. There are limited studies on the predictors of achievement motivation for learning chemistry but related studies cite school related factors, quality of teaching and learner factors as the correlates of achievement motivation. Most of the studies largely focused on factors such as attitude, motivation, learning strategies and learning context and how they influence performance in chemistry. Locally, related studies focused on the relationship between motivation and performance in chemistry and therefore there was need to find out the relationship between executive functioning and achievement motivation for learning chemistry in Kiambu County to bridge the existing gap.

III. Aim of the Study

This study aimed to investigate the extent to which executive functioning is related to achievement motivation for learning chemistry. The findings may be used to enhance chemistry performance in secondary schools in Kenya.

IV. Review of Related Literature

The relationship between executive functioning and achievement motivation for learning chemistry has not attracted much attention from educational researchers. However, a number of studies on the relationship between executive functioning and academic achievement, reading achievement, mathematics achievement and

attention deficit hyperactivity disorder have been carried out mostly using samples of young children. Since past research has established that achievement motivation for learning is significantly related to academic achievement, literature on the relationship between executive functioning and learning outcomes was considered important to guide the current study.

Engel et al. (2014) conducted a study to examine the relationship between executive functioning and reading achievement. A sample of 106 six to eight year old children drawn from different social backgrounds in Brazil was used. Data were collected using a battery of twelve executive functioning tasks. Principal component analysis findings revealed that executive functioning components made differential contributions to early reading achievement. Cognitive flexibility was revealed to be the best predictor of reading performance. Even though the study reported significant positive relationship between executive functioning and reading ability, principal components analysis ignores latent factors that might have influenced the results. The current study focused on the relationship between executive functioning and achievement motivation for learning chemistry with the use of correlation analysis to compare the findings. Additionally, the cultural setting and the age of the respondents prompted a similar investigation in Kenya using a sample of secondary school students.

In a related study, Kira et al. (2021) examined the relationship between executive functioning and mental health. The study was conducted among 262 adults. The researchers gathered data using questionnaires and then subjected it to regression analysis. The results showed that better executive functioning skills were associated with low levels of stress, depression and anxiety. The study concluded that executive functioning skills were associated with better cognitive functioning. Cognitive functioning is a general construct and therefore there was need to examine the relationship between executive functioning and achievement motivation for learning chemistry to create new knowledge in this area.

In Spain, Gutierrez et al. (2020) examined the association between executive functioning skills and procrastination tendencies among students. The study involved a sample of 52 students who completed executive function inventory and procrastination scale. The results showed that procrastination was associated with executive functioning skills. The researchers concluded that students who had high tendency of academic procrastination had difficulties in executive functioning. The current study was conducted to establish if this was the case with achievement motivation for learning chemistry in the Kenyan context.

In another study, Bull (2008) examined executive functioning as a predictor of children's mathematics ability. Multiple measures including Wisconsin Card Sorting Task (WCST), Dual Task Performance, Stroop Task and Counting Span were used to collect data. It was established that mathematical ability was significantly correlated with all measures of executive functioning. The regression analysis findings also revealed that each domain of executive functioning predicted unique variance in mathematics achievement. The results were important to the current study because achievement motivation correlates highly with mathematics achievement (Areepattamannil, 2014; Stevens et al., 2004). The study focused on the relationship between executive functioning and mathematics ability. The current study investigated the relationship between executive functioning and achievement motivation for learning chemistry to advance knowledge in this area.

Relatedly, educational psychology researchers have established that executive functioning is significantly related to metacognitive control. Roebers et al. (2012) explored the interrelationship between executive functioning, metacognition and self-perceived competence in elementary school children. A sample of 209 first grade children was initially assessed in terms of academic self-concept and executive functioning. A year later the children's executive functioning, self-concept and mathematics achievement were evaluated. Structural equations modeling analyses revealed that executive functioning and metacognitive control were significantly related to academic achievement. However, the study did not focus on the relationship between executive functioning and achievement motivation which is linked to academic achievement, a gap the current study sought to fill. Furthermore, the age of the participants and the context in which the study was carried out limit the generalization of the results to secondary school students in Kenya, hence the need for the current study.

Research evidence also indicates that executive functioning processes predict academic outcomes (Van Divner & Perkin, 2008; Wagner & Forbes, 2006; Biederman et al., 2004; Bull & Scorif, 2001). Miller et al. (2011) studied the relationship between executive functioning and academic achievement. Clinical executive functioning and academic tasks tools were administered to 2036 children aged 15-17 years. The findings showed that executive functioning scores had significant correlation with mathematics scores and reading scores across the ages. In educational research, evidence has shown that achievement motivation is significantly related to academic achievement but there is limited research on the predictors of achievement motivation for learning chemistry. Therefore, the current research was necessary to bridge this gap.

Similarly, the findings of Pascual et al. (2019) established that executive functions have a strong predictive power on primary education, and it was higher at younger ages. Furthermore, the study found that executive functions and unique qualities determine how their components interact to influence learning and the mediation effect of aspects like physical fitness, motor abilities, and memory processes. Based on 21 samples (*n*

= 7, 947), a meta-analysis of random effects revealed a moderately significant weighted effect size (r = 0.37) and executive functioning was found to be a good predictor of academic performance. The random effects model produced similar results for language and mathematics, with mathematics somewhat higher (r = .35; r = .37). Because it comprised studies from different continents, socioeconomic levels, and rural or urban areas, the meta-analysis examined the indirect impact that various educational systems can have on intellectual development. However, no significant variations were discovered that could have resulted in executive component variability as a function of the samples' sociocultural and educational backgrounds. The current research focused on executive functioning and achievement motivation for learning chemistry to address the knowledge gap.

Achievement motivation has also been found to be related to training gains and, potentially, transfer of those gains to non-trained cognitive tasks. Zhao et al. (2018) investigated the effects of working memory training and transfer on accomplishment motivation. Students in two studies; 1 and 2 participated in a 14-day visuospatial WM updating training program with HAM or LAM. The students in study 2 completed a set of activities measuring various executive functions and fluid intelligence before and after training. In both instances, the HAM students received more training than the LAM students. Both groups improved on near-transfer tasks after training in study 2, but not on far-transfer tasks. In contrast to the LAM students, the HAM students' differential training gain was not associated with higher post-training performance on any of the transfer tasks. These findings suggested that AM is associated with the effect of the benefits of WM training, but not on the transfer of those benefits to other tasks. It was necessary to investigate if this is similar with achievement motivation for learning chemistry.

Sung et al. (2018) conducted a research on the longitudinal relationship between early academic achievement and executive functioning, as well as the mediating impact of learning modalities. Researchers employed latent development curve modeling to examine trajectories of children's reading and math success, executive function (EF), and learning styles from kindergarten to first grade. The researchers also looked at the extent to which initial levels and growth rates of EF and learning styles independently predicted the initial level and growth rate of reading and math achievement. They also examined the extent to which learning styles mediate the relationship between EF and academic achievement. According to the findings from the early childhood longitudinal study-kindergarten cohort of 2011, children's reading and math achievement, EF, and learning styles in the autumn of kindergarten varied greatly. Significant disparities in the rates of change of primary variables over time showed that some children had faster growth in certain qualities than others, while others had declines in some qualities. Children with higher EF and learning styles levels and who grew at a faster rate had a faster rate of change in reading and math achievement. Finally, via learning styles trajectories, EF trajectories had direct and indirect effects on academic achievement trajectories. There was an empirical gap as to whether this was the case among adolescents. This study aimed to address this gap.

In order to facilitate planning, monitoring, and control processes in the service of academic goals, student self-regulated learning (SRL) is thought to depend on cognitive resources such as EF. Prior research has shown a link between direct measures of EF and accounts of regulatory behaviors, but this has rarely been extended to classroom behaviors and consequent school accomplishment using SRL framework. Rutherford et al. (2018) investigated the link between achievement, EF and SRL. The study findings showed that there existed an association between EF inhibition and shifting elements and SRL teacher reports, as well as student accomplishment in standardized tests and classroom grades in maths and arts. Furthermore, the findings showed that SRL mediates the relationship between EF and mathematics achievement. This implied that some features of EF might help or hinder SRL and hence academic achievement, which has implications for cognitive and educational achievements.

In a related study, Obradovic and Finch (2016) conducted a study to investigate the relationship between executive functioning skills and academic achievement of students in elementary school. The sample consisted of 813 students (48% female and 52% male). The study adopted a longitudinal research design. The participants completed executive functioning tasks on tablet computer over a period of three years. The findings revealed that executive functioning had a positive significant relationship with academic achievement. However, the findings might have been influenced by aging as opined by Von Hippel (2007). The current study used cross-sectional survey to control for the effect of age on executive functioning.

Locally, there is scanty research literature on the predictors of achievement motivation for learning chemistry. However, literature on the predictors of academic resilience both external protective and internal protective factors indicate a positive and significant relationship (Mwangi, 2015). The findings of Mutweleli (2014) revealed that academic motivation has a positive significant relationship with academic achievement. The studies recommended further research on the predictors of achievement motivation to create new knowledge.

Relatedly, Wambua et al. (2017) conducted a study to investigate the predictors of achievement motivation among university students. A total of 167 students were sampled from five universities. The findings

revealed that prior achievement predicted achievement motivation. The study involved university students and the domains of executive functioning were not given attention in the prediction of achievement motivation in chemistry. Informed by these studies, the current study investigated the extent to which executive functioning is related to achievement motivation for learning chemistry to address the existing gaps.

V. Research Methodology

5.1 Research Design and Target Population

The researcher used convergent parallel mixed research design to examine the relationship between the study variables. In this design, both quantitative and qualitative data are collected, analyzed and then the results are compared to see if they answer the research questions the same way (Creswel & Creswell, 2018). Questionnaires and interview schedule were used to collect data that were used to address the research issue. This research approach was a useful strategy for an in depth understanding of the relationship between executive functioning and achievement motivation for learning chemistry. It provided a broader perspective with regard to the cognitive factors that may be associated with below average performance in chemistry among secondary school students in Kiambu County. Creswell and Creswell (2018) states that mixed research design is important for heightened validity and knowledge on the research problem. The target population was 284 public secondary schools with 10528 form three students taking chemistry in the year 2020.

5.2 Sampling Techniques and Sample Size

The study used purposive sampling to select form three classes in public secondary schools in Kiambu County. Stratified sampling was used to select secondary schools to participate in the study. Data were collected from 4 national schools, 6 county and extra county schools and 7 sub county schools making a total of 17 secondary schools. Proportionate sampling was also used to select students from each school category. In schools that had more than one stream, simple random sampling was used to select one stream from which the students were selected. The students were selected using simple random sampling. The use of simple random sample technique ensured unbiased representation of the students. A sample size of 395 students was obtained out of the target population of 20528 form three student. The sample of students was obtained using Slovins (1960) formula. To take care of attrition and non-response, the researcher increased the sample size to 440 students. The sample size from each school category was calculated using the proportion of students in the school category and the total target population. To address the issue of gender bias in interpretation of results, an equal number of boys and girls was selected from each school category.

5.3 Research Instruments

a) Executive Functioning Skills Scale

The study adapted executive functioning skills scale in children and adolescents developed by Dawnson and Guare (2010), α =.81. This questionnaire was modified to focus on four domains that were relevant to the current study. The four domains include; initiation, sustained attention, inhibitory control and shifting. Most of the items in the original scale focused on general task or work and to appropriately address the issue of the current study, in the place of task or work the researcher used the term chemistry.

In the adapted scale, each of the three domains consisted of three items that measured executive functioning skills on a five point Likert scale ranging from *Strongly Disagree* to *Strongly Agree*. The expected lowest score was 12 while the expected highest score was 60. The items that were negative were reverse scored. A score of 12-24 indicated below average executive functioning skills, 25-47 indicated average while a score of 48-60 indicated high level of executive functioning skills.

To establish the reliability and validity of the adapted scale, the researcher carried out a pilot study in one school which was not included in the actual study. Content validity of this scale was examined through literature review on measurement of executive functioning skills. Through this process, unclear items were revised and simplified to the level of form three students in Kenya.

b) Student's Motivation towards Science Learning Questionnaire (SMTSL)

This questionnaire obtained from International Journal of Science Education (α =.89) was developed by Tuan et al. (2005). The researcher was granted permission by the authors to use the questionnaire. The questionnaire has 29 items that measure motivation on a five point Likert scale.

c) Interview Schedule

Qualitative data were collected using self-constructed interview schedule to complement quantitative data. To ensure reliability and validity of the research tool, the researcher conducted rigorous literature review on qualitative measurement of psychological constructs. The knowledge and skills gained together with guidance from the university supervisors, the researcher developed the interview schedule to measure executive

functioning skills. Four items were developed to measure this construct in relation to achievement motivation for learning chemistry under four domains namely; initiation, sustained attention, inhibitory control and shifting.

5.4 Data Collection Procedures, Analysis and Presentation

Questionnaires and interviews were used to collect data from the respondents. The researcher explained in details to the respondents what they were supposed to do before allowing them to proceed with filling the questionnaire and answering the interview questions. The respondents were allowed to submit the questionnaire after counterchecking for completeness. This technique was appropriate because it enabled the researcher to collect a lot of information within the shortest time. Furthermore, the researcher was competent to handle data collected using self-reports. Data analysis was done using three methods; descriptive statistics, inferential statistics and thematic analysis. Analysis of qualitative data involved grouping the responses into themes and sub themes, development of executive functioning skills and achievement motivation for learning chemistry rubric. The results were used to complement quantitative data results.

VI. Results And Discussions

This section presents descriptive statistics of the data, hypothesis testing and discussion of the results.

6.1 Descriptive Statistics of Executive Functioning Achievement Motivation Scores

Table 1 presents the descriptive statistics of executive functioning skills.

Table 1: Descriptives of Executive Functioning

Gender	*N*	Range	Min	Max	*M*	*SD*	*Sk*	*Kur*
Male	174	32	24.00	56.00	38.13	6.92	.14	-.36
Female	164	40	12.00	52.00	36.60	7.17	-.59	.59
Total	338	44.00	12.00	56.00	37.39	7.07	-.24	.28

Note. N=338; Min- Minimum; Max-Maximum; *M*-Mean; *SD*-Standard deviation; *Sk*-Skewness; Kur – kurtosis

The results indicate that the mean score of male students was 38.13 (*SD* = 6.92) while that of the female students was 36.60 (*SD* = 7.17). The maximum score for male students was 56 while the minimum score was 24 with a range of 32. The maximum score for female students was 52 while the minimum score was 12 with the range of 40. The skewness and kurtosis coefficients indicate that the scores were near normal distribution. The results indicated that male respondents had slightly better executive functioning skills than female students.

Table 2 : Description of the Scores of the Levels of Executive Functioning

	N	Range	Min	Max	*M*	*SD*	*Sk*	*Kur*
Initiation	338	12	3	15	9.17	2.34	.05	-.27
Sustained Attention	338	12	3	15	8.70	2.99	-.04	-.72
Inhibitory Control	338	12	3	15	10.15	2.52	-.44	.14
Shifting	338	12	3	15	9.37	2.79	-.27	-.46

Note. N=338; Min- Minimum; Max-Maximum; *M*-Mean; *SD*-Standard deviation; *Sk*-Skewness; *Kur* – kurtosis

Executive functioning skills were measured at four levels namely; initiation, sustained attention, inhibitory control and shifting. The mean score of the respondents on initiation skills was 9.17 with a standard deviation of 2.34. Regarding sustained attention skills, the mean score of the students was 8.70 (*SD* = 2.99). The mean score of inhibitory control and shifting skills was 10.15 (*SD* = 2.52) and 9.37 (*SD* = 2.79) respectively. The kurtosis and skewness coefficients of the four domains of executive functioning skills were within the recommended range, implying that the scores were normally distributed.

The executive functioning skills of the respondents were grouped into three categories namely; below average, average and above average. . A score of 12-24 indicated below average executive functioning skills, 25-47 indicated average while a score of 48-60 indicated high level of executive functioning skills. The results are presented in Table 3.

Table 3 : Levels of Executive Functional Skills

	Frequency	Percent
Below Average	12	3.6
Average	303	89.6
Above Average	23	6.8
Total	338	100.0

Table 3 shows that 12 students representing 3.6% had below average executive functioning skills. Majority of the students representing 89.6% had average level of executive functioning skills while 6.8% of the respondents had above average level of executive functioning skills.

Table 4 : **Descriptives of Achievement Motivation Scores**

Gender	*N*	Min	Max	Range	*M*	*SD*	*Sk*	*Kur*
Male	174	53	116	63	97.48	13.67	-0.23	0.47
Female	164	52	116	54	95.06	12.55	-0.63	0.45
Total	338	52	116	64	96.30	13.18	-.37	.51

Note. N=338; Min - Minimum; Max-Maximum; *M*-Mean; *SD*-Standard deviation; *Sk*-Skewness; Kur – kurtosis

The results in Table 4 indicate that the minimum and maximum score for male students was 53 and 116 respectively. The mean and standard deviation was 97.48 and 13.67 respectively. The skewness coefficient was -0.23 while the kurtosis coefficient was 0.47. For female students, the minimum and maximum score was 52 and 116 respectively while the mean and standard deviation was 95.06 and 12.55 respectively. The skewness coefficient was -0.63 while kurtosis coefficient was 0.45.

6.2 Hypothesis Testing

To establish the relationship between executive functioning skills and achievement motivation for learning chemistry, the following hypothesis was tested.

H_{01} There is no significant relationship between executive functioning skills and achievement motivation for learning chemistry.

Table 5 : Correlation between Executive Functioning and Achievement Motivation

		Achievement Motivation
Executive Functioning	Pearson Correlation	.45*
	Sig. (2-tailed)	.00
	N	338

The results presented in Table 5 shows that there was a significant positive correlation between executive functioning and achievement motivation for learning chemistry, r (336) = .39, $p < .05$. Based on the results that were obtained, the null hypothesis was rejected and the alternative one adopted. Therefore, executive functioning skills significantly influence achievement motivation for learning chemistry. The findings suggest that an increase in executive functioning is associated with an increase in achievement motivation for learning chemistry and vice versa.

The scale that was used to measure executive functioning skills comprised of four sub scales namely; initiation, sustained attention, inhibitory control and shifting. To understand how each of the sub constructs was correlated to achievement motivation for learning chemistry, the following supplementary hypotheses were tested.

$H_{01.i}$ There is no significant relationship between initiation executive functioning skills and achievement motivation for learning chemistry.

$H_{01.ii}$ There is no significant relationship between sustained attention executive functioning skills and achievement motivation for learning chemistry.

$H_{01.iii}$ There is no significant relationship between inhibitory control executive functioning skills and achievement motivation for learning chemistry.

$H_{01.iv}$ There is no significant relationship between shifting executive functioning skills and achievement motivation for learning chemistry.

The hypotheses were tested using Pearson correlation analysis and the results are presented in Table 6.

Table 6 : Correlation between Types of Executive Functioning Skills and Achievement Motivation

Types of Executive Functioning Skills	Achievement Motivation
Initiation	.21*
Sustained Attention	.31*
Inhibitory Control	.30*
Shifting	.35*

Note. $N = 338$; $^{*}P < .05$

The results presented in Table 6 indicate that shifting executive functioning skills had the highest correlation coefficient with achievement motivation for learning chemistry, r (336) = .35, $p < .05$ followed by sustained attention executive functioning skills, r (336) = .31, $p < .05$. Initiation executive functioning skills and inhibitory control executive functioning skills had a correlation coefficient of r (336) = .21, $p < .05$ and r (336) = .30, $p < .05$ respectively with achievement motivation for learning chemistry.

Executive functioning skills were categorized into three groups namely; below average, average and above average. To establish if achievement motivation for learning chemistry differed based on the different levels of executive functioning skills, the researcher conducted one way ANOVA and the results are presented in Table 7.

Table 7 : ANOVA Results for Mean Differences in Achievement Motivation

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	6053.06	2	3026.53	19.32	.00
Within Groups	52480.56	335	156.66		
Total	58533.61	337			

Note. $N = 338$

The results presented indicate that there was a statistically significant difference in achievement motivation for learning chemistry among students with different levels of executive functioning skills, F (2, 335) = 19.32, $p < .05$. Tukey's honestly significant difference test was conducted to establish how each pair of the levels of executive functioning skills contributed to the difference.

Table 8 : Tukey's HSD for Achievement Motivation Scores Across the Levels of EF

(I) EF Levels	(J) EF Levels	Mean Difference (I-J)	Std. Error	Sig.
Low	Average	-15.01*	3.68	.00
	High	-27.13*	4.46	.00
Average	Low	15.01*	3.68	.00
	High	-12.12*	2.71	.00
High	Low	27.13*	4.46	.00
	Average	12.11*	2.71	.00

Note. $N = 338$; EF- Executive Functioning**;** Sig. - Significance

The results presented in Table 8 show that there was a significant difference in achievement motivation for learning chemistry between students with low and average levels of executive functioning skills. The difference in achievement motivation for learning chemistry between students with low and high levels of executive functioning skills was also significant. The results also indicate that achievement motivation for learning chemistry between students with average and high levels of achievement motivation differ significantly.

Executive functioning scale consisted of four levels namely; initiation, sustained attention, inhibitory control and shifting. Since it was found that there was a positive and significant relationship between the types of executive functioning skills and achievement motivation for learning chemistry, it was important to investigate how each of the types of executive functioning skills predict achievement motivation for learning chemistry. The data were subjected to multiple regression analysis and the results are presented.

Table 9 : Regression Model Summary for EF Sub Domains

Model	*R*	*R* Square	Adjusted *R* Square	*SE* of the Estimate
1	.45[a]	.21	.19	11.83

Note. $N = 338$

a. Predictors: (Constant), Shifting, initiation, inhibitory control, sustained attention

b. Dependent Variable: Achievement motivation

Table 9 indicates that the multiple regression coefficient is 0.45 which suggests a moderate prediction of achievement motivation for learning chemistry from shifting, initiation, inhibitory control, sustained attention executive functioning skills. The results also indicate that R square is 0.21 which means that 21% variance in achievement motivation for learning chemistry can be explained by the predictor variables.

To establish if the regression model was significant in predicting achievement motivation for learning chemistry, ANOVA summary table was used and the results are presented in Table 10.

Table 10 : ANOVA for EF Sub Domains

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	11893.61	4	2973.40	21.23	.00[b]
	Residual	46640.01	333	140.06		
	Total	58533.61	337			

a. Dependent Variable: Achievement motivation

b. Predictors: (Constant), shifting, initiation, inhibitory control, sustained attention

The F ratio in the ANOVA suggests that shifting, initiation, inhibitory control, sustained attention executive functioning skills significantly predict achievement motivation for learning chemistry, F (4, 333) = 21.23, $P < .05$. Table 11 presents the regression coefficients for the prediction model.

Table 11 : Regression Coefficients for EF Sub Domains

Model		Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
		B	*SE*	Beta		
1	(Constant)	64.14	3.81		16.84	.00
	X_1	.79	.29	.14	2.77	.00
	X_2	.58	.25	.13	2.34	.02
	X_3	1.06	.28	.20	3.85	.00
	X_4	.97	.26	.20	3.71	.00

Note. X_1 = Initiation; X_2 = Sustained Attention; X_3 = Inhibitory Control; X_4 = Shifting

As shown in Table 11, the regression coefficient for initiation executive functioning skills was 0.79 while that of sustained executive functioning skills was 0.58. Inhibitory executive functioning skills had the highest predictive value of 1.06 followed by shifting executive functioning skills with a predictive value of 0.97. All the regression coefficients significantly predicted achievement motivation for learning chemistry.

The prediction equation developed from the regression coefficients is as follows;

$\hat{Y} = 0.79X_1 + 0.58X_2 + 1.06X_3 + .97X_4 + 64.14$

Where $\hat{Y}$ = Predicted achievement motivation

Based on the regression equation, a unit change in initiation executive functioning skills and sustained attention executive functioning skills leads to 0.79 and 0.58 change in achievement motivation for learning chemistry respectively. A unit change in inhibitory control was associated with 1.06 change in achievement motivation for learning chemistry.

6.3 Results of Qualitative Data

The researcher was guided by Levitt et al. (2018) propositions of identifying themes in qualitative data. The suggestions given by the researchers include; repetition, metaphors and analogies, typologies, transitions, theory related data and linguistic connectors. This study majorly used repetition to identify the themes in the responses that the students provided. Coding of executive functioning is presented in Table 12.

Table 12 : Executive Functioning Skills

Executive functioning Skills levels	String
Initiation	Starting to do assignment in good time and completing it
Sustained attention	Focusing on chemistry assignment until it is completed
Inhibitory control	Using effective strategies used to successfully complete chemistry tasks
Shifting	Putting more effort to improve in performance

a. Analysis on Executive Functioning Skills

The participants were assigned pseudo names to conceal their identities. Therefore, the names used in the presentation of the findings are not the real names of the participants.

Jane: This participant was asked when she starts doing chemistry assignments and whether she always finished them. The participant said, "I always start my chemistry assignments immediately after the lessons and when it is time to do the cleaning in the evening. Regarding finishing chemistry assignments, the participant said, "I always finish my assignments and when the questions are difficult, I consult other students or the teacher." The findings indicate that this student had a high level of initiation skills.

Regarding sustained attention, the student was asked to give the strategies she uses to remain focused on chemistry assignments until they are completed. The student said, "I always focus on my chemistry assignments until they are completed and get satisfied that I have gotten the correct answers. In case am unable to do the questions, I always consult the teacher or fellow students for assistance." The responses provided indicate that the student was able to come up with innovative strategies to enable her complete learning tasks in chemistry. According to Braem and Egner (2018), students with high levels of sustained attention skills use a variety of strategies in performing learning tasks and modify them depending on the prevailing conditions to achieve learning objectives. In this regard, when Jane is faced with challenges in handling chemistry tasks she seeks assistance (scaffolding) to achieve learning objectives.

On inhibitory control, Jane was asked to give the strategies she used to avoid disappointment while answering chemistry questions. Jane replied, "I always read again and again until I master the content. I also avoid distractions that can interfere with my studies. You know chemistry is largely a practical subject and therefore when I learn a concept, I try to relate it to real-life situations. This strategy helps me to understand the concepts thus minimizing chances of forgetting. If a given text book does not present the content in a way that I can understand, I always refer to another text that presents the content in a simpler manner.

Concerning shifting domain of executive functioning skills, the respondent said, "When am faced with learning challenges while studying chemistry, I look for questions from past papers, revision books that have tested the same concept to give me direction on the most important learning points. This statement demonstrates that Jane had the ability for cognitive adjustment to fit in changing learning contexts, especially when faced with challenges. According to Wixted et al. (2016), shifting skills help students to navigate through dynamic learning contexts and content. For instance, students learn different subjects, face learning challenges concerning the content and are taught by different teachers. Under such circumstances, shifting skills are very instrumental for effective learning.

Agnes was asked the strategies she used to avoid disappointments when answering questions and her response was "First I write summary notes on the topic to study and then do questions carefully." The findings indicate that Agnes' active learning strategies are summarizing notes and reading the questions carefully. The study by Muraina et al. (2014) is that summary notes are essential for students especially when studying for approaching exams.

b. Achievement Motivation For learning Chemistry

The researcher sought to establish the level of achievement motivation for learning chemistry and its relationship with executive functioning skills. On whether they have what it takes to do well in chemistry, Jane said, "Yes, it is because I have the best teacher, revision books, and conducive environment for studying. I also participate actively during chemistry lessons." This student applies mastery goal skills of believing in oneself to do well in chemistry. This response also indicates that the student uses active learning strategy while studying Chemistry. However, the student said that the effort has not had a significant impact on learning outcomes in chemistry.

Mikes' response on whether they have what it takes to do well in chemistry was, "*Yes, chemistry is an interesting subject that makes you want to know more things that you never knew. The teacher has a simple way of teaching chemistry that makes it more interesting. Our teacher goes an extra mile to give us questions, CATS to help us understand and improve in the subject*."

On the same question, Peter said,

"*I believe I have what it takes to do well in chemistry. My teacher and parents tell me that I am a bright student, I wouldn't like to disappoint them".*

This student is motivated to do well in chemistry to avoid disappointing his teacher and parents. Moreover, the students' source of motivation is from his and parents who insist that he is a bright student.

Moneva et al. (2018) points out that the support that students get from teachers and parents motivates them to put more effort in their studies. Concerning chemistry-learning value, Agnes was asked the importance of performing well in Chemistry and she said,

"Performance in Chemistry is important because it will enable me to achieve my career goals. Also it will make me to inspire other students. I feel happy when I pass and help my friends who want to improve their performance. It is a subject with many careers too."

The findings indicate that the participant understands the value of performing well in chemistry. The student indicated that she is aware of the chemistry learning value which was associated with executive functioning skills.

Using qualitative data, in the first question the researcher aimed to establish how executive functioning skills help students in achievement motivation for learning chemistry. The findings show that executive functioning skills help to enhance students' achievement motivation for learning chemistry. The findings supported quantitative data results, which shows that there is a significant relationship between executive functioning skills and achievement motivation for learning.

6.4 Discussion of the Results

The first objective of this study was to investigate the extent to which executive functioning is related to achievement motivation for learning chemistry. The results showed that there was a positive and significant relationship between executive functioning and achievement motivation for learning chemistry. Executive functioning scores of the students were categorized into three levels namely; low, average and high. The results of further analysis showed that there was a significant difference in achievement motivation for learning chemistry among students with low, average and high level of executive functioning. Past research work that has been conducted on executive functioning mostly focused on academic achievement. Since research has established that there is a significant relationship between achievement motivation and academic achievement, the results are important to guide the discussion of the findings of the present study.

The results of current study support the findings of Pascal et al. (2019). The research stablished that there was a significant relationship between executive functions and academic achievement. The researchers established that the random effects of initiation, sustained attention, shifting and inhibitory control had a

combined random effect of 0.37 on academic achievement. It was established that the executive functions regulate educational processes such as achievement motivation which in turn affect academic achievement.

In another research by Duckworth et al. (2019) it was established that inhibitory control was associated with academic achievement. Missier et al. (2011) found that executive functions influence student's competencies in decision making. The students involved in the study used executive functioning skills in making decisions in educational settings. The decisions made influence the effort made and educational achievement. Cognitive reflection especially on matters related to academics was associated with executive functioning skills. Executive functioning skills guide students' actions in academic goal setting. These actions include emotional control, self-regulation and problem solving. The actions are the mental strategies that students use in information processing to guide learning as suggested in the information processing theory.

The results of the current research were also consistent with the findings of Engel et al. (2014) who established that there was a significant relationship between executive functioning and reading comprehension performance. The study was carried out among children aged 6-8 eight years sampled from different backgrounds in Brazil. Cognitive flexibility and working memory were the best predictors of reading performance. The researchers established that individual differences in reading comprehension performance was explained by executive functioning domains. Pupils with low scores in reading performance were found to have limitations in executive functioning skills. The results confirmed that executive functioning skills are crucial in school achievement regardless of age and the learning context.

The results also support the findings of Bull (2015) who demonstrated that executive functioning skills uniquely contribute to learning effort and academic achievement. The researcher observed that the difficulties in school achievement were associated with poor executive functioning skills. Even though the study focused on learning effort and academic achievement as the outcome variable, the results clearly demonstrate that executive functioning is important in achievement motivation because of its significant relationship with academic achievement.

Even metaanalysis studies have established that executive functioning is an important construct in educational settings. Pascual et al. (2019) found that the components of executive functioning significantly predicted performance in school. The study also established that age significantly moderated the relationship between executive functioning and achievement. The researchers demonstrated that the domains of executive functioning affect learning orientation and academic achievement. Even though the study focused on academic achievement, the findings suggest that executive functioning skills are important in achievement motivation which is directly related to academic performance. Similar results were obtained by Gomez-Veiga et al. (2013) who demonstrated that 33% variance in reading performance was explained by executive functioning skills. Information processing theory that anchored this study suggests that learning behavior that enhance academic achievement are based on inherent processes of executive functioning skills. Therefore, executive functioning is an important factor for achievement motivation for learning chemistry.

VII. Conclusions

The study established that there was a significant relationship between executive functioning skills and achievement motivation for learning chemistry. The domains of executive functioning skills namely; shifting, sustained attention and inhibitory control were found to play an important role in the prediction of achievement motivation for learning chemistry. The results suggest that students with high levels of executive functioning skills have high levels of achievement motivation for learning chemistry and vice versa. Therefore, it is important that students are trained on how to advance executive functioning skills in order to enhance achievement motivation for learning chemistry. This will go a long way in improving performance in chemistry.

VIII. Recommendations

The study established that there was a positive and significant relationship between executive functioning and achievement motivation for learning chemistry. Therefore, school counsellors and chemistry teachers should sensitize and support chemistry students to enhance their executive functioning skills. This will go a long way in boosting the student's achievement motivation for learning chemistry for better learning outcomes. Curriculum developers should also integrate executive functioning learning activities in the learning content in order to enhance the development of these skills for better learning outcomes in chemistry.

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