Learning Styles as Predictors of Students' Chemistry Achievement in Public Secondary Schools in Kenya

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Abstract: Underachievement in Chemistry amongst secondary schools in Kenya has dimmed the hopes of many students in progressing into higher institutions to study science-based courses and greatly impacting the growth of the labour market. The study was based on establishing how learning styles predicts achievement in Chemistry among Form three secondary school students in Njoro Sub-County, Nakuru County, Kenya. Through this study, the cases of poor Chemistry achievement among public secondary school students in the Sub-County was addressed. The quantitative study adopted correlational research design in the study. A target population of 3976 form three students from 47 public secondary schools were selected for the study, from which 400 students in 14 schools made up the study sample. Data collection was done through use of questionnaires and document analysis. A pilot study used a total of 40 students from two public secondary schools in the Molo Sub-County. Cronbach's alpha was used to determine internal consistency of the research instruments and a reliability coefficient above 0.7 was established. The Statistical Package for Social Sciences (SPSS) version 24.0 examined quantitative data. Inferential statistics consisted determining Pearson Product Moment correlation coefficient and multiple regression analysis, and descriptive statistics entailed frequency counts, range, minimum and maximum values, percentages, mean and standard deviations. Results from the study indicated a positive and significant relationship between auditory, kinesthetic and visual learning preference and Chemistry achievement. For auditory preference the correlation was positive and significant ($r(360)=.80$, $p<.05$). For kinesthetic preference a positive and significant relationship was found ($r(360)=.76$, $p<.05$). Moreover, a positive and significant relationship was established for visual preference ($r(360)=.74$, $p<.05$). Further findings revealed that most respondents opted for visual learning preference (76.9%) as it was linked to higher Chemistry scores (mean score was 56.13). Also, results indicated that self-efficacy, auditory, visual and kinesthetic learning preference significantly affected Chemistry achievement ($F(4,355)$, $p = .00$. This study recommends that parents and teachers should be concerned with activities that can reinforce students' skills in learning styles.

Keywords: Chemistry academic achievement, learning styles, public secondary schools.

I. INTRODUCTION

Education is a process in which a student is fully engaged in the learning process. According to Kinsey et al. (2019) Chemistry is a branch of science that deals with the form and properties of matter and the interaction between the substances. Helmenstine (2020) notes that Chemistry is one of the oldest sciences in the history of man which is everywhere in the world around us, it's in the food we eat, water we drink, medicines, air and cleaners. Also, Chemistry as a science inculcates crucial skills of how to reason and solve problems. Chemistry therefore influences a person's development and contributes to the wealth of a nation through problem solving and critical thinking (Marie, 2019). Academic achievement in Chemistry

is of concern across the world because of dwindling results achieved by students in different evaluations. However, Chemistry achievement is direr in Kenya since its dismally performed compared to the other subjects. This study therefore sought to explore if learning styles predict Chemistry achievement. This study was crucial to enable parents and teachers to assist students to apply appropriate learning styles to foster better Chemistry achievement.

Learning styles preferences is a psychological theme that significantly affects academic achievement in that, students learn better when their individual learning style is connected appropriately to favorable learning environment. Apparently, a learning style shows how students confront their study approaches through perception and towards their environment and how they yield good results from tasks presented to them (Richardson, 2011; Mose, 2015). According to Radhwan (2016) learning styles domain consist mainly of; visual, auditory and kinesthetic learning styles that have a great bearing in determining students' academic achievement. The significance of performance of students in Chemistry is in enhancing socio-economic development and transforming nations into industrial centres. Of all the sciences, Chemistry performance both at school level and national level has remained persistently low in Kenya. The performance of students in Chemistry in national examinations in Njoro Sub-County has been comparatively low in relation to other Sub- Counties in Nakuru County, Kenya. The performance in Chemistry has subsequently negatively affected overall academic achievement of some students who enrolled for the subject since the points gained in the subject contributes to their final mean grades.

The prevalence of underachievement in Chemistry subject amongst secondary schools in Njoro Sub-County has dimmed the hopes of many students in progressing into higher institutions to study science-based courses. Leading to a scenario whereby the Kenyan society and job markets are not self-sufficient in terms of the quantity of professionals and hence, derailing industrial and economic development of the country. Despite the urgent need to examine if learning styles predicts Chemistry achievement, there is scarcity of studies in Njoro Sub-County that have been conducted on predicting the relationship between learning styles and Chemistry achievement. Based on this premise, the study therefore was geared towards determining the predictive power of learning styles on Chemistry achievement among students in Njoro Sub-County.

Neil (1995) gave a model of learning VAK, which identifies three main sensory modes of learning: Visual, Auditory and Kinesthetic that depends on the neural system and with which a student will prefer to receive information. According to the proponents of the theory visual learning style involves students that learn through seeing and preferably through images, drawings and pictures. Auditory learning style involve those students that learn preferably via hearing and are active listeners of lectures and explore through discussions as they communicate their ideas. Kinesthetic learning style involves those students that learn through a sense of touch and preferentially learn from experiences that is based on doing, manipulation of things and physical involvement. Learning styles (kinesthetic, visual and auditory) were the predictor variable in the research.

This study was centered on the three learning styles because they are prevalent and they represent basic perceptual means of getting information (Mose, 2015). Renou (2008) tested this model and results indicated that about half of the students were visual students followed by significant percentage being auditory students and less than ten (10) percent were kinesthetic students. Good Chemistry achievement is portrayed by students who apply learning styles appropriately (Cittoor, 2015). This theory therefore also guided this study in predicting the relationship between students' learning styles and their achievement in Chemistry with those choosing learning styles well hypothesized to do well and vice versa.

II. REVIEW OF RELATED LITERATURE

A. *Learning Styles and Chemistry Achievement*

A study in Miami, USA by Stacey (2017) investigated plethora of learning styles that are used to categorize students to optimize student learning. The study employed experimental research design, a sample size of 200 high school learners were utilized in collecting statistical data. Researcher found out that there is no experimental evidence to support the hypothesis that instruction designed based on the outcomes of students' learning styles can without doubt improve Chemistry achievement. However, the study reviewed focused on 200 high school students while employing experimental design but this study focused on 400 students while applying correlational design that was crucial in predicting behaviour and establishing relationships.

Jun (2018) carried a research on the correlation between self-efficacy, learning style and aptitude test in South America. The study employed quantitative survey research design and utilized a questionnaire as a research tool to collect data from

a sample size of 260 female students from San Jacinto High School. Results from the study indicated a significant correlation concerning learning styles and aptitude test. However, the study reviewed focused on a sample size of 260 and employed quantitative survey design but this study was based on 400 students while employing correlational research design that was more elaborate in giving relationships between variables.

A study was carried in China by Xiaojie and Xianmin (2016) on the impacts of learning styles and interest on concentration on academic performance of students in studying using mobile phones. The correlational research study dealt with the interrelationship effect of learning styles and interest on the concentration and achievement of learners, the students used their own mobile phones to learn conceptual knowledge in their classrooms. A sample of ninety-two (92) education college students participated in the study whereby data was analysed using regression analysis, and variance analysis. It was noted that learning styles did not exhibit a significant relationship on concentration and academic achievement. However, the study reviewed here was based on a smaller sample size of 92 college students but this study used a bigger sample size of 400 students at a different developmental stage that is, adolescence.

In India a study was carried by Cittoor (2015) on learning styles in enhancing the information processing capability in Chemistry teaching and learning, a sample size of hundred students between 14 to 15 years old were involved. The hundred students were categorized into control group and experimental group. Here experimental group through ICT were involved in classroom teaching balancing chemical equations for a period of six (6) weeks. The methodology involved integration of ICT by designing self-learning interactive Microsoft power point presentation on balancing of chemical equations. Researcher found out significant relationship in experimental group whereby adopting ICT as a visual tool in teaching and learning fosters understanding and ensures learning is more meaningful. The study was inconclusive on the other learning styles apart from visual learning style. Also, the study reviewed focused only on a sample size of 100 students in experimental design but this study was focused on correlational design using a bigger sample size that without biases reflected the characteristics of a larger population set-up.

In Nigeria a study was carried by Nja and Edoho (2019) on the impact of learning styles on students' academic performance involving educational science undergraduates at the Calabar University. The study employed Expo facto design and used learning styles questionnaire to collect data from a sample size of 200 undergraduate university students. Results indicated a positive correlation between learning styles and students' academic achievement. However, the study reviewed focused on a small sample size of 200 undergraduate students while employing expo-facto design but, this study was based on correlational design and a sample size of 400 high school students that can be generalized to a larger population.

Also, in Nigeria, Emeka and Sanni (2017) investigated indirect and direct influences of personality type and choices of learning styles on Biology performance involving high school students in Osun state. The purpose of the research study was determining the impact of VAK (visual, auditory and kinesthetic) learning style preferences and Myer's Briggs personality type, which is Extraversion, Sensory, Thinking and Judging (EST) on Biology academic achievement at the senior secondary schools. A sample size of one thousand four hundred and eighty (1,480) senior secondary Biology students were subjected to the study. The study employed correlational research design whereby multiple regressions and path analysis were adopted in interpretation of data that was collected. Researchers found out that predictor variables such as kinesthetic, thinking, sensing, extraversion and age had a direct effect on Biology achievement. However, kinesthetic learning style had the greatest impact on Biology academic achievement. The study reviewed focused on Biology achievement however, this research was on Chemistry academic achievement.

In Kenya, Mose (2015) carried a research on the influence of perceptual learning styles preferences and self-efficacy on Mathematics performance in Nyamira North District of Kenya. The study adopted descriptive and correlational research design and used learning style test tool, self-efficacy questionnaire and document analysis to collect data from 311 secondary school learners and 69 teachers. Results pointed to a significant variability in learning styles preferences. The study reviewed here focused on a sample size of 311 students but this study was based on a larger sample size of 400 in another geographical area.

Further in a study carried in Kenya, Aurah and Wesonga (2017) explored the impact of instructional strategies and learning styles on Physics academic achievement involving high school students. The study adopted quasi-experimental research design and employed learning style questionnaire to collect data from a sample size of 519 Form 3 students of Navakholo Sub-County in Kakamega County. A significant difference in learning styles and instructional strategies on Physics

students' academic achievement was established. The study reviewed here focused on quasi-experimental research design however, this study was based on correlational research design that predicted relationship between variables.

B. Preference of Learning Styles on Chemistry Achievement

In Malaysia, Ling et al. (2017) carried a study on the effect of learning styles on academic performance in private college of Malaysia. The explanatory quantitative research design used descriptive and regression analysis while studying a sample size of 200 MBA students from a private college. In the study the researcher found out that visual learning styles have a significant impact on academic performance. However, study being reviewed here was based on explanatory research design with a small sample size of 200 MBA students, but this study was based on correlational research design with a sample size of 400 high school students that can be generalized to a larger population.

In Indonesia Romansyah (2018) carried a research on the impact of visual learning style and school climate on academic achievement of students that involved learning entrepreneurship. The study adopted correlational research design and focused on determining the impact of visual learning style and school climate on academic achievement of students. A sample size of three hundred and ten (310) college students was arrived at using Slovin formula. Questionnaires were employed in data collection and whereby multiple regression was adopted in analysis of the data. Apparently from the study, the researcher noted a significantly high variation between visual learning style and school climate on academic achievement of entrepreneurship learning. The study reviewed focused on a sample size of 310 students and in entrepreneurship achievement but, this study was based on 400 high school student taking Chemistry.

In a study in Saudi Arabia Jehad (2019) studied preferred visual, auditory and kinesthetic cognitive patterns among secondary school students admitted to king Saud University and its effects on Physics academic achievement. The Objective of the study was to find out the preferred cognitive learning pattern and their influence on Physics academic achievement. Correlational study design was adopted that involved application of the cognitive learning pattern (VAK) scale which consisted 16 items. A sample size of six hundred and twenty-eight (628) was employed in the study. Researcher found a significant difference in styles that students desired. Visual pattern had the highest preference while auditory pattern was the second and kinaesthetic pattern came last and was least desired among students. However, those that preferred kinesthetic pattern were the highest achievers while those who preferred audio pattern were the least in terms of academic achievement. The study reviewed focused on cognitive patterns (VAK) in Physics academic achievement but this study limited itself to learning styles in another subject that is, Chemistry.

In Indonesia, Dani et al. (2020) carried a study on the designation of vacuum learning styles (kinesthetic, auditory and visual) on primary school pupils. This study was a case study that adopted qualitative research method with descriptive analysis. A questionnaire as a research instrument was employed in collecting data from 300 pupils. Purposive sampling was used in the study to sample all the 4th, 5th and 6th grade students of Miftahul Ulum Beru Lamongan school students. The researchers found out that in the fourth-grade 30 percent of the students used visual learning style, 21 percent kinesthetic and 49 percent auditory. In the 5th grade, 50 percent used auditory learning style, 16 percent kinesthetic and 34 percent visual. Finally, in the 6th grade there are 16 percent with kinesthetic learning style, 46 percent visual and 34 percent auditory. In conclusion, about 50 percent of all students preferred and used auditory learning style. The study reviewed focused on qualitative research method while with descriptive analysis but this study was based on correlational research design that predicted relationship between variables.

In Tanzania, Kaswa (2015) explored the effect of visual learning aids on students' academic performance in government high schools. The researcher employed mixed designs (qualitative and quantitative research techniques) and employed questionnaires in obtaining data from a sample size of 102 high school students. From the research, it was determined that schools poorly ranked in academics used learning aids and recorded improved academic performance. However, the study reviewed here focused on a sample size of 102 students and applied mixed research designs, but this research was based on 400 students while applying correlational research design that, predicted relationship between variables.

In Kenya, Kang'ahi et al. (2015) explored the alignment between teaching and learning styles in Kiswahili language classrooms. The target population was 2,520 Form 4 students and 42 Form 4 teachers in 42 high schools in Kakamega North Sub-County. This study used a sample size of 345 students and 38 Kiswahili teachers. Correlational research design was employed and questionnaires were adopted in collecting data from students and teachers, as well, chi-square test and Pearson's correlational coefficient were utilized to establish the connection between dependent and independent variables.

A weak alignment x2 (1, N=383) =3.60, P=.06 between teaching and learning styles that was not significant was established. Apparently, teaching styles didn't match student's learning styles which perhaps are the major contribution to low academic achievement in Kiswahili subject. The study reviewed here focused on Kiswahili language (subject) but this study was based on Chemistry subject.

III. METHODOLOGY

Target Population

This study targeted a population of all 3,976 Form 3 students from all 47 public secondary school in Njoro Sub-County, Kenya. According to Mose (2015) the Form three students were considered for study because of their advanced experience of being in secondary school and because they have attained self-identification.

Sample Size and Sampling Techniques

Sample Size

According to Kothari (2004) generalization to the entire population from the result of a sample is possible if the sample is truly represented. A simplified formula developed by Yamane (1967) was used to come up with a sample size of 400 students. The sample size was determined as follows;

$$n = \frac{N}{1 + N(e^2)}$$

Formula key,

n= sample size,

N = is the population size,

e = is the level of precision,

Since the population proportion is definite, N = 3,976 and e = 0.05. Therefore, the sample size will be 400 students.

$$n = \frac{3976}{1 + 3976(0.05^2)} = 400$$

The Sampling Techniques

Njoro Sub-County in Kenya was purposely sampled since the investigator was very conversant with the selected area, thus providing a convenient opportunity and concentration to collect data. After purposively selecting Njoro Sub-County, 47 public secondary schools in the Sub-County were segmented by employing stratified sampling to sub-divide schools into sub-groups based on the school composition (Yongjun, 2015). Stratified sampling technique was used to ensure equal chance in sampling the population. Within the sub groups simple random sampling was enacted to come up with 14 schools whereby numbers were assigned and picked randomly to ensure fairly represented population, according to Iddagoda (2017) 14 schools are above the minimum requirement of 10 schools. In each school category selected, numbers were allocated and picked randomly from a basket to provide equal chance in sampling the population to obtain the sample size that was well represented (Kothari, 2004).

The summary of the target population, sample size and percentage proportion of the sample size to target population is presented in table 3.1

Table 3.1: Sample Percentage and Target Population

Description	Population	Sample Size	Percentage (%)
Njoro Sub-county schools (public schools)	47	14	30
Number of Form three Students	3976	400	10

Source: Nakuru County Ministry of Education office.

The Table 3.2 summarized the target population, sample size and percentage proportion of the mentioned two. According to Singh and Masuku (2014) the proportion of the sample size should be between 10 to 30 percent of the target population. Further the respondents were segmented across various categories of schools as indicated in table 3.2

Table 3.2 Respondents Breakdown Based on Sample Size

Form 3 Respondents per school category	sample size	No. of school per category
Mixed boarding school category	80	2
Male students boarding school category	90	3
Mixed day school category	130	5
Female boarding school category	100	4
Total	400	14

The Table 3.2 shows the respondents breakdown based on school stratification in Njoro Sub-County. This indicated how a sample size of 400 participants was allocated among the different categories of schools that exists in Njoro Sub-County. It also gave the number of schools per each category making a total of 14 schools that participated in the study.

Chemistry Students Learning Styles Scale

A learning style questionnaire developed by University of California, Merced Learning center (2006) was adapted. The scale required students to show the frequency with which they applied the visual, auditory and kinesthetic learning styles. The frequency rates were **seldom** (1 point)**, sometimes** (3 points) and **often** (5 point). The scale consisted of 24 items that were answered by respondents. The questions were scored independently to determine students' preferences and the relationship between learning styles and Chemistry academic achievement. The scale had excellent psychometric properties of content validity, construct validity, internal consistency and stability.

IV. RESULTS

Learning Styles and Chemistry Achievement

To determine the relationship between learning styles and chemistry academic achievement, the sampled respondents were provided with a questionnaire whereby the items were indicators of learning styles such as auditory, visual and kinaesthetic learning styles in chemistry achievement. The items in the scale were in a 3 point likert format rating from 1 (seldom), 3 (sometimes) and 5 (often). The summary of the ratings of participants in auditory learning styles were presented in table 4.1.

Table 4.1: summary responses to statements an auditory preference

Statement	Seldom	Sometime	Often	Mean	Std. Dev.
I enjoy explanations by use of graphs, diagrams/drawing or visual procedures in Chemistry	58 (16.1)	145 (40.3)	157 (43.6)	3.55	1.45
I can recall well by listening to a Chemistry lecture that involves explanation, information and discussion in Chemistry	39 (10.8)	137 (38.1)	184 (51.1)	3.81	1.35
I easily isolate and tell when sounds match presented pairs of sounds in Chemistry.	138 (38.3)	148 (41.1)	74 (20.6)	2.64	1.49
I master spelling Chemistry all words by repeating words out loud than by having to write them on a book	140 (38.9)	160 (44.4)	60 (16.7)	2.56	1.42
I score well in Chemistry by listening to tapes and lectures	104 (28.9)	156 (43.3)	100 (27.8)	2.98	1.51
I prefer following oral Chemistry procedures or steps than reading the written steps or procedures	89 (24.7)	151 (41.9)	120 (33.3)	3.17	1.51
I like listening to news online or from the radio than reading newspapers	97 (26.9)	134 (37.2)	129 (35.8)	3.17	1.57
I prefer listening to a Chemistry presentation or lecture than reading about them.	63 (17.5)	160 (44.4)	137 (38.1)	3.41	1.43

The summary of the ratings of participants in auditory learning styles were presented in table 4.2.

Table 4.2: Summary Responses to Statements on Kinesthetic Learning Style

Statement	Seldom	Sometime	Often	Mean	Std. Dev.
I like to use Chemistry models and posters or Chemistry practical activities in the classroom.	95 (26.3)	151 (41.9)	114 (31.7)	3.11	1.52
I recall best by writing Chemistry content down many times	36 (10)	98 (27.2)	226 (62.8)	4.06	1.34
I prefer to work with my hands or making things happen during a Chemistry practical activity.	92 (25.6)	88 (24.4)	180 (50)	3.49	1.67
I like chewing gum or taking snacks while reading Chemistry materials or notes.	254 (70.6)	51 (14.2)	55 (15.3)	1.89	1.49
I engage myself by playing with keys, dolls or coins in my pocket	262 (72.8)	58 (16.1)	40 (11.1)	1.76	1.36
I enjoy griping or holding apparatus with my hands in Chemistry practical lessons.	61 (16.9)	117 (32.5)	182 (50.6)	3.67	1.50
I prefer to touch others, hug and shake hands.	248 (68.9)	61 (16.9)	51 (14.2)	1.91	1.46
I like to spell Chemistry words through "finger spelling" the words.	182 (50.6)	123 (34.2)	55 (15.3)	2.29	1.46

The summary of the ratings of participants in auditory learning styles were presented in table 4.3.

Table 4.3: Summary Responses to Statements on Visual Preference

Statement	Seldom	Sometime	Often	Mean	Std. Dev.
I prefer writing notes on my book for visual review in Chemistry.	17 (4.7)	117 (32.5)	226 (62.8)	4.16	1.16
I like to see Chemistry information written on the black wall or white board together with the use of visual charts and assigned content.	87 (24.2)	116 (32.2)	157 (43.6)	3.38	1.60
With ease I understand and follow written steps, procedures during Chemistry practical.	35 (9.7)	124 (34.4)	201 (55.8)	3.93	1.33
I enjoy to skilfully draw charts and graphs in Chemistry.	82 (22.8)	157 (43.6)	121 (33.6)	3.23	1.49
I prefer understanding Chemistry articles by reading about them online or from newspapers rather than listening reports about them on the internet platforms or from a radio	144 (40)	129 (35.8)	87 (24.2)	2.68	1.57
I like obtaining interesting information in Chemistry by reading about it.	49 (13.6)	121 (33.6)	190 (52.8)	3.78	1.43
I enjoy solving Chemistry puzzles and mazes e.g., Chemistry flow charts.	86 (23.9)	138 (38.3)	136 (37.8)	3.29	1.54
I prefer to recall Chemistry concepts by picturing them in my mind	22 (6.1)	114 (31.7)	224 (62.2)	4.12	1.21

The researcher further obtained the descriptive statistics of the learning styles as enumerated in Table 4.4.

Table 4.4: Learning Styles Scores Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	SD	Sk	Kur
Auditory preference	360	26.00	12.00	38.00	25.52	4.33	- 0.04	-0.09
Kinesthetic preference	360	28.00	10.00	38.00	21.83	4.78	0.38	- 0.02
Visual preference	360	28.00	12.00	40.00	27.60	5.96	- 0.39	- 0.36

From Table 4.4 it is indicated that the mean auditory learning score was and standard deviation were (M = 25.52, SD = 4.33). The lowest and highest auditory preference scores were 12 and 38 respectively, they gave a difference (range) of 26. Kinesthetic preference mean score and standard deviation were (M = 21.83, SD = 4.78) whereas the highest kinesthetic score was 38 and a minimum score of 10 diving a range of 28. The mean score for visual preference score was 27.60. From

the results it is indicated that visual preference had the highest mean score implying that most respondents preferred visual learning style.

The researcher further obtained the descriptive learning styles by gender as shown in Table 4.5 below.

Table 4.5: Descriptive Statistics of Learning Styles based on Gender

Learning Style	Gender	N	Min	Max	Range	Mean	SD	Sk	Kur
Auditory	Male	207	16	32	16	24.37	3.78	0.32	-0.99
	Female	153	12	38	26	26.37	4.52	-0.37	0.58
Kinesthetic	Male	207	10	38	28	22.69	5.16	0.14	-0.04
	Female	153	14	30	16	20.66	3.92	0.55	-0.41
Visual	Male	207	12	40	28	28.37	6.12	-0.62	0.15
	Female	153	12	36	24	26.57	5.60	-0.11	-0.87

In Table 4.5 it is indicated that among the students who took part in the survey, 207 were males while 153 students were females. Results indicated that the mean score and standard deviation for auditory preference were (M = 24.37, SD = 3.78) and (M = 26.37, SD = 4.52) for male and female respectively. Moreover, a kinesthetic mean score and standard deviation were (M = 22.69, SD = 5.16) and (M = 20.66, SD = 3.92) was obtained for males and females respectively. The maximum kinesthetic score was 38 and 30 for males and females respectively. The maximum visual preference score was 40 and 36 for male and females respectively. The mean score and standard deviation for visual preference were (M = 28.37, SD = 6.12) and (M = 26.57, SD = 5.60) for males and females respectively. From the results it is revealed that male respondents embraced the learning styles more than females. Furthermore, our results implies that majority of the respondents practiced visual learning preference.

In determining the presence of any significant interrelation between learning styles and Chemistry achievement, hypothesis that follows was formulated.

H_{01} here is no significant variations between learning styles and students' Chemistry achievement among Form Three students in Njoro Sub-County, Nakuru County.

The hypothesis was evaluated using the Pearson's correlation and results are as shown in Table 4.6.

Table 4.6: Correlation between Student's Learning Styles and Chemistry Achievement

Learning Style		Chemistry Achievement
	Pearson Correlation	.80**
Auditory preference	Sig. (2-tailed)	.00
	N	360
	Pearson Correlation	.76**
Kinesthetic preference	Sig. (2-tailed)	.00
	N	360
	Pearson Correlation	.74**
Visual preference	Sig. (2-tailed)	.00
	N	360

The researcher hypothesized that there is no significance relationship between the learning styles and Chemistry achievement. However, from the results, a positive and significant correlation was found out between auditory, kinesthetic and visual learning styles and Chemistry achievement thereby the null hypothesis was rejected. For auditory learning style the correlation was positive and significant ($r(360)$=.80, p<.05). For kinesthetic learning style a positive and significant relationship was found ($r(360)$=.76, p<.05). Moreover, a positive and significant relationship was established for visual learning style ($r(360)$=.74, p<.05). The researcher anticipated to establish if a significant relation existed between kinesthetic learning style, auditory learning style, visual learning style and Chemistry achievement. The findings suggested that all the three learning styles; kinesthetic, auditory and visual learning preferences had a significant and positive correlation with Chemistry achievement. Specifically, participants with the learning styles had higher Chemistry achievement scores than those with no learning style.

The findings established a positive and significant relationship between auditory learning style and Chemistry achievement. Consistent with our results is the study by Alade and Ogbo (2014) who carried out a study to investigate the poor Chemistry performance of students in public evaluations. A null hypothesis was set that there is no significant correlation among learning style preference and students achievement in a continuous assessment test. Data was collected by questionnaires and data were analysed by chi square statistics. Results from analysis indicated a chi square value that is bigger than critical chi square value from the table thereby the null hypothesis was rejected and conclusion based on study findings is that the learning styles preferences significantly affected Chemistry achievement.

The positive correlation between the learning styles and Chemistry achievement is explained further by the assertion of Olic and Adamov (2018). The study was carried out on a total of 265 students from seven different schools. A Chemistry test was given to the participant students as a method of data collection. The individual student participant's preferred learning style was recorded for each case. Analysis of the recorded data indicated better Chemistry achievement for students who preferred any of the learning styles. Given that most students weren't able to identify the different solutions during practical study recommends that learning styles could enable students differentiate different Chemistry practical. Moreover, since the study found out positive and significant relationship between the learning styles and Chemistry achievement and it recommends students to apply the learning styles when dealing with difficult Chemistry topics.

Outcomes of this study show similarity with the findings of a survey by Ibitham (2020) in Nigeria. The study did a correlation survey and a sample size of 200 learners were selected for the study. Research instruments (questionnaires) and Chemistry achievement test were administered to sample students. Data collected were analysed by Pearson's correlation revealing the students' approach towards auditory learning style significantly affected their Chemistry achievement. Additionally, the results reveal visual and kinesthetic learning style correlates positively with Chemistry achievement. Students who approach studies with the three-learning style scored better Chemistry scores in contrast with students who neither preferred any of the three learning styles.

In Kenya, similar trend of a significant relationship between the learning styles and Chemistry achievement is established in the study by Mutua (2015). The study employed purposive sampling technique to collect data from the students. The study findings reveal presence of correlation between the learning styles and performance scores. The most preferred learning styles being visual learning styles. The study further established that there are no significant differences in the learning preferences based on gender.

Consistent with the present study findings is the findings by Nzesei (2015) in a correlation study between the learning styles and academic achievement among secondary school students in Kenya. The study collected data by Barsch Learning style inventory to establish levels of academic achievement from the different learning styles. The study's analysed data indicates a strong positive and statistically significant relationship between auditory, kinesthetic, visual learning style and academic achievement. This implies students who preferred to learn Chemistry content by any of the three preferences were likely to record higher academic grades in contrast with students who neither preferred any of the style. Visual, auditory and kinaesthetic model by Neil (1995) identifies the three learning styles, but Mose (2015) a proponent of this theory indicates that appropriate learning styles relates to high achievement. Hence, the theory supports the findings that learning styles are significantly related to Chemistry achievement.

Preference of Learning Styles on Chemistry Achievement

The study intended to find the preferences in learning styles in Chemistry achievement among the Form three students.

Descriptive Statistics of Learning Styles Preferences on Chemistry Achievement are presented in table 4.7

Table 4.7: Learning Style and Chemistry Achievement

learning style	Frequency	Percent	Chemistry Mean score	Std. Deviation
Auditory	74	20.6	47.30	10.93
Kinaesthetic	9	2.5	50.52	14.88
Visual	277	76.9	56.13	9.41
Total	360	100	50.00	10.00

From Table 4.7 it is indicated a total of 74 respondents preferred auditory learning style translating to 20.6 %. For students who practiced auditory preference, had their Chemistry mean score and standard deviation at (M = 47.30, SD = 10.93). A

total of 277 respondents practiced visual learning preference. This translates to 76.9% of the total respondents. The Chemistry mean score for respondents who practiced visual learning style were 56.13. From the findings it is revealed that most respondents opted to visual learning style as it was linked to higher Chemistry scores. This implies that students that prefer visual learning style had a higher achievement in Chemistry than those preferring the other two styles. In order to establish the presence of any significant relationship between preference of learning styles and Chemistry achievement the following hypothesis was formulated.

H_{02} There were no significant relationship in the preferences of learning styles and Chemistry achievement among Form Three students.

The hypothesis was tested using the Pearson's correlation and study outcomes are as shown in Table 4.8.

Table 4.8: Correlation between Student's Preference of Learning Styles and Chemistry Achievement

learning style	Chemistry Mean score	Pearson Correlation Sig. (2-tailed) .00	Frequency
Auditory	47.30	.80**	74
Kinaesthetic	50.52	.76**	9
Visual	56.13	.74**	277

Table 4.8 presents the Student's Preference of Learning Styles and Chemistry Achievement. The researcher hypothesized that there is no significance in preference of learning styles on Chemistry achievement. However, from the results it is established that there exists a positive and significant relationship in the preference of learning styles and Chemistry achievement thereby the null hypothesis is rejected. For visual preference the correlation was positive and significant ($r(360)$=.74, p<.05) whereby more students (277) opted for the style and scored highly as compared to the other students. The presented study findings indicate a positive and significant relationship between the preference of learning styles of kinesthetic, auditory and visual learning style and chemistry academic achievement. The statistics indicates that a larger number of students had preference in visual learning style, a sizable number opted for auditory learning style and the least preferred was kinaesthetic learning style.

Globally, in Africa and Kenya researchers have documented similar findings with the findings of the present study. A study by Albeta et al. (2021) in Indonesia indicated same outcomes in a survey that looked at the effects of learning styles on students' learning performance during Covid 19 pandemic. The study identifies the shift to online learning at the onset of Covid 19 pandemic. To test the learners learning style preference, the study administered questionnaires to 269 students of Chemistry education from three Indonesian universities. Students' responses were grouped in Likert scale of 5. The results indicated students enjoyed learning Chemistry by seeing, observations of pictures. The study further highlights that student with visual learning style are quicker learners. The study associates visual learning style with higher academic performance which makes it the most preferred learning style.

The present study findings indicates the mean of Chemistry scores obtained from respondents who had kinesthetic and visual learning preference did not differ significant. Moreover, pertaining Chemistry scores of students with auditory and kinesthetic learning preference style the study argues a significant mean difference. It was also found out that mean Chemistry scores of students with auditory and visual learning preference style differed significantly. This supports Alade &Ogbo (2014) findings of the same in a comparative study of Chemistry student's learning preferences in Nigeria.

In a study carried out by Panggabean et al. (2019) similar findings with the present study are reported. The study involved a sample size of 30 students where data were collected by learning style tests. Analysis of data collected indicated that visual learning preference style score was the highest among the three learning styles. This implies visual learning preference style as the most preferred among the three. Furthermore, ANOVA analysis reveals that there are differences in increase in students learning achievement. On finding the group which gives the best influence, Tukey's Honest Significance Test showed a significant difference between students with visual learning preference and kinesthetic learning preference which proves similarity with the findings of the present study.

Contrary to the present study findings that visual learning preference is the most preferred is the study by Flavin (2022). Flavin identifies kinesthetic learning preference learning style as the most preferred. He identifies kinesthetic learners as the more on hands. Kinesthetic learners often preferred to do tasks by themselves. By doing by themselves what they are interested in, they did best. Flavin recommends that students should be in a position to adapt to their preferred style.

In the same vein, Kibet et al. (2019), reports similar findings in a study of the learning preferences among university undergraduates in Kenya. In the survey a sample size of 238 learners were involved. Findings of the study reveal visual learning preference as the most preferred by the students. The study further recommends that teachers should be able to understand their students' preferred learning preference. Additionally, the study points out that students learn best when given an opportunity to learn in manner they feel comfortable with.

This study aimed at investigating the declining performance in Chemistry among students from Njoro Sub-County. Based on the study findings, this may be attributed to student's unawareness of the learning preferences. Moreover, school environments may have failed to provide an opportunity to students to practice learning styles. Renou (2008) a proponent of visual, auditory and kinaesthetic model by Neil (1995) noted that a large percentage of students with a higher achievement are students implementing visual learning style. Therefore the theory supports the findings that higher Chemistry achievement is correlated to visual learning style.

Heteroscedasticity and homoscedasticity assumptions was evaluated by scatter plots and results presented in Figure 4.1.

Figure 4.1: Scatter Plot for Observed Cumulative Probabilities and Expected Cumulative Probabilities
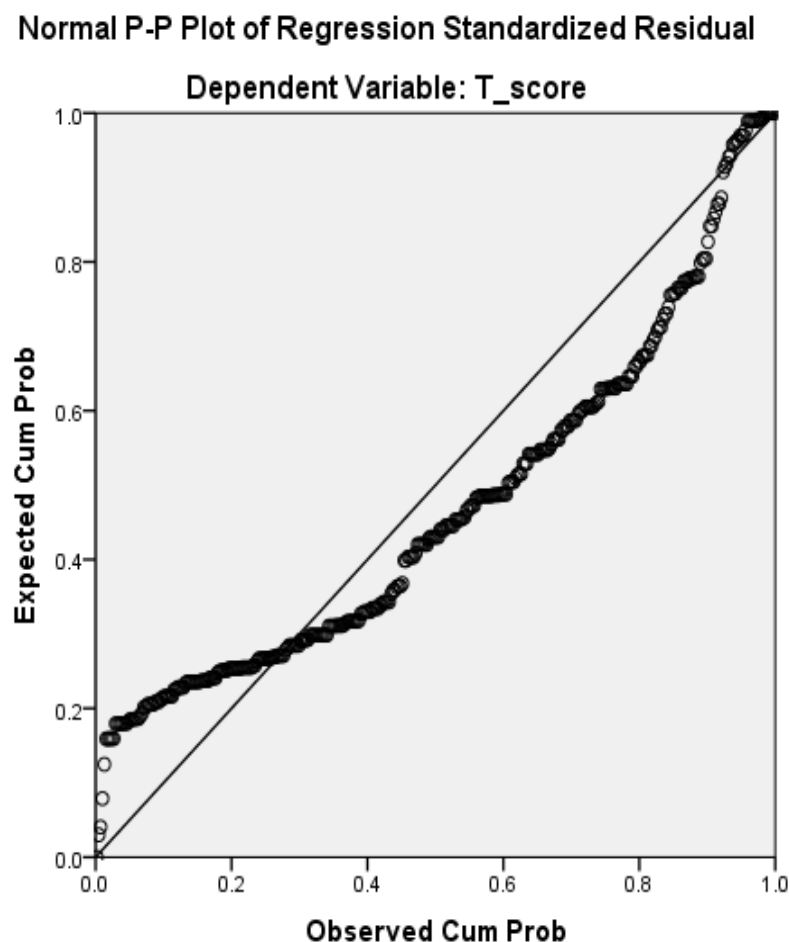

Figure 4.1 indicates that the scatter plot forms a definite pattern. This implies that the data were equally distributed. The error was thus spread out consistently in the predictor variable and therefore this indicates heteroscedastic assumption of equal variance of outcome variable.

To test normal distribution error, the assumption was tested using a histogram as presented in Figure 4.2.

Figure 4.2: Scatter Plot for testing normality distribution
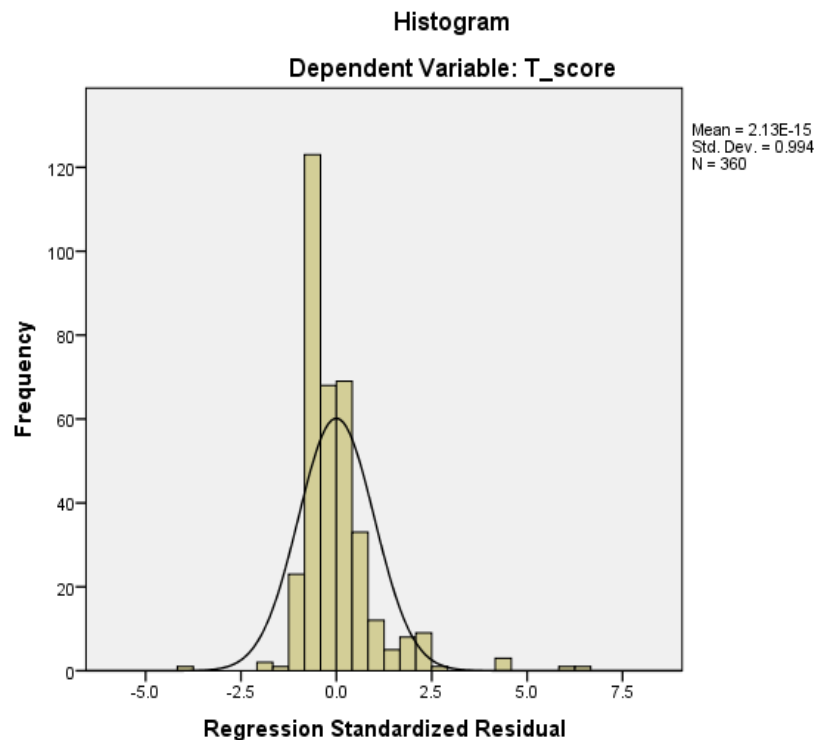

Figure 4.2 indicates the normality test results. The figure indicates that learning styles of auditory, kinesthetic and visual preferences were approximately normally distributed.

The Assumptions of Multi-Collinearity and Singularity are indicated in table 4.9

Table 4.9: Assumptions of Multi-Collinearity and Singularity

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Auditory preference	kinesthetic preference	visual preference
	1	4.95	1.00	.00	.00	.00	.00
	2	.02	13.72	.74	.00	.01	.03
1	3	.01	17.37	.00	.01	.03	.02
	4	.01	30.75	.23	.00	.03	.04
	5	.00	50.87	.03	.03	.02	.03

The results in Table 4.9 indicates that $p<.05$ thereby implying that auditory, kinesthetic and visual learning preference significantly predicted academic scores in Chemistry.

Durbin-Watson assumption of the independence of observations is indicated in table 4.10.

Table 4.10: Model Summary for Predicting Chemistry Achievement

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.85[a]	.72	.71	5.34	.37

Table 4.10 above indicates that the Durbin-Watson value was .37. This suggests that the data did not meet assumption of the independence of observations. According to (Tabachnick & Fidell, 2019) assumption for independent errors should range from 1.5-2.5. Thereby our data violated the assumption for independent errors.

Regression analysis was evaluated in table 4.11.

Table 4.11: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2.53	1.75		1.44	.00
Auditory preference	.99	.15	.43	6.56	.00
kinesthetic preference	.73	.09	.35	8.17	.00
visual preference	.37	.12	.22	2.94	.00

A-Auditory preference K-Kinesthetic preference V-Visual preferences

Based on Table 4.11 the equation predicting Chemistry achievement from learning preference is;

$\hat{y} = 0.99A + 0.733K + 0.365V + 2.529$

The results reveal that auditory preference had the highest predictive index for Chemistry achievement followed by kinesthetic preference. Visual learning preference had the lowest predictive index of Chemistry achievement. All the variables displayed positive variation in Chemistry achievement. From the multiple regression equation it can be seen that learning predicts Chemistry achievement however, the equation indicates auditory learning style had the highest predictive index on chemistry achievement.

V. SUMMARY AND CONCLUSION

On the relationship between learning style and Chemistry achievement. The findings indicated that all the three learning styles; kinesthetic, auditory and visual learning styles had a significant and positive correlation with Chemistry achievement. Specifically, participants with the learning styles had higher Chemistry achievement scores than those with none.

Additionally, the study findings indicate a significant and positive relationship between the learning preferences and Chemistry achievement. On auditory learning preference style, a majority of the students enjoyed explanations by use of graphs, diagrams or visual procedures in Chemistry. The study established that often students recalled well by listening to Chemistry lectures that involved explanation, information or discussion of Chemistry concepts. Moreover, the study established that on auditory learning preference some students learned Chemistry by playing tapes.

Furthermore the study pointed out a significant positive relationship between Kinesthetic learning preference and Chemistry achievement. It was revealed that some of the students preferred writing the content many times to recall. Descriptive statistics indicated that male students' kinesthetic learning preference was slightly higher than that of females.

Concerning visual learning preference, findings indicated a positive variation between the variable and Chemistry achievement ($r(360)=.74, p<.05$). The students responded that writing notes on their books aided them for visual review. Majority of the students sought to understand Chemistry by reading about it online or from newspapers. In addition, the students responded picturing Chemistry concepts in mind enabling them to recall the concepts. Visual learning preference was the most preferred among the three learning preferences. Male students' visual preference score was slightly higher than that of females.

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