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Analysis of Student-Teacher Cognitive Styles Interaction: An Approach to Understanding Learner Performance

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Abstract
Cognitive styles are persistent patterns of behavior that determine how an individual acquires and processes information. In the classroom the cognitive styles of the teacher interact with those of the learner resulting in differential understanding. This study which is informed by cognitive styles theories is a descriptive study that examined the interactive effects of cognitive styles and their influence on academic performance. The study specifically explored the interactive effect of cognitive styles of students and teachers on learners' performance in Mock and in Kenya Certificate of Secondary Education (KCSE) Examinations. The target population for the study was all students in sixty schools elevated to National School status across Kenya's 47 Counties. Six schools from three counties were randomly selected. From the sampled schools, one class of Form Four students was randomly selected. A total of 293 students, 6 teachers and 6 Academic Masters formed the sample. Data was collected using a Cognitive Styles Inventory, interview guide for Academic Masters and marks record forms. Data was analyzed using SPSS Version 20 to run correlation, t-tests and ANOVA tests. The study revealed two compelling findings: (i) interaction between the four dimensions of cognitive styles results in significant differential performance, and (ii) students whose cognitive styles matched those of their teachers to a level of 100% performed poorest in both Mock and KCSE Chemistry Examinations and further, they registered significantly lower improvement between the two examinations as compared to learners with lower levels of match. The study recommended that teachers and learners should profile themselves early in the learning cycle and adjust teaching/learning strategies accordingly.
Keywords: Cognitive styles, congruence, learning strategies, academic performance

1.0 Introduction

Learning is a shared social experience where the teacher provides an enabling environment for learners to acquire and use knowledge. Learning is also a personal and private affair, reflective of mental activity on the part of the learner; it is not something that others can undertake on behalf of learners (Pritchard, 2009). Further, learning is a metacognitive process requiring learners to reflect on their various experiences and how they reacted to the learning situations. Every learner has his/her own unique way in which they acquire and construct knowledge. These unique ways are termed as cognitive styles. Cognitive styles is a term used to describe the way individuals think, perceive and remember information. According to Sewall (1998) these characteristic behaviours serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment. Riding and Rayner (1998) agree with Sewall (1998) adding that cognitive styles are an 'in-built and automatic way of responding to information…probably present at birth…deeply pervasive, affecting a wide range of individual functioning.' Describing cognitive styles of an individual thus requires an understanding of the thought processing of the person. Douglas (2003) posits that as many as 19 different ways of describing cognitive styles have been identified over the years, all of which consist of bipolar distinctions of thinking and thought processing styles. Some of these distinctions are highlighted by: The Wholist-Analytic and Verbal-Imagery model by Riding (1991), The Field Dependence-Field Independence model (FI-FD) by Witkin (1973), Hudson's (1967) Conveger-Diverger Construct, Ornstein's Hemispherical Lateralisation concept commonly called the Left-brain/ Right-brain theory, and The Adaption-Innovation theory by Kirton (1976, 2003).

The level at which the learner perceives the information given, and the degree to which the information is processed is dependent on (i) the personal disposition of the learner, (ii) personal disposition of the teacher and (iii) the learning environment. This study was conceived on the premise that in any learning environment, the cognitive styles of the teacher interact with those of the learner resulting differential learning experiences for each individual learner. The study thus aimed at determining the effect of interaction of student-teacher cognitive styles on the academic performance of the learner.

1.1 Statement of the Problem

Learners all perceive and process information, however, they linger at different places along the way (McCarthy, 1990); this lingering forms the basis for differential performance among learners who have shared the same learning experiences. For this reason, an evaluation of how learners think is paramount in assessing knowledge acquisition. According to Buli-Holmberg, Schiering and Bogner (2008), many teachers simply assess 'how much' rather than 'how' the student has learnt. Thus, not many learners are aware of how they acquire and process new information. Furthermore, teachers are also unaware of their own thought processing and that of their students. It follows then that in an effort to get learners to understand, teachers tend to impose their own cognitive styles on learners. Such imposition results in a blockage in knowledge transfer which results in teaching of concepts repeatedly instead of moving to subsequent content. Delayed delivery of content has direct bearing on any future learning considering that when concepts in the syllabus are not adequately covered, some important building blocks are skipped. Learners then enter the next level of learning with a shortfall on requisite skills.

1.2 Purpose of the Study

The purpose of this study was to determine the effect of the interaction between teachers' cognitive styles with those of the learner on academic performance of the learner in selected National Secondary schools in Kenya.

1.3 Objectives of the Study

The study was guided by the following: To

[1] Describe the cognitive styles of students and teachers

[2] Determine levels of match in cognitive styles between students and teachers

[3] Determine whether level of student-teacher cognitive styles match influences academic performance of learners

1.4 Significance of the Study

Cognitive styles is a potent variable in students' academic performance. Awareness of this variable may assist in modifying thought and behavioural strategies of learners. Moderations can also be incorporated into teaching so that students are taught how to learn thereby reducing frustration for both the learner and the teacher.

1.5 Limitations and delimitations of the Study

Given the constraints of time and availability of funds, the researcher sampled six out of 60 schools that had been elevated to National Schools status in Kenya between 2011 and 2012. Since the study was limited to this category of schools, generalisation to any other school outside of this grouping should be done with caution.

1.6 Theoretical and Conceptual Framework

The Four Matrix System (4MAT) is a theory developed by McCarthy (1990) to help teachers organise their teaching based on differences in the way people learn. 4MAT is a four step cycle of instruction that capitalises on individual Learning Styles and brain dominance processing preferences. The theory was designed to raise awareness among teachers as to why some techniques work with some learners and not with others. Two major premises guide the 4MAT System: (i) people have major Learning Styles and hemispheric preferences, and (2) designing and using multiple instructional strategies in a systematic framework to reach to these preferences can improve teaching and learning. McCarthy forwards that learners all perceive and process information, however, they linger at different places along the way; this lingering forms the Learning Styles preferences. On one continuum is the preference to experience concretely or abstractly. On the second continuum is the preference to reflect by observation or through active experimentation. When these two continuums are cross-matched, they form quadrants that define learner preferences in perception and processing of information (see Figure 1).

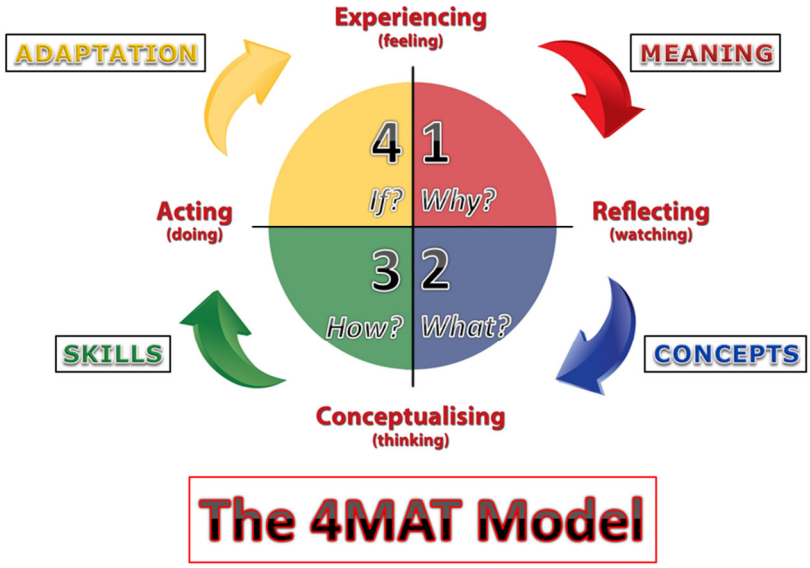

Figure 1: The Four Matrix System (McCarthy, 1990)

As detailed in Figure 1, McCarthy (1990) identifies four types of learners: Type 1 learners are innovative learners who are primarily interested in personal meaning. They need to have reasons for learning. This calls for cooperative learning, brainstorming, and integration of content areas. Type 2 learners are analytic learners primarily interested in acquiring facts in order to deepen their understanding of concepts and processes. They are capable of learning effectively from lectures, and enjoy independent research, analysis of data, and hearing what 'the experts' have to say. Type 3 are common sense learners primarily interested in how things work, they want to 'get in and try it', they prefer hands-on work and kinesthetic experiences. Type 4 are dynamic learners who are primarily interested in self-directed discovery. They rely heavily on their own intuition, and seek to teach both themselves and others, they enjoy simulations, role play and games.

According to McCarthy's theory, the Type 1, Type 3 and Type 4 learners are learners who predominantly engage the right hemisphere of the brain by seeking patterns and solving problems by looking at the whole picture. On the other hand the Type 2 learner mostly engages the left brain which controls logical and analytical operations. McCarthy posits that traditionally, instructional techniques used best address the needs of the Type 2 learner, with heavy reliance on linear sequential processing of information. The 4MAT curriculum thus advocates for teaching that contains 'something for everybody'. As such, each student not only finds the mode that is comfortable for them, but is also challenged to adapt to other less comfortable but equally valuable modes.

1.7 Conceptual framework

Based on The 4MAT System (McCarthy, 1990), the researcher proposed a conceptual framework (see Figure 2) that accounted for cognitive styles, performance and six extraneous variables. Figure 2 depicts that cognitive styles as a variable (operationalised as Perception and Processing by the learner) has an effect on performance (measured by considering scores obtained on Mock and KCSE Examinations) of the learner. It was considered that gender, age, location of school, school culture, and the length of contact time between the teacher and the individual learner were likely to influence the interaction between cognitive styles and performance.

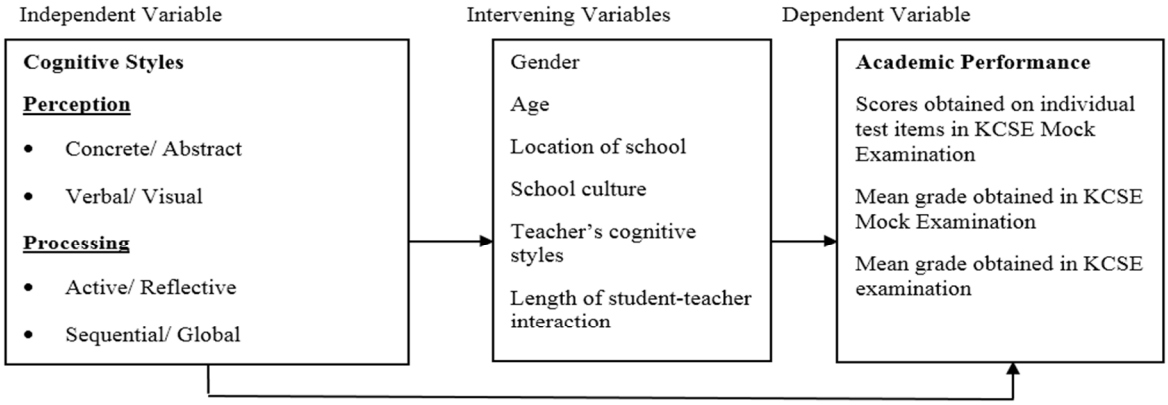

Figure 2. Conceptual Framework

2.0 Literature Review

Although there is consensus that cognitive styles have an effect on learner performance, the nature of this effect has resulted in contradictory reports. Differences in how well a student learns and performs in different teaching environments is more marked for students identified as belonging to certain cognitive style categories (Kai-Ming, 1997; Cano, 1999; Alamolhodaei, 2001; Grimley & Banner, 2008; Atkinson, 2010). Kai-Ming (1997) determined the role of cognitive styles as a moderator variable in students' performance across a variety of assessment methods. He found out that Field-Independent students tended to perform better than Field-Dependent students across three assessment types. This finding is further supported by Alamolhodaei (2001) whose results supported the hypothesis that students with divergent cognitive styles showed higher performance than convergent ones in pictorial problems. A similar conclusion on importance of cognitive styles was reached by Witkin (1973), Riding and Grimley (1999), Peklaj (2003), Gellel (2005), Atkinson (2010) and Ibrahim and Aljughaiman (2012). The researchers revealed significant differences in performance of various groupings of cognitive styles on academic tasks. Atkinson (2010) and Ibrahim and Aljughaiman (2012) found that there were significantly more wholists and verbalisers among the high performers, while analytics and imagers performed at lower levels. In fact, Atkinson's findings revealed that 100% of wholists achieved a score above the mean of the sample, while only 50% of analytics managed the same. The Atkinson (2010) study went further and captured the effect of interaction of cognitive styles as they related with performance. Significant interaction was found between two cognitive style categories and performance: Wholist verbalisers and analytic imagers; the mean for wholist verbalisers was almost double that of analytic imagers. Analytic imagers were found to have achieved poorest results and had benefited least from the learning experience provided.

When considering influence of cognitive styles on performance, other variables such as gender, age and culture must be considered. The gender differences model stipulates vast psychological differences between males and females; a hypothesis advanced by Maccoby and Jacklin (1974). In stark contrast to the gender differences model is the gender similarities hypothesis supported by Hyde (2005). It stipulates that men and women, boys and girls are alike on most, but not all, psychological variables. Findings by Maccoby and Jacklin (1974) and Benbow and Stanley (1980, 1983) in Galotti (1999) are however sharply contrasted in a subsequent study by Brandon, Jordan and Higa (1995) and Kenney-Benson, Pomerantz, Ryan and Patrick (2006) who found that girls had higher grades than boys in math and that girls' grades increased over time while boys' grades remained the same. Studies relating culture and cognitive styles (Clemmensen, Hertzum, Hornbæk, Shi & Yammiyavar, 2008; Allinson & Hayes, 2012; Imai & Saalbach, 2006) reveal that cognitive styles are also culturally aligned, however Helms-Lorenz and de Vijver (2015) added to this debate noting that differential performance across geographical regions is not a function of intelligence but is more linked to the cultural loading of tests.

Further a study by Zhang (2007) showed that the manner in which student–teacher styles match relates to student achievement varied as a function of academic discipline. In addition, Samms (2010) demonstrated that where the cognitive styles gap was small between the teacher and the learner, the learners did not explore resources effectively and they showed less effort.

3.0 Methodology

The study was a descriptive survey that aimed to profile students' and teachers' cognitive styles and to relate the profiles to the learners' academic performance. The variable 'cognitive styles' was operationalised as an embodiment of preferred ways of acquiring new knowledge (perception) and using it (processing). Cognitive style profiling resulted in categorisation of the learner and the teacher on four dimensions: active or reflective, visual or verbal, abstract or concrete, and sequential or global.

The dependent variable was performance which was measured by scores in Mock and KCSE Chemistry Examinations. The following intervening variables were taken into account: gender, age, location of the school, school culture, and length of student-teacher interaction. The study was carried out across Kenya in secondary schools that were elevated to National School status in 2011 and 2012. The population for the study comprised all Form Four students taking Chemistry in secondary schools, all teachers of Chemistry and all Academic Masters in 60 newly elevated National Schools in Kenya. Three counties were chosen as follows: Trans-Nzoia, Bungoma and Kwale. Two schools were selected from each county to make a total of six schools. One Form Four stream was randomly sampled for participation. A total sample of 342 participants (330 students, 6 chemistry teachers and 6 academic masters) was selected.

Three instruments were used in this study:

[1] A Cognitive Styles Inventory that comprised of 32 objective questions that queried preferences in perception and processing.

[2] An interview schedule for Academic Masters

[3] Marks Record Form - designed to record results from Mock tests and KCSE Examinations.

A pilot study was carried out on a 36 students in one school outside of the sampled counties. The reliability

indices were all above the 0.50 threshold; all instruments were also peer reviewed and were reviewed by experts. Study data was collected between 2013 and 2014. The researcher adhered to the principles of informed consent, voluntary participation, anonymity, confidentiality and honesty. Data was analysed both qualitatively and quantitatively.

4.0 Findings and Discussions

4.1 Profile of Respondents

All the six schools in the sample were single gender schools; 3 boys' schools and 3 for girls' schools. 52% of the student respondents were male while 48% were female. It was found that 95% of the students joined their respective schools in Form 1, only 5% joined either in Form 2, Form 3 or Form 4. The mean age of students in the six schools was 17.66 years. Mean age varied from 17.23 to 18.07 years in the various schools. It was determined that the school cultures in the sampled schools were positive and were designed to enhance performance. Furthermore, it was determined that the school cultures in the sampled schools were comparable given that specific variables (admission criteria, location of school, co-curricular activities, and test-taking training program) did not differ greatly among the schools. The variable was also controlled for by selecting only National Schools which reduced the infrastructural and programmatic differences among the schools.

4.2 Performance in Mock Chemistry Examinations

The Mock examinations are regional examinations done in the second term of the academic year in preparation for the national examinations to be done in the third term. Typically each County offers its own examinations to schools within it. As shown in Table 1, performance in Mock Chemistry Examinations for in the six schools averaged at a grade point of 4.79 (Grade C Minus), out of a possible maximum score of 12 points. The highest score was from School 1 with 7.21 points (Grade C Plus) while the lowest was School 6 with 3.50 points (Grade D Plus).

Table 1. Descriptives - mean performance in Mock Examination

School	n	Mean	Std. Dev	Min	Max
School 1	29	7.21	2.161	2	12
School 2	40	6.45	2.171	1	11
School 3	61	4.56	2.164	1	9
School 4	46	4.54	1.974	2	12
School 5	43	3.88	2.813	1	10
School 6	56	3.50	1.375	1	7
Total	275	4.79	2.433	1	12

A One-way ANOVA test was run to determine whether performance in Mock Chemistry among the six schools was significantly different, the results showed that the six schools differed significantly in performance $F = 18.455$ (5,269), $p < .05$. Post hoc analysis showed that School 1 was significantly different ($p < .05$) from all the sampled schools except School 2 ($p > .05$). School 2 was also significantly differently from all schools except School 1. Performance in School 6 differed significantly with that of all the schools except School 5.

4.3 Performance in Kenya Certificate of Secondary School Examination (KCSE) Chemistry Examinations

KCSE is the national examination done in the third term by all Form Four students across Kenya at the end of their four-year learning cycle. Performance in KCSE Chemistry Examinations among the sampled students was comparatively higher (grade C Plus of 7.41 points) than performance in Mock Chemistry (Grade C with 4.79 points). As seen in Table 2, the highest score was recorded from School 1 that posted an average grade of A Minus (10.34 points) and the lowest was from School 4 that with a grade D Plus (4.08 points).

Table 2. Descriptives - mean performance in KCSE Chemistry

Shool	n	Mean	Std. Dev	Min	Max
School 1	29	10.34	1.344	6	12
School 2	50	8.88	2.288	1	12
School 3	61	8.92	2.603	3	12
School 4	48	4.08	2.071	2	12
School 5	44	6.09	2.971	1	12
School 6	61	6.85	2.851	2	12
Total	293	7.41	3.180	1	12

A One-Way ANOVA test determined that performance was significantly different among the schools ($F = 35.244$, $n = 293$, $p < .05$). Post hoc analysis revealed that with a mean of 10.34, School 1 was significantly different from all the other five schools. In fact, difference in performance between schools was significant for

all schools except between School 2 and 3, and between School 5 and 6.

4.4 Cognitive Styles Profiles of Students and Teachers

Cognitive styles of students and each teachers were determined on four dimensions of cognitive styles: concrete-abstract perception, active-reflective perception, verbal-visual processing, and sequential-global processing.

4.4.1 Cognitive Styles of Students

On the concrete-abstract dimension, 85% of all the learners were found to be concrete learners while 15% were abstract learners. On the active-reflective dimension, it was determined that 74% of the learners were active learners while 36% were reflective. On the verbal-visual dimension, most students (74%) were visual learners, only 26% were found to be verbal learners. The sequential-global dimension revealed that students were predominantly sequential learners (82%), and only 18% were global learners (See Table 3).

Table 3. Cognitive styles of students

Cognitive Process	Dimension	Preference	Sch1	Sch2	Sch3	Sch4	Schl5	Sch6	Average
Perception	Concrete-Abstract	Concrete	79%	74%	93%	90%	85%	85%	85%
		Abstract	21%	26%	7%	10%	15%	15%	15%
	Active-Reflective	Active	33%	61%	83%	90%	70%	72%	74%
		Reflective	67%	39%	17%	10%	30%	28%	26%
Processing	Verbal-Visual	Verbal	38%	29%	22%	33%	25%	24%	26%
		Visual	63%	70%	78%	67%	75%	76%	74%
	Sequential Global	Sequential	83%	91%	93%	76%	75%	74%	82%
		Global	17%	9%	7%	24%	25%	26%	18%

4.4.2 Cognitive Styles of Teachers

Cognitive styles of the teachers was determined on the four cognitive style dimensions. On a scale of 0 to 8, cognitive styles of the teachers were determined as follows:

Table 4. Profile of cognitive styles of Chemistry teachers

Cognitive dimension	Sch 1	Sch 2	Sch 3	Sch 4	Sch 5	Sch 6
Concrete-Abstract	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete
Active-Reflective	Active	Active	Reflective	Active	Active	Active
Verbal-Visual	Visual	Verbal	Visual	Visual	Visual	Visual
Sequential Global	Sequential	Sequential	Global	Sequential	Sequential	Sequential

From Table 4, it was observed that:

[1] All 6 teachers were concrete, with an average score of 3 out of 8 on the concrete-abstract scale

[2] 5 teachers (83.3%) were active, with an average of 3

[3] 5 teachers (83.3%) were visual; with an average of 6

[4] 5 teachers (83.3%) were sequential, with an average of 3

4.5 Congruence in Student-Teacher Cognitive Styles

To determine impact of cognitive styles on performance it was necessary to narrow down the analysis to the teacher and the individual student. A 100% match meant that the student-teacher Styles matched on all four scales (e.g. teacher is concrete, active, verbal and sequential, and the student displays the same four characteristics), 75% meant they matched on three out of the four dimensions, a 50% match meant they matched on two dimensions, 25% meant they matched on only one dimension, and 0% match meant student-teacher Styles did not match at all on all the four dimensions. Results summarised in Table 5 showed that three schools (School 4, School 5 and School 6) registered very high numbers of students who had 100% match in cognitive styles with their teachers (51%, 42% and 39% respectively) in contrast to School 1, School 2 and School 3 that had 8%, 12% and 2% respectively.

Table 5. Percentage match in student-teacher cognitive styles

	0% Match	25% Match	50% Match	75% Match	100% Match	Total
School 1	0	13	29	50	8	100%
School 2	0	14	26	48	12	100%
School 3	0	23	63	12	2	100%
School 4	0	5	15	29	51	100%
School 5	0	5	13	40	42	100%
School 6	0	4	26	31	39	100%

4.6 Effect of Congruence in Cognitive Styles on Performance

a. Relationship Between Congruence and Performance in Mock Chemistry Examinations

The present study sought to determine whether the level of match in cognitive styles between the teacher and his/her learners related significantly with the learner's performance in Mock Chemistry Examinations. Table 6 shows the levels of congruence in each of the six schools, and the mean performance for the learners. The table also shows the F ratio and level of significance from ANOVA analysis.

It has been shown that the mean scores in Mock Examinations did not differ among the levels of congruence, all the *p* values are higher than .05 alpha level. The findings indicate that in all six schools, academic performance of the students did not relate significantly with student-teacher congruence in cognitive styles. These findings support findings of Spoon and Schell (1998) who also found that increased academic performance could not be attributed to student-teacher congruence in styles. However, the findings contrasts those of Cafferty (1980) who found that high student-teacher congruence resulted in higher grades.

Although difference in performance was found to be non-significant in the present study, results revealed an interesting trend of performance that depended on the type of match in cognitive styles. The level of student-teacher match in profile on concrete, reflective and global styles seemed to influence the direction of performance of the learner. When the teacher was profiled as being concrete, reflective and global, learners who were 100% congruent achieved the highest scores among the four levels of congruence (as seen in School 3). On the other hand, when the teacher was neither reflective nor global (as was the case in Schools 1, 2, 4 and 6), the learners who were 100% congruent left more questions unanswered and registered the lowest mean scores. School 5 presented a unique scenario in which the teacher was neither reflective nor global but had the 100% congruent students being among the high performers, their high performance was however attributed to the fact that even when the student was 100% congruent with the teacher, the two were significantly different when it came to the level of score on the cognitive style scales.

Table 6. One-Way ANOVA - Congruence and Performance in Mock Chemistry Examinations

School	Match	n	Mean	F	Sig
Sch 1	25%	3	7.33		
	50%	7	7.71		
	75%	12	7.58		
	100%	2	4.50		
	Total	24	7.33	1.871	.167
Sch 2	25%	5	6.80		
	50%	8	6.13		
	75%	18	6.83		
	100%	5	6.00		
	Total	36	6.56	0.318	.812
Sch 3	25%	14	4.79		
	50%	38	4.37		
	75%	7	5.43		
	100%	1	8.00		
	Total	60	4.62	1.496	.226
Sch 4	25%	1	4.00		
	50%	6	5.83		
	75%	12	4.42		
	100%	20	4.00		
	Total	39	4.41	1.455	.244
Sch 5	25%	2	3.00		
	50%	5	3.40		
	75%	15	4.60		
	100%	17	3.59		
	Total	39	3.92	0.448	.721
Sch 6	25%	2	4.00		
	50%	11	3.45		
	75%	15	3.67		
	100%	18	2.94		
	Total	46	3.35	1.246	.305

b. Relationship between Congruence and Performance in KCSE Chemistry

The researcher also set out to determine how the level of congruence in cognitive styles of the teacher and the

learner related with learner's performance in the Kenya Certificate of Secondary School Examination (KCSE). Results from all the six (6) schools shown in Table 7 revealed that, just as was seen in Mock examinations, learner performance did not differ significantly among the levels of congruence since all *p* values are above the .05 alpha level. It has also been shown that the trend of performance observed in the Mock Examinations was evident in the KCSE Examinations among the individual schools; When the teacher was profiled as being concrete, reflective and global, learners who were 100% congruent achieved the highest scores among the four levels of congruence (as seen in School 3). On the other hand, when the teacher was neither reflective nor global (as was the case in Schools 1, 2, 4 and 6), the learners who were 100% congruent registered much lower mean scores. The similarity in trends confirms the finding that it is not adequate to focus only on the level of student-teacher match in profile, the profile on which the teacher and learner are congruent on is also important. In this study, possession of the concrete, reflective and global styles seemed to positively influence performance of the learner.

Table 7: Congruence and difference in performance in KCSE Chemistry Examinations

School	Match	n	Mean	F	Sig
Sch 1	25%	3	10.87		
	50%	7	10.86		
	75%	12	10.42		
	100%	2	9.00		
	Total	4	10.46	1.495	.147
Sch 2	25%	6	8.00		
	50%	12	8.67		
	75%	22	9.50		
	100%	5	8.80		
	Total	45	9.00	0.672	.574
Sch 3	25%	14	9.07		
	50%	38	8.74		
	75%	7	10.00		
	100%	1	12.00		
	Total	60	9.02	0.990	.404
Sch 4	25%	2	4.00		
	50%	6	4.67		
	75%	12	3.92		
	100%	21	3.62		
	Total	41	3.88	0.402	.752
Sch 5	25%	2	5.00		
	50%	5	5.80		
	75%	16	6.63		
	100%	17	5.88		
	Total	40	6.13	0.076	.842
Sch 6	25%	2	7.50		
	50%	13	6.23		
	75%	17	7.18		
	100%	21	6.62		
	Total	53	6.74	0.354	.786

c. Relationship between Congruence and Mock to KCSE improvement

This study further sought to determine whether the level of student-teacher cognitive styles congruence related with the margin of improvement in performance between Mock and KCSE. Margin of improvement in performance was calculated for each learner by subtracting their grade score in Mock Chemistry Examinations from their grade score in KCSE Chemistry Examinations. The difference was then related to level of congruence in cognitive styles. The findings on margin of improvement summarised in Table 8 showed that among the six schools, School 3 had the highest improvement (+4.40 grade points). School 4 on the other hand, registered a negative improvement (-.59 grade points) since performance in Mock Chemistry Examination was higher than performance in the KCSE Examination.

Table 8. Congruence and Mock to KCSE improvement in Chemistry Examinations

School	Match	n	Mean improvement in grade	F	Sig
Sch 1	25%	3	3.33		
	50%	7	3.14		
	75%	12	2.83		
	100%	2	4.50		
	Total	24	3.13	0.922	.448
Sch 2	25%	5	2.60		
	50%	8	2.75		
	75%	17	2.65		
	100%	5	2.80		
	Total	35	2.69	0.030	.993
Sch 3	25%	14	4.29		
	50%	38	4.42		
	75%	7	4.57		
	100%	1	4.00		
	Total	60	4.40	0.112	.952
Sch 4	25%	1	-1.00		
	50%	6	-1.17		
	75%	12	-.500		
	100%	20	-.450		
	Total	39	-.590	0.609	.613
Sch 5	25%	2	2.00		
	50%	5	2.40		
	75%	15	2.40		
	100%	17	2.29		
	Total	39	2.33	0.054	.983
Sch 6	25%	2	3.50		
	50%	11	3.21		
	75%	15	3.40		
	100%	18	3.56		
	Total	46	3.43	0.047	.986

Further, results also showed that although differences in margins of improvement among the levels of congruence within every school were evident, these differences were all found to be non-significant, all *p* values are above the .05 alpha level. Nevertheless, several observations made from the trends of performance are further discussed. As has been shown in a previous findings of this study, the School 3 teacher was profiled as being concrete/reflective/visual/global. It was also deduced in this study that this profile is likely to be advantageous to the learner's performance in Chemistry. Analysis of margins of improvement in School 3 showed that those with higher levels of congruence with the teacher (75% and 100%) had the highest improvement; the 75% congruent learners were also the category who had the highest improvement when compared with all other categories among the six (6) schools. The conclusion earlier reached in this study that, high performance in School 3 and was attributable to possession of reflective and deductive skills is upheld. The finding is now supported by the fact that learners who were 75% congruent had highest improvement in performance.

A separate observation also indicated that, although the 100% congruent learners were predominantly the low scorers in the Mock Examinations in their respective schools, they happened to be the learners with the highest margins of improvement (4.50 in School 1, 2.80 in School 2, -.45 in School 4, 2.5 in School 5 and 3.56 in School 6). This finding indicates that, irrespective of the type of profile on which the student matches the teacher, high congruence presents an advantage for the student in KCSE Examinations. This is likely due to the fact that, where there is high congruence, the packaging of the content being delivered resonates well with the learner's cognitive preferences. Performance of the highly congruent learner may be enhanced by the way in which the teacher and the learner view each other. As shown by Distefano (1969) in Witkin (1973), teachers and students who matched in cognitive styles described each other in highly positive terms whereas teachers and students who were mismatched showed a strong tendency to describe each other negatively. A positive perception from those who were 100% congruent may, therefore, have enhanced performance due to positive attitude between the teacher and the learner.

Ultimately, this study is concluded with the following facts:

1. The cognitive styles of about 89% of students matched those of their teachers to a level of 50% and above;

about 25% of students had a 100% match in cognitive styles with their respective teachers, 32% had a 75% match, 31% had a 50% match, 11% had a 25% match, and less than 1% had a 0% match.

2. Performance in Mock and KCSE Chemistry Examinations did not differ significantly among the four levels of congruence in all six schools
3. Learner performance is dependent on the type of profile that the student and teacher are congruent on, and is typically in favour of students and teachers who are reflective and global.
4. Irrespective of the type of profile on which the student matches the teacher, high congruence tends to present an advantage for the student in KCSE Examinations.

Findings of this study support the Four Matrix (4MAT) theory by McCarthy (1990) that cognitive preferences do exist, they can be delineated and that they do have instructional impact on both the learner and the teacher. The findings also supports those of Cafferty (1980) Kai-Ming (1997), Cano (1999), Alamolhodaei (2001), Grimley and Banner (2008), and Atkinson (2010) who underscore the importance of cognitive styles in learner performance. The relationship between cognitive styles and performance as has been established in this study can be used to objectively pinpoint systematic pedagogical weaknesses which are likely to undermine performance for certain categories of learners. In the Kenyan evaluation system, most institutions use both formative and summative evaluation techniques. Theoretically, formative evaluation is meant to help learners to diagnose their weaknesses and correct them in preparation for the summative evaluation. However, more often than not the formative score is taken as a cumulative assessment score and is then totaled up with the summative score. In essence then, the learner is not given a fair chance to be assessed formatively. Rather than wait for the learner to fail an examination then intervene, findings of this study are an attestation of the fact that diagnosis of cognitive styles can be done as a true formative assessment. This can be done early as the learner joins the school. Going forward the teacher and the individual learner can work together to ensure that the learner does not get too comfortable or even worse languish in their cognitive comfort zones. The learner can then be challenged early in their learning cycle to adapt new and/various learning strategies for the various learning tasks presented to them.

5.0 Recommendations

The following are the study recommendations:

1. Early in the learners' educational cycle, teachers should (i) determine their own cognitive styles and (ii) get to know their learners' cognitive styles to enrich the teaching-learning process
2. Depending on the content matter being taught, teachers and learners both need to shift from their cognitive comfort zones so that they can consciously explore and adopt a variety of learning strategies.
3. Teacher training institutions should include the concept of cognitive styles in the teacher training curriculum.
4. Being that this study only sampled Chemistry as a subject, it is suggested that in further research, educational psychologists should explore the effect of congruence in cognitive styles on performance of the learner in a range of subjects.

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