Influence of Coaching Classes and Cognitive Style on Students' Academic Achievement in Mole Concept in Chemistry in The Ibadan Metropolis

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Abstract

The study examined the influence of coaching classes and cognitive style on the students' achievement in Mole concept. Anchored to Fine et al's GROW model, this descriptive survey involved two hundred senior secondary school students from nine randomly chosen schools in the Ibadan North Local Government of Oyo state, and quantitative data were collected using three adequately validated instruments (Mole Concept Achievement Test (MCAT), Attendance of Coaching Classes Survey (ACCS, r = 0.76) and Cognitive Style Checklist (CSC, r = 0.75). Multiple regression and Descriptive statistics were used for the analysis. The findings are that 78.5% of the students reflected the Field dependent cognitive style while 21.5% appeared to be Field independent. Also, most students who attended coaching classes had low performance in the mole concept. 66.7% of students who did not participate in coaching classes had low performance while 33.3% had high performance. Furthermore, there was no significant composite influence of students' attendance of coaching classes and cognitive styles on achievement in the mole concept. There was a weak and negative correlation (r = 0.11; p>0.05) between students' achievement and their coaching lessons. The same was the case for cognitive style. It was concluded that students' attendance of coaching classes and cognitive styles do not necessarily determine students' achievement in the mole concept. However, for better outcomes, we recommended that students should have access to high-quality coaching classes that align with the curriculum.

Keywords: Coaching class, cognitive style, achievement in chemistry, mole concept.

ntroduction

Chemistry plays a crucial role in science students' intellectual development and remains a strong professional path (Helmenstine, 2020). It focuses on the properties and structure of matter, particularly molecules, and atoms, which are fundamental in chemical reactions. Learning the mole concept in chemistry is essential for understanding mass-mole calculations, as it links the mass of substances with the number of particles and gas volumes involved in reactions (Chang, 2008; Petrucci et al., 2017) and mastering the mole is crucial for students, especially in stoichiometry. Also, a solid grasp of this concept is vital for various experiments, including buffer preparation, cell culture, and biochemical tests (Arya & Kumar, 2018). However, students often find the mole concept challenging, and was ranked the tenth most

difficult chemistry topic (Shehu, 2015; Olugbuyi et al. 2023). Speculations about the students' problems with the mole concept point towards insufficient focus on the content, and lack of access to textbooks, laboratory equipment, chemicals, and lab models (Sang et al., 2014; Malcolm, Rollnick, and Mavhunga, 2014; Ndifon et al., 2019).

To improve performance, it is common for students to seek tutoring, which is expected to enhance exam preparation (Gyuse et al., 2013). Houchens et al. (2017) and Howlett et al. (2021) found that coaching helped students develop metacognitive skills, improving goal setting, self-reflection, and learning outcomes. Rodríguez Fuentes et al. (2023) conducted a study on the impact of a hybrid coaching program on university students' academic performance, using a quasi-experimental design. Results showed that the experimental group, which received coaching, demonstrated significant improvement in practical tasks compared to the control group. This highlights coaching's ability to enhance learning strategies, teamwork, and motivation. Similarly, Alzen et al. (2021) found that academically at-risk students who participated in coaching sessions improved their GPAs and retention rates, with more coaching sessions linked to better academic outcomes. Capstick et al. (2019) further supports these findings, showing that students with lower GPAs experienced a half-point increase after receiving academic coaching, emphasizing its role in both immediate and long-term academic success.

For learners to achieve meaningful learning, factors such as gender, motivation level, background, personality, and cognitive style play an important role. Cognitive style which refers to individual differences in perception, thought processes, and memory is a part of the broader concept of learning styles, which encompass cognitive, emotional, and psychomotor behaviors during learning (Idika, 2017). According to the American Psychological Association (2023), cognitive styles are personal modes of thought and problem-solving, with preferences like group work versus independent tasks or visual versus verbal processing. Teachers can create learning strategies that better fit each student's requirements and preferences by having a deeper understanding of the cognitive types of their students (Susanti et al., 2020).

Cognitive styles like verbalize/visualize, field dependence/independence, impulsivity/reflectivity, and serialist/holist have been extensively researched, with field dependence/independence being the most studied (Idika, 2017). Field-dependent learners rely on external structures and intuition, while field-independent learners are

more analytical (Vandana,2017).

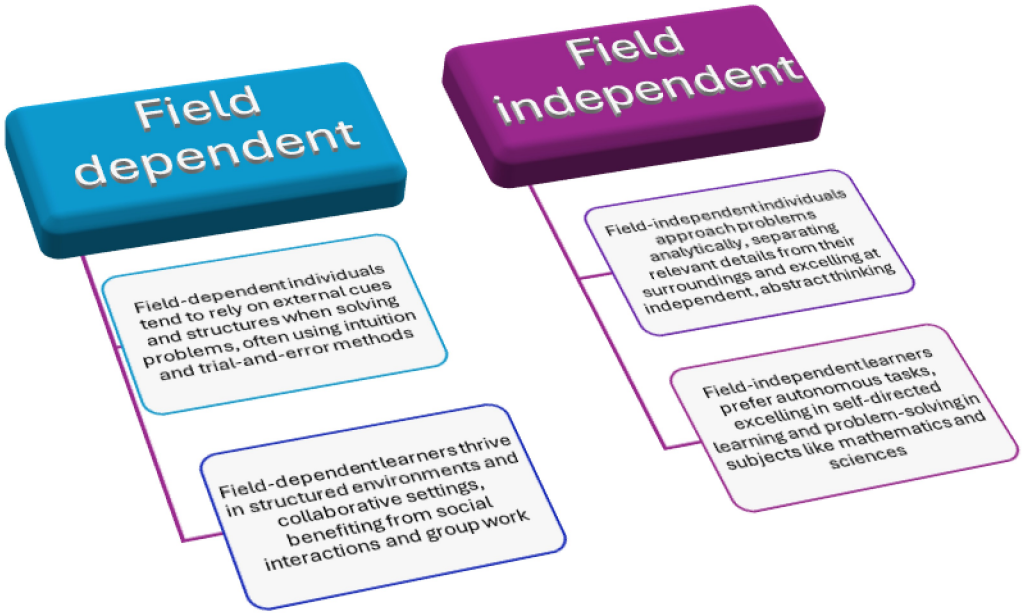


Fig.1 Differences between Field-dependent and Field-independent Cognitive Style

Teachers should consider these styles to enhance learning outcomes (Kitayama et al., 2019). Nafar et al. (2019) found a positive correlation between cognitive styles and academic achievement, with no significant gender differences. Similarly, Kumar et al. (2017) examined cognitive styles in school principals, revealing varied cognitive profiles, including split and systematic styles. These studies emphasize the importance of understanding cognitive styles for improved educational outcomes.

Sharma et al. (2018) examined the relationship between cognitive styles and academic achievement among secondary school students, focusing on field-independent and field-dependent styles. Using Witkin's Group Embedded Figure Test (GEFT) on 64 ninth-grade students found a positive correlation between cognitive styles and academic performance. Field-dependent students excelled in social information retention and subjects like languages and history (Aggarwal et al., 2019) but struggled with problem-solving in exact sciences. Conversely, field-independent students performed better in problem-solving and subjects like mathematics and sciences (Chuang et al., 2021).

THE G.R.O.W MODEL

The G.R.O.W model, developed in the 1980s by Alan Fine, Graham Alexander, and Sir John Whitmore, is a widely used coaching framework. It stands for Goal, Reality, Options, and Will, focusing on solving problems through a structured, solution-driven

approach. The first step is setting clear, SMART (Specific, Measurable, Achievable, Realistic, and Timely) goals, crucial for directing the coaching process. Next, the reality stage helps the coachee assess their current situation and identify challenges (Weinstein, 2013). The third stage explores multiple options, fostering creativity and decision-making. Finally, the coachee chooses one option, creating an action plan to achieve their objectives (Lesley et al., 2015). This model allows coachees to take ownership of their solutions, with the coach facilitating the process by asking the right questions (Grant et al., 2009).

G. R.O.W Model and Coaching classes

The G.R.O.W model encourages collaboration between coaches and students to enhance ownership and awareness at every level. The process starts with setting a SMART goal (Specific, Measurable, Achievable, Realistic, and Time-bound) that motivates success. Next, the coach and student assess the current situation, identify obstacles, and recognize strengths. Together, they explore various options for moving forward. Once possibilities are presented, they agree on actions, timelines, and responsibilities, ensuring commitment to the next steps. The coach's role is to guide, not solve problems, helping the student choose the best solutions. Though simple, the model is powerful if the goal inspires, considers the present, and ensures full commitment.

Generally, there is not much in the literature on the impact of attendance of coaching classes or in combination with cognitive styles, on chemistry students' academic achievement in chemistry (mole concept). Hence, this study was carried out.

Research Questions

1. What is the level of performance of:

a. Students who attend coaching classes?

b. Students who do not attend coaching classes?

2. What are the cognitive styles of senior secondary school chemistry students?

3. What is the relationship between students' attendance of coaching classes, cognitive styles, and their achievement in mole concept?

4. What is the composite influence of students' attendance of coaching classes and cognitive style on their achievement in mole concept?

METHODOLOGY

The correlational type of descriptive design was used in the research. Participants in this research included two hundred (200) SS 2 chemistry students from four (4)

randomly selected schools from two local government areas within the Ibadan metropolis, Oyo state. The researcher adapted and validated the research instruments, Attendance of Coaching Classes Survey (ACCS) (r = 0.76), Cognitive Style Checklist (CSC) (r = 0.754), and Mole Concept Achievement Test (MCAT) (r = 0.69).

Validation of Mole Concept Achievement Test (MCAT)

The MCAT was validated through a multi-step process including item generation and scrutiny for correctness, appropriateness, and difficulty. The final test comprised 20 multiple-choice, one-correct-answer questions. A trial run was conducted with a subset of students not involved in the main study to evaluate the test's reliability. A Kr-20 value of 0.69 was obtained, indicating moderate reliability.

Validation of Attendance to Coaching Classes Survey (ACCS)

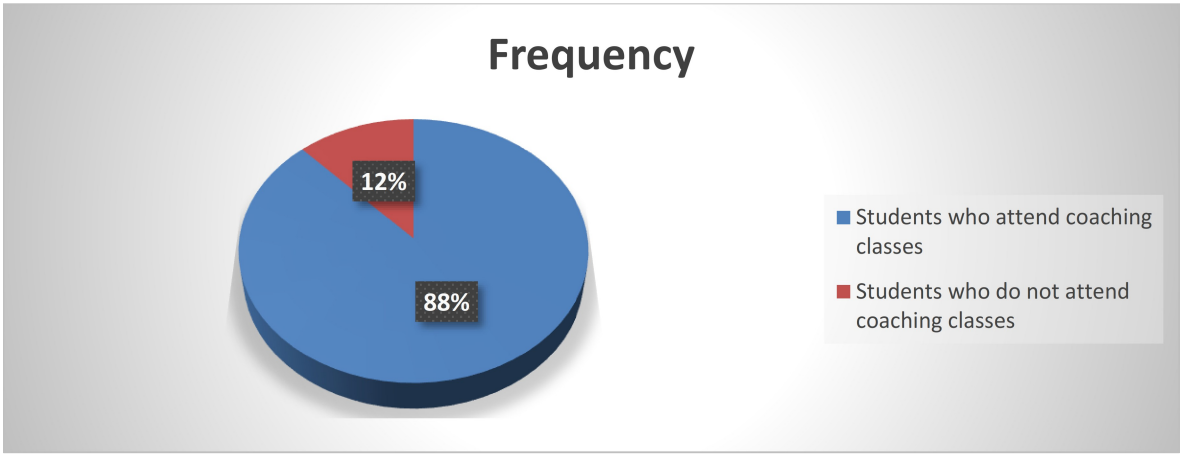
The researcher adapted the questionnaire used by Des Moines Public Schools, to identify factors influencing low attendance, focusing on classroom learning, student-teacher relationships, and emotional support. The questions were organized using a Likert scale of Strongly Agree, Agree, Disagree, and Strongly Disagree. This adapted version was trial-tested with an independent group of students, and a reliability analysis yielded a Cronbach alpha value of 0.76, indicating strong consistency.

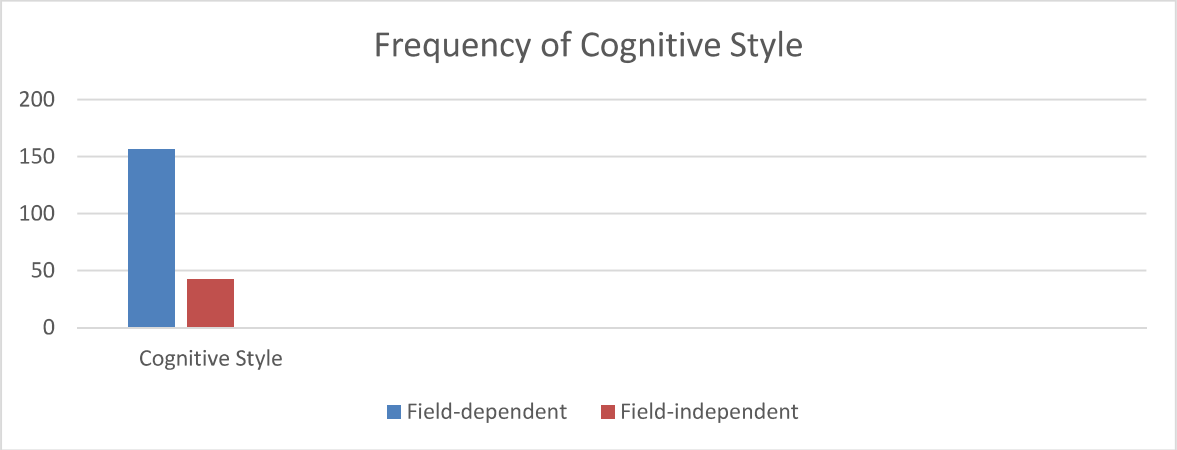
Validation of Cognitive Style Checklist

The Cognitive Style Checklist, developed by Robert Wyss (2002), was modified and pilot-tested before being used in the main study. It consists of 10 items, each with two sub-statements. The checklist yielded a reliability coefficient of 0.754, indicating strong consistency. The instrument was used to categorize students as Field-dependent or Field-independent. Multiple regression and Descriptive statistics were used to analyze quantitative data.

RESULTS

Descriptives





Research question 1a: What is the level of performance of students who attend coaching classes?

Table 1a: Performance of students that attend coaching classes.

Level	Range	Frequency	Percentage
Low	0-10	161	91.5
High	11-20	15	8.5
Total	20	176	100.0
Mean = 6.76			

Table 1a indicated that 91.5% of the students' performance in mole concept who attended coaching classes was low, while the remaining 8.5% was high. Table 1a also revealed the mean performance score in chemistry of 6.76, implying that the achievement in chemistry of students who attend coaching classes is low.

Research question 1b: What is the level of performance of students who do not attend coaching classes?

Table 1b: Performance of students who do not attend coaching classes

Level	Range	Frequency	Percentage
Low	3-10	16	66.7
High	11-20	8	33.3
Total	20	24	100.0
Mean = 8.17			

Table 1b indicates that 66.7% of students who did not attend coaching classes performed poorly in chemistry, while the remaining 33.3% performed well. The mean performance score in chemistry is 8.17, indicating that the achievement of students in chemistry who did not attend coaching classes is low.

Research question 2: What are the cognitive styles of senior secondary school chemistry students?

Table 2: Cognitive style of senior secondary school chemistry students

Cognitive style	Frequency	Percentage
Field dependent	157	78.5
Field independent	43	21.5
Total	200	100.0

Table 2 indicates that 78.5% of the respondents belong to the field-dependent cognitive style, while the remaining 21.5% belong to the field-independent cognitive style. This result implies that the majority of the respondents belong to the field-dependent cognitive style category.

Research question 3: What is the relationship between students' attendance of coaching classes, cognitive styles, and their achievement in mole concept?

Table 3: Correlation matrix illustrating the connection between independent variables and students' mole concept achievement.

Variables	Achievement	Coaching classes	Cognitive styles
Achievement	1		
Coaching classes	0.110	1	
	0.148		
Cognitive styles	-0.061	0.138	1
	0.423	0.068	
Mean	6.77	34.00	16.98
STD.D	2.90	2.08	0.99

Table 3 demonstrated a weak, negative correlation ($r = 0.11$; $p>0.05$) between students' performance in chemistry and coaching classes. There was a small, negative correlation ($r = -0.06$; $p>0.05$) between students' performance in chemistry and their cognitive style.

This suggests that attendance of coaching classes and cognitive styles of students are not related to their achievement in chemistry.

Research question 4: What is the composite influence of students' attendance of coaching classes and cognitive styles on achievement in chemistry?

Table 4: The composite contribution of the independent variables to the chemistry achievement of the students is displayed using multiple regression analysis.

Sources of Variance	Sum of Squares	Df	Mean Square	F	Significant
Regression	32.451	3	10.817	1.291	0.279
Residual	1440.997	172	8.378		
Total	1473.449	175			
R = 0.148 R Square = 0.022 Adjusted R Square = 0.005 Std. Error of the Estimate = 2.89446					

Table 4 demonstrates the combined effect of students' attendance at coaching classes and cognitive styles on their achievement in chemistry was not significant. ($F_{(3,172)} = 1.29$; $p>0.05$). This indicates that when students' attendance to coaching classes and

cognitive styles were taken together, did not jointly influence students' achievement in chemistry.

Discussion of Results

The study reveals that most students attend coaching classes and performed poorly on the mole concept, with only 8.5% achieving high scores. This suggests ineffective coaching methods or inadequacy in practice, indicating a need for significant restructuring to improve outcomes. Although Adeyemi (2016) and Hussein (2018) emphasize that coaching quality, including teachers' subject knowledge, is vital for student success, this finding agrees with Lavi and Golan (2017) who argue that rote learning in coaching does not foster deep understanding in complex subjects like chemistry. Thus, the findings highlight the necessity to re-evaluate and improve coaching methods to enhance students' comprehension and performance in chemistry. Effective coaching methods should move beyond traditional rote learning and embrace interactive, student-centered approaches that foster critical thinking and problem-solving skills. This includes personalized coaching tailored to individual learning needs, frequent formative assessments to track progress, and targeted feedback to address misconceptions.

The performance of students who did not attend coaching classes also highlighted poor outcomes, though a notable 33.3% performed relatively well. This suggests that while many students struggle without extra support, a minority succeed through independent learning. Research by Van der Zee et al. (2018) supports this finding, showing that some students excel in self-directed learning environments, leveraging their cognitive strengths. The study's results underline the importance of supplementary resources, such as study groups and tutoring, to cater to diverse student learning needs. Study groups encourage collaborative learning, allowing students to discuss complex concepts, clarify misunderstandings, and reinforce their knowledge through peer interactions. By incorporating these strategies, educators can ensure that students receive well-rounded support, ultimately improving their performance in chemistry.

It was also found that most of the student were field-dependent. This distribution suggests that most students are inclined towards structured learning environments, and align with guided instruction. These findings are consistent with that of Garcia and Pintrich (2016). However, field-independent learners, who excel in autonomous and analytical thinking, can thrive in less structured environments. Given these cognitive

differences, we agree with Kirschenbaum et al. (2020) and hold the position that instructional strategies should accommodate both classes of learners by integrating structured group activities and independent problem-solving tasks. This approach would ensure that chemistry education meets the diverse cognitive needs of students, ultimately improving learning outcomes.

The weak correlation between students' coaching attendance, cognitive styles, and achievement in the mole concept underscores the limited impact these variables have on students' performance. This finding aligns with studies by Johnson and Pugh (2017), who argue that factors such as teaching quality, student motivation, and the learning environment play more significant roles in academic success. Additionally, the negligible influence of coaching and cognitive styles on chemistry achievement, as revealed by the regression analysis, suggests that other factors, such as curriculum design or teaching methodologies, may play a more dominant role in student success. Overall, this research highlights the need to rethink coaching strategies and instructional methods to meet the diverse cognitive styles of students and enhance their achievement in chemistry. Traditional one-size-fits-all teaching approaches often fail to accommodate the varied ways in which students process and retain information. By integrating differentiated instruction, educators can tailor their teaching methods to support visual, auditory, read/write, and kinesthetic learners, ensuring that every student engages with the subject matter in a way that resonates with them.

CONCLUSION

Cognitive styles and attendance in coaching classes had no significant impact on students' achievement in the mole concept.

RECOMMENDATIONS

The study's findings led to the suggestion of the following recommendations:

1. Students should have access to top-quality coaching sessions that are closely aligned with the curriculum.
2. It is critical to make resources accessible that can support students learning such as online tutorials, study groups, and academic support centers.
3. Students can improve their academic performance and achieve their goals by understanding their cognitive style of learning.

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