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E-B Environment - Behaviour Proceedings Journal

AicQoL2024KotaKinabalu

https://www.amerabra.org

e-IPH e-International Publishing House Ltd., United Kingdom

12th AMER International Conference on Quality of Life
The Magellan Sutera Resort, Kota Kinabalu, Malaysia, 26-28 Jan 2024

Exploring Chemistry Educators' Insight into Cognitive Styles and Related Teaching Strategies

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Abstract
This study, using quantitative research, surveyed 120 middle school chemistry teachers in Zunyi City, Guizhou Province, China, assessing their awareness of cognitive styles and related teaching strategies. Results revealed a low level of overall knowledge(M=2.31), and moderate familiarity with cognitive styles (M=2.34) among the Chemistry teacher. Improvement is needed in teaching strategies based on cognitive styles (M=2.30), learning characteristics of students with varied cognitive styles (M=2.25), and emphasizing cognitive styles (M=2.31). The study recommendations include enhancing teachers' understanding of cognitive styles and teaching strategies, aiming to improve the quality of student learning and life.

Keywords: Cognitive styles; Chemistry education; Teaching strategies; Teacher knowledge

DOI: https://doi.org/10.21834/e-bpj.v9i27.5724

1.0 Introduction

Quality education is explicitly stated as an aspiration in China's education policy; it aims to cultivate students' all-round development, improving their ability to innovate, practice what they have learned, work in a team, and respect others; in short, to enhance their own life, enrich the life of those around them, and prepare to contribute to the society (Deng, 2021). The subject of chemistry focuses on the use of natural and artificial resources in a sustainable manner, using knowledge of chemistry and skills to solve problems in everyday life as well as improve human well-being (Cui, 2019). In producing chemistry students who learn well and can apply knowledge, teachers need to teach effectively. Taking cognizance of students' cognitive styles in teaching has been proven to be an important tool in enhancing the quality of chemistry teaching (Boulmetis & Dutwin, 2019). Many chemistry teachers in China tend to prioritize teaching knowledge and preparing students for examinations rather than focusing on their understanding of chemistry concepts and taking notice of students' cognitive styles. Therefore, it is crucial to understand the current level of awareness of cognitive styles and teaching strategies among chemistry teachers and to emphasize the importance of incorporating cognitive style-based teaching strategies to make learning more meaningful and effective.

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DOI: https://doi.org/10.21834/e-bpj.v9i27.5724

1.1 Problem of Study

Teachers often overlook the differences in students' cognitive styles when implementing teaching strategies (Zhao, 2019). In a study of junior high school chemistry teachers in China, Cui (2019) discovered that most middle school teachers had not considered students' cognitive styles adequately, and some were unaware of it. Churngchow et al. (2020) found that some students struggled to adapt to their teachers' teaching strategies, which were not aligned with their cognitive styles. When the strategies used do not match the cognitive styles of the students, it becomes difficult for them to understand the lessons taught. Therefore, teachers must not only consider factors such as the type of knowledge, level of difficulty, students' personality, and existing knowledge level but also focus on students' cognitive styles (Wei, 2019). At the same time, there is a lack of research on the teaching of Chemistry in China (An, 2017). Most recent papers on cognitive styles have focused on their relationship with foreign language learning (Wang, 2020). However, there is limited research on the connection between cognitive styles and secondary school chemistry teaching, and even fewer studies on chemistry teaching strategies for different cognitive styles (Shan, 2020).

1.2 Objectives of Study

This study first drew on existing research to explain the importance of teaching based on cognitive style in facilitating chemistry learning and improving the quality of student learning life. This paper presents a quantitative study that examined the knowledge of Chinese middle school chemistry teachers on cognitive styles and related teaching strategies. It also investigated their familiarity with the characteristics of students with different cognitive styles and their emphasis on cognitive styles. The paper concludes by analyzing the findings and proposing directions for future research.

The research objectives are as follows:

RO1: To investigate Chinese middle school chemistry teachers' knowledge of cognitive styles.
RO2: To investigate Chinese middle school chemistry teachers' knowledge of the characteristics of students with different cognitive styles.
RO3: To assess Chinese middle school chemistry teachers' knowledge of cognitive style teaching strategies.
RO4: To assess the extent to which Chinese middle school chemistry teachers emphasize cognitive styles.

2.0 Literature Review

The study utilized the Differential Teaching Theory to elucidate the significance of teaching strategies that are tailored to cognitive styles. Specifically, it focuses on the teaching strategies of chemistry teachers concerning field-dependent and field-independent cognitive styles.

2.1 Differential Teaching Theory

Differential Teaching Theory originated from the Analects of Confucius (400 B.C.), which refers to the teaching theory to improve the quality of teaching and learning, attention is paid to the individual differences of students in the classroom to meet the individual learning needs, and to promote the full development of each student (Wu, 2021). Differential Teaching Theory comprehensively recognizes that students differ and that cognitive style is a dimension of these differences (Zhang et al., 2021).

2.2 Cognitive style

Cognitive style is a crucial individual difference that refers to an individual's personalized and stable cognitive processing preference in organizing and processing information (Setiawan et al., 2020). It serves as a bridge between cognition and personality (Guynn, C. L., 2019). Information processing involves two cognitive styles: field dependence and field independence (Witkin et al., 1977). Field-dependent (FD) cognitive style relies on information provided by the external world, i.e., a situational or environment, and their perceptions are based on this overall field or overall environment (Chasanah & Usodo, 2020). Field-independent (FI) cognitive styles tend to rely on information provided by internal referents (subjective feelings) and are not easily influenced by external factors to make independent judgments (Alalouch, 2021).

2.3 FI & FD Teaching Strategy

Teaching strategies based on cognitive styles refer to the use of appropriate teaching methods and strategies to promote students' learning and understanding (Yang, 2020). Field-dependent (FD) cognitive styles are appropriate for teaching strategies that are more interactive and story-based, and teachers should provide clear instructions when teaching (Aguilera et al., 2020). The field-independent (FI) cognitive style is suitable for teaching strategies that are logical and holistic.

3.0 Methodology

This study employed a quantitative research method to investigate the extent of Chinese middle school chemistry teachers' knowledge of cognitive styles and related teaching strategies.

3.1 Sample

In this study, a random sampling method was used to survey 120 middle school chemistry teachers from 30 middle schools in Zunyi City, Guizhou Province, China. The number of chemistry teachers in Zunyi City is 164, and according to Morgan's table, the sample size should be 113, and the final sample size of this study is 120.

3.2 Instruments

The instrument for this study was adapted from Sellah et al. (2017); it is a five-point Likert scale questionnaire with four dimensions. The first part is the level of chemistry teachers' knowledge about cognitive styles. The second part is the level of knowledge of chemistry teachers about the characteristics of students with different cognitive styles. The third part is the level of chemistry teachers' knowledge about cognitive style teaching strategies. The last part is the level of chemistry teachers' emphasis on cognitive styles. The reliability of the instrument is shown in Table 1.

Table 1: Reliability test results (N=40)

Dimensions	Items	Cronbach's Alpha	
Knowledge of cognitive styles (KCS)	5	0.848	0.912
Knowledge of the characteristics of students with different cognitive styles (KCSDCS)	6	0.877	
Knowledge of cognitive style teaching strategies (KCSTS)	7	0.775	
Emphasis on cognitive styles (ECS)	6	0.810	

(Source: Author)

3.3 Data Collection

The survey was conducted online, using Questionnaire Star (Wang, J. C., 2020). A total of 140 questionnaires were distributed, and 120 were returned, giving a return rate of 85.7%. Each questionnaire received was scrutinized by the researcher, and the 120 were considered suitable for subsequent data analysis.

3.4 Data Analysis

According to Alalouch (2021), descriptive statistics can judge the level of a variable based on its mean value. The data collected from the questionnaire was using SPSS 25 to analyze the level of knowledge of middle school chemistry teachers about cognitive styles and related teaching strategies, the level of familiarity with the characteristics of students with different cognitive styles, and the level of emphasis on cognitive styles using descriptive statistical data.

4.0 Findings

In this section, the findings of the data analysis are explained according to the four research objectives. Rothman (2000) suggested that the means of the variables could be classified as high, medium, or low according to the 5-point Likert scale (Table 2). This study measures levels according to this criterion.

Table 2: Levels indicated by different ranges of mean values

Mean Value	1.00 – 2.33	2.34 – 3.67	3.68 – 5.00
Level	low	moderate	high

(Source: Rothman, 2000)

4.1 General awareness of cognitive styles and related teaching strategies

The mean value of teachers' overall knowledge of cognitive styles and related teaching strategies (from all the dimensions in the instruments) in the sample schools in Zunyi City, Guizhou Province, China, was 2.31, indicating that their knowledge of cognitive styles and related teaching strategies was low overall.

4.2 Knowledge of cognitive styles (KCS)

KCS refers to teachers' knowledge of the cognitive style, encompassing their concepts, types, and applications. The overall mean of chemistry teachers' knowledge of cognitive styles in the samples was moderate level, indicating that most of them had average knowledge of the concepts, types, and applications of cognitive styles (Table 3).

Although the level of KCS was low (M=2.4), the data from the individual items showed that the level of knowledge varied among the KCS items. Specifically, teachers' knowledge of cognitive style characteristics and properties was at a moderate level. Subjects' knowledge of cognitive style concepts, students' cognitive style types, and field cognitive style types were insufficient and at a low level.

Table 3. Means and standard deviations of all items related to KCS (N=120)

Item	Mean	Std. Deviation
C5 Knowledge of cognitive style characteristics	2.70	0.616
C4 Knowledge of the nature of cognitive styles	2.58	0.529
C1 Knowledge of cognitive style concepts	2.28	0.688
C3 Knowledge of students' cognitive style types	2.28	0.661

C2 Knowledge of field cognitive style types	2.27	0.658
Overall	2.42	0.482

(Source: Author)

4.3 Knowledge of the characteristics of students with different cognitive styles (KCSDCS)

The KCSDCS refers to teachers' knowledge of students with two types of cognitive styles, field-dependent (FD) and field-independent (FI), on their learning characteristics in six areas: learning motivation, self-motivated problem-solving skills, interpersonal relationships, self-study, logical learning style and satisfaction with learning outcomes. The overall mean of the KCSDCS was less than 2.33, suggesting a low level of chemistry teacher knowledge about the characteristics of students with different cognitive styles.

The mean values for knowledge of interpersonal relationships between FD and FI students, knowledge of FD and FI students' learning motivation, and knowledge of FD and FI students' self-study both ranged from 2.34 to 3.67, indicating that chemistry teachers had a moderate level of understanding of the above three items (Table 4). However, the knowledge of satisfaction with the learning outcomes of FD and FI students, knowledge of the logical learning styles of FD and FI students, and knowledge of FD and FI students' independent problem-solving skills all had mean values between 1.00 and 2.33, which indicates that chemistry teachers' knowledge of the above three items was at a low level.

Table 4. Means and standard deviations of all items related to KCSDCS (N=120)

Item	Mean	Std. Deviation
C9 Knowledge of interpersonal relationships between FD and FI students	2.69	0.887
C6 Knowledge of FD and FI students' motivation to learn	2.40	0.666
C11 Knowledge of FD and FI students' self-study	2.39	0.892
C8 Knowledge of satisfaction with the learning outcomes of FD and FI students	2.13	0.751
C10 Knowledge of the logical learning styles of FD and FI students	1.95	0.839
C7 Knowledge of FD and FI students' independent problem-solving skills	1.95	0.818
Overall	2.25	0.649

(Source: Author)

4.4 Knowledge of cognitive style teaching strategies (KCSTS)

The KCSTS is a measure of chemistry teachers' knowledge of the teaching strategies applicable to the field-dependent (FD) cognitive style and the field-independent (FI) cognitive style before and during lesson preparation in selected schools in Zunyi City, Guizhou Province, China. The overall mean of KCSTS was less than 2.33, which suggests that teachers' knowledge of cognitive style teaching strategies is low level (Table 5).

In terms of item means, respondents' "lesson planning takes into account the differences in students' cognitive styles" and "choose questioning styles based on students' cognitive styles" both had means ranging from 2.34 to 3.67, suggesting that chemistry teachers had a moderate level in these two items.

However, the respondents' lecture styles are selected based on students' cognitive styles, the communication style based on the students' perceived style, teaching strategies according to students' cognitive styles, classroom activities are selected according to the cognitive style of the students, and learning groups are assigned according to the cognitive style of the students all had means less than 2.33, indicating that for these five items, chemistry teachers' familiarity was at a low level.

Table 5. Means and standard deviations of all items related to KCSTS (N=120)

Item	Mean	Std. Deviation
C12 Consideration of students' cognitive styles in lesson preparation.	2.53	0.565
C14 Choose questioning styles based on students' cognitive styles.	2.49	0.565
C15 Lecture styles are selected based on students' cognitive styles.	2.23	0.775
C18 Choose the communication style based on the student's perceived style.	2.23	0.739
C13 Apply teaching strategies according to students' cognitive styles.	2.21	0.732
C16 Selecting classroom activities based on students' cognitive styles.	2.20	0.705
C17 Learning groups are assigned based on students' cognitive styles.	2.19	0.702
Overall	2.30	0.607

(Source: Author)

4.5 Emphasis on cognitive styles (ECS)

The ECS refers to the importance teachers place on self-learning, application, and promotion of cognitive style-based teaching. The overall mean of the ECS is less than 2.33, which suggests that the importance chemistry teachers place on cognitive style is low level (Table 6).

According to Table 6, in terms of item means, respondents were more likely to say that schools should organize training on cognitive styles for teachers", regularly read the literature on the impact of cognitive styles on student learning and often help teachers of other subjects to understand students' cognitive styles both had means ranging from 2.34 to 3.67, indicating that chemistry teachers were moderate level in all three items.

However, the mean values for the necessity of the skill of teaching strategies based on field-dependent and field-independent cognitive styles, teachers assist parents in understanding cognitive styles, and cognitive style is essential as a reference factor for teaching strategies were both less than 2.33, indicating that teachers were low level in all three items

Table 6. Means and standard deviations of all items related to ECS (N=120)

Item	Mean	Std. Deviation
C23 Schools should organize training on cognitive styles for teachers.	2.54	0.578
C22 Regularly read the literature on teaching based on cognitive styles.	2.52	0.594
C21 Often helps other teachers to understand the cognitive styles of their students.	2.50	0.535
C24 Necessity of the skill of teaching strategies based on field-dependent and field-independent cognitive styles.	2.19	0.802
C19 Often assists parents in understanding cognitive styles.	2.08	0.811
C20 Cognitive style is essential as a reference factor for teaching strategies.	2.04	0.814
Overall	2.31	0.534

(Source: Author)

5.0 Discussion

This section discusses the main findings of the study. First, the overall level of knowledge of chemistry teachers about cognitive styles and related teaching strategies is described. Then, the level of chemistry teachers' knowledge about cognitive styles, knowledge about the characteristics of students with different cognitive styles, knowledge about cognitive style teaching strategies, and emphasis on cognitive styles are described separately.

5.1 Overall knowledge of cognitive styles and related teaching strategies

This study found that chemistry teachers' overall knowledge of cognitive styles and related teaching strategies was at a low level. This is similar to the findings of other scholars who found that many chemistry educators do not know how to use cognitive style-based teaching strategies to promote student learning (An, 2017; Idika, 2017). There are significant differences in educators' understanding of cognitive styles and teaching strategies, some of which are related to educators' experience and level of education (Sheng, 2016).

5.2 Knowledge of cognitive styles

The results of the study showed that chemistry teachers' familiarity with cognitive styles was at a moderate level (M=2.34). Similar results were found in previous studies (Cui, 2019), which means that chemistry teachers' knowledge of cognitive styles is only at a superficial layer, with only a cursory understanding of the characteristics and nature of cognitive styles and half understanding of the concept of cognitive styles, not to mention a lack of knowledge about the types of cognitive styles of their students and the types of cognitive styles in the field, which can even be said to be relatively unfamiliar. Setiawan et al. (2020) stated that the reason for the lack of awareness of cognitive styles among chemistry teachers is that research related to teaching based on cognitive styles has not yet been well disseminated in middle schools, and many teachers have not even heard of the term cognitive styles, let alone its use. Therefore, it is crucial to popularise and promote the contribution of cognitive styles to teaching and learning for middle school teachers.

5.3 Knowledge of the characteristics of students with different cognitive styles

The results showed that chemistry teachers were less familiar with the characteristics of students with different cognitive styles. This finding is not surprising as it is consistent with previous findings (Idika, 2017). In terms of cognitive styles, less than a third of the educators were able to correctly differentiate between students' cognitive styles (Yeldham & Gao, 2021). According to the findings of Akcayir and Akcayir (2018), teaching based on cognitive styles has a significant impact on students' academic performance and course completion rates. Therefore, it is necessary to enhance chemistry teachers' knowledge about the characteristics of students with different cognitive styles.

5.4 Knowledge of cognitive style teaching strategies

The results of the study showed that chemistry teachers' familiarity with cognitive teaching strategies was low. This is consistent with the findings of Wang C. L. and Wang Y. P. (2016). Their study confirmed that most chemistry teachers understood the concept of cognitive style, but only a few of them were able to accurately identify their students' cognitive style and adjust their teaching strategies accordingly. In addition, most chemistry teachers have insufficient knowledge of teaching strategies and do not understand the characteristics, advantages, and disadvantages of different teaching strategies, which makes it difficult for them to use them flexibly in their teaching practice.

5.5 Emphasis on cognitive styles

The results showed that the emphasis on the cognitive styles of chemistry teachers is at a low level. This is consistent with the findings of Cui (2019) that the low level of spontaneity and implementation of self-study, application, and promotion of cognitive styles by chemistry teachers is a significant indicator of neglect of teaching based on cognitive style.

6.0 Conclusion & Recommendations

The study analyzed the questionnaire data, and results showed that chemistry teachers' knowledge of cognitive styles and related teaching strategies was at a low level. This finding is detrimental to the quality of chemistry teaching in Guizhou China as it indicates the Chemistry teachers' inability to understand individual differences and provide differentiated teaching strategies to meet the needs of

their students. Students with Field-dependent and Field-independent learning styles have a kind of 'opposing' paradigm in their approach to learning, thus, chemistry teachers need to be aware as well as appreciate their differences and use relevant teaching strategies. Education Departments and schools need to provide teachers with more training and lectures on cognitive style-based teaching and empower management to implement and support more academic and behavioral interventions. In addition, teachers' theoretical knowledge can be enriched through regular training to provide the latest research theories and teaching cases on cognitive style-based teaching. At the same time, simulated lesson planning based on cognitive style teaching strategies should be conducted, where teachers take turns to simulate lessons and peer teachers listen to each other's lessons and give each other suggestions and recommendations for improvement. By creating richer training methods to improve teachers' theoretical knowledge and practical experience, the quality of teaching can be improved.

Furthermore, regular collective lesson planning by teachers supports cognitive style teaching. In the early stages of implementing the cognitive style teaching strategies, the inexperience of some teachers may impact the teaching effect. Collective lesson planning can assist inexperienced teachers to grow faster professionally. Moreover, collective lesson planning can better integrate the use of various teaching resources and provide richer and more effective teaching strategies.

This study also had some limitations, including the fact that demographic variables such as gender as well as years of teaching were not included in this study. In addition, the sample was taken from a few locations, which may affect the generalisability of the results. To avoid these limitations in the future. It is possible that in the future, we will continue to expand the scope of the survey to get a more accurate picture of chemistry teachers' knowledge of cognitive styles and related teaching strategies. A novel avenue for future investigation involves exploring quasi-experimental interventions employing cognitive style-based teaching strategies to further elucidate their impact on chemistry education.

Paper Contribution to Related Field of Study

This study takes the perspective of Chinese middle school chemistry teachers to investigate their knowledge of cognitive styles and related teaching strategies. As most studies have focused on the impact of cognitive styles on students' learning, and there are few studies on teachers' knowledge of cognitive styles, this study enriches this area of research to some extent and helps teachers focus on students' cognitive styles, which can better support their emotional needs and learning, and contribute to improving the overall quality of life.

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