RELATIONSHIP BETWEEN COGNITIVE STYLES, LEVELS OF COGNITIVE THINKING AND CHEMISTRY ACHIEVEMENT AMONG FORM FOUR SCIENCE STUDENTS

(PERHUBUNGAN ANTARA GAYA PEMBELAJARAN, TAHAP PEMIKIRAN KOGNITIF DAN PENCAPAIAN KIMIA DI KALANGAN PELAJAR TINGKATAN EMPAT SAINS)

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<td>Analysis of Variances</td>
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<td>CAT</td>
<td>The Chemistry Achievement Test</td>
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<td>SPSS</td>
<td>Statistical Package for Social Science</td>
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This research is aimed to identify the cognitive styles, level of cognitive thinking and the chemistry achievement of form four science students in Johor Bahru. The research also investigated the relationship between the cognitive styles, the level of cognitive thinking and chemistry achievement. The Group Embedded Figures Test (GEFT), the Group Assessment of Logical Thinking (GALT) and the Chemistry Achievement Test (CAT) were used to determine the students’ cognitive styles, level of cognitive thinking and chemistry achievement respectively. A sample of 163 form four science students were involved in the research. The collected data were analyzed using the SPSS version 10.0 for Windows software. Results showed that most of the students were Field Dependent and they were at the concrete level of cognitive thinking. The analysis of CAT indicated that their achievement was low. There was a weak relationship between the students’ cognitive styles, the level of cognitive thinking and the chemistry achievement. This indicated that the chemistry achievement among the students was not very much influenced by the cognitive styles and the level cognitive thinking. Results also indicated that there was no significant difference between the cognitive styles, the level of cognitive thinking and the chemistry achievement. Several recommendations were made at the end of the report on ways educators could accommodate the diverse cognitive styles, and the level of cognitive thinking as well as ways to improve students’ achievement in chemistry.
ABSTRAK

Kajian ini bertujuan untuk mengenal pasti taburan gaya kognitif pelajar, tahap pemikiran kognitif dan tahap pencapaian kimia, di samping menentukan sama ada terdapat hubungan antara gaya kognitif, tahap pemikiran kognitif dan pencapaian kimia di kalangan pelajar tingkatan empat sains. 3 instrumen digunakan dalam kajian ini. The Group Embedded Figures Test (GEFT), the Group Assessment of Logical Thinking (GALT) dan the Chemistry Achievement (CAT) digunakan untuk menentukan gaya kognitif, tahap pemikiran kognitif dan pencapaian kimia pelajar masing-masing. Seramai 163 orang pelajar tingkatan empat aliran sains dekolah di Johoe Bahru terlibat dalam kajian ini.. Data yang diperolehi dianalisis dengan menggunakan perisian SPSS 10.0 for Windows. Hasil kajian menunjukkan sebilangan besar pelajar adalah Field Dependent dan berada pada tahap pemikiran kognitif konkrit. Pencapaian mereka dalam ujian kimia adalah rendah. Analisis korelasi menunjukkan terdapat pertalian yang rendah antara gaya kognitif pelajar, tahap pemikiran kognitif dan pencapaian kimia. Keputusan kajian juga menunjukkan tidak terdapat perbezaan signifikan antara gaya kognitif, tahap pemikiran kognitif dan pencapaian kimia. Beberapa cadangan telah dikemukakan agar para pendidik dapat memenuhi kepelbagaian gaya kognitif, tahap pemikiran kognitif dan meningkatkan pencapaian pelajar dalam mata pelajaran kimia.
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Thank you is also dedicated to the Research Management Centre (RMC) by which their financial grant made this research possible. Special thanks should also go to our colleagues in the Faculty of Education, UTM for their supports and recommendations. This work, as is true for all significant efforts, is a collaborative achievement. We believe that the findings will contribute to an awareness and understanding of the importance of the topic studied in the preparation of the prospective teachers.

There are also people out there who contributed their efforts and insights to this research in which in the end make this research viable.

Finally, we owe thanks to our family and also those who were directly or indirectly supporting us, who always encouraged us to believe in ourselves during the research period. We cannot find words to express our appreciation.

May Allah give us all the rewards.

Thank you.
CHAPTER I

INTRODUCTION

1.0 Introduction

Malaysia is moving through an era of development in gearing towards becoming a developed nation by the year 2020. As part of its effort, science and technology are indeed considered as a vital aspect in achieving the goal. Both the National Philosophy of Education and the National Science Philosophy clearly stated that individual potential development should be emphasized throughout the learning process:

The National Philosophy of Education:

Education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious based on a firm belief and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards and who are responsible and capable of achieving a high level of personal well-being as well as being able to contribute to the harmony and betterment of the family, society and the nation at large

(Curriculum Development Centre, 2002)

The National Science Philosophy:
Based on these two philosophies, individuals’ development must be addressed. It can be clearly seen that the aim of science education in Malaysia, as stated in the National Science Philosophy, is to produce students who are knowledgeable in science and technology. Thus to produce such individuals, students should not only be science literate but are able to think critically and creatively as well.

These philosophies indicated that in general, educators should play an important role to ensure that the objectives are achieved. Usually, educators will have to make use of the psychology field to get idea on how teaching should take place (Lourdosamy, 1994). But nowadays, more researchers have focused in the field of psychology and cognitive science to enhance their teaching skills. It has also be shown that learning process in the classroom has strong relationship with cognitive styles of an individual. In this research, focus will be on the difference in cognitive styles among form four students.

The implication to this is that educators should always be aware of their significant roles to ensure the national aspirations are achieved. Thus, the focus and objectives of teaching and learning should be on the development of the students’ potential. Cognitive abilities for instance, have a significant impact on the way teaching and learning process are conducted. Students with high cognitive ability are assumed to be able to engage in learning, especially in a highly skill tasks. Therefore their cognitive development should be emphasized in terms of enabling them to specific tasks, such as problem solving, creative and innovative thinking, and so on.
It is the educators’ responsibility to consider the students’ cognitive differences in their teaching and learning processes. Their aim should be on how the students could develop their cognitive abilities as well as to apply them in real life situations. The way they learn and use their cognitive in internalizing all incoming information is vital, not just to their understanding, but to the way they engage in a specific situation. In this sense, cognitive psychology is one way of studying the impact of cognitive ability on the teaching and learning process.

In fact, cognitive psychology will allow us to learn and understand the underlying process of specific behavior or activity. In terms of teaching, it could act as a tool to improve the teaching and learning procedures. It shows that learning of science is not just memorizing of facts but more on how the information is being internalized, especially by the learners. This is consistent with the aim of the chemistry education, which stated:

“Kurikulum Kimia bertujuan untuk melahirkan murid yang mempunyai pengetahuan dan kemahiran dalam bidang kimia dan mampu mengaplikasikan pengetahuan dan kemahiran ini berlandaskan sikap saintifik dan nilai murni untuk membuat keputusan dan menyelesaikan masalah dalam kehidupan harian. Justeru, murid mempunyai landasan kimia untuk melanjutkan pelajaran di samping mengamalkan budaya sains dan teknologi ke arah pembentuk masyarakat bersifat ikram, dinamik, progresif, bertanggung jawab terhadap alam sekeliling dan mengagumi penciptaan alam.”

(Pusat Perkembangan Kurikulum, 2001)

We could conclude that the process of teaching and learning of chemistry should be effective in order to enhance the students’ ability to think and apply the learned chemical concepts in real situations. How could this be achieved? This could be done by investigating the students’ cognitive styles and cognitive thinking. These two
factors need to be investigated and to see if there is any relationship between these factors and the achievement form four science students in chemistry.

1.1 The background of the study

The then Minister of Education, Tan Sri Musa Mohamed stressed that with the implementation of the new KBSM, the ratio of science to arts students would be improved to 60:40. He further stressed that the students would be trained in the Smart Schools to think critically and creatively in the teaching and learning process. Thinking skills are to be inculcated indirectly in the process.

Researches have shown that thinking skills are related to the students’ cognitive styles and thus, will affect their achievement in learning. The issues here are of cognitive style, whether it has a significant impact on the students’ learning styles and their thinking ability. There are tendencies however for the teachers to use ‘chalk and talk’ approach in the classroom (Abu Hassan and Meor Ibrahim, 2000). This is to show that the chances of engaging in more complex cognitive activities are automatically minimized. Riding and Mathias (1991) stated that in the teaching process, teachers always assume that students learn the same way as they do. This old approach is opposed to the aim of the National Philosophy of Education that emphasized on intellectual development.

Individual differences exist among form four students in the way they learn (Shaharom and Yap, 1992). Thus, as Cronbach (1967) argued that the best way to overcome individual differences is to teach according to their cognitive styles. Witkin et. al. (1976) explained that the teaching style of a person is determined by the students’ cognitive styles. Research by Kannan (1996) showed that differences exist in the way the students process information. Teachers should identify their students’ cognitive styles as to improvise their teaching technique to match the students’ cognitive styles.
Researches on cognitive styles were mostly conducted in overseas (Saracho, 1991, Spodek, 1989 and Snider, 1992). There were limited researches conducted in the Malaysian context (Alias and Chong, 1992 and Siti Hawa, 1998). In Malaysia, many students face difficulty in the learning of chemistry (Low, 1999), while Chan (1988) concluded that students were facing difficulty in the learning of quantitative chemistry. This shows that there are some issues that are associated to the cognitive styles and level of cognitive thinking of the students.

Sijil Pelajaran Malaysia (SPM) results for chemistry from the year 1999 to 2001 showed there was a decline on the students achievement (Examination Board of Ministry of Education, 2002). In Johor, the percentage of students passing the chemistry in 2001 SPM dropped as much as 3% compared to those in the 2000 SPM (Jabatan Pendidikan Negeri Johor, 2001).

Niaz (1987) concluded that cognitive styles and cognitive thinking play an important role in the chemistry problem solving tasks. In contrast, however Alias Baba (1996) found that cognitive styles did not have relationship with chemistry achievement.

In this sense, the understanding of science principles at secondary level requires abstract thinking. This means the students would have to be functioning at formal stage (Kavanaugh and Moomaw, 1981, Herron, 1978, Smith, 1978, Shayer and Adey, 1981). The students need certain skills to think logically and by investigating the students’ thinking skills and the overall picture about students’ thinking styles would be explored (Alias Baba, 1996).

Cantu (1978) in his research found that cognitive styles and level of cognitive thinking are two important variables in learning of a concept. He indicated that the thinking skills of a student need to be on the same level of understanding of a particular science concept.
In Malaysia, researches by Palanisamy (1986), Cheah (1984) and Zhang (2002) found that differences in cognitive styles and cognitive thinking had not taken into serious consideration in the learning process by the society. This however, contradicted to what has been proposed that cognitive variables such as thinking skills and cognitive styles play an important role in one’s chemistry achievement (Gerald, 2002).

Inhelder and Piaget (1958) argued that at the age of 16-17, students should have been in the formal stage, that is they should be able to think logically and formally. The question here is whether our form four students have the ability to think and use their cognitive effectively, especially in the learning of chemistry. In other words, have they achieve that stage of cognitive thinking?

1.2 The statement of problem

This research is designed to identify the cognitive styles, the level of cognitive thinking and the chemistry achievement among form four science students. The research will also determine the relationship between cognitive styles, level of cognitive thinking and the students’ chemistry achievement.

1.3 The research objectives

The following are the objectives of the research:

i. To determine the cognitive styles of form four science students.
ii. To determine the levels of cognitive thinking of form four science students.

iii. To determine the chemistry achievement of form four science students.

iv. To identify whether there are significant relationship between students’ chemistry achievement and their
   a) cognitive styles
   b) levels of cognitive thinking

v. To identify whether there are significant difference in chemistry achievement between:
   a) students of different cognitive styles
   b) students of different cognitive thinking

1.4 The research questions

The research sought to address the following questions:

i. What are the cognitive styles of the form four science students?

ii. What is the level of cognitive thinking of form four science students?

iii. What is the level of chemistry achievement of the form four science students?

1.5 The research hypotheses

Hypotheses 1

The null hypotheses
There is no significant relationship between the students’ chemistry achievement and their
a) cognitive styles  
b) level of cognitive thinking  

Hypotheses 2  
The null hypotheses  
There are no significant differences between students’ chemistry achievement and  
a) the cognitive styles  
b) the level of cognitive thinking.  

1.6 The importance of research  
The main aim of this research is to determine if there are any relationships between the cognitive styles, the level of cognitive thinking and the chemistry achievement among form four science students.  
This research will benefit many parties, namely students, teachers, and Ministry of Education. For the students, they would be able to know their cognitive styles and the level of cognitive thinking. Thus it will enhance their thinking styles to be more critical and creative when making decisions.  
Finding from this research would help teachers to choose appropriate learning materials that suits the students’ cognitive styles. Apart from that, teachers could also choose appropriate teaching strategies that could cater the students’ different cognitive styles and level of cognitive thinking.  
The information gathered in this research could help the Ministry of Education as well, in developing new curriculum. The ministry could consider the students’
different cognitive styles and level of thinking when developing the curriculum so that the students would be able to learn effectively.

There is a need to improve students’ understanding in chemistry concept. This research acts as a guide to educators and curriculum developer. Hopefully, this research will give overall view of cognitive styles, level of cognitive thinking and chemistry achievement of form four students.

1.7 Scope of the research

This research investigates cognitive styles, level of cognitive thinking and chemistry achievement among form four science students in Johor Bahru, Johor. The students’ cognitive styles were determined by using the translated Group Embedded Figures Test (GEFT) by Witkin, et. al (1971). While the translated Group Assessment of Logical Thinking (GALT) by Roadrangka, et. al (1983) was used to determine the logical reasoning of the students. The Chemistry Achievement Test (CAT) was constructed to determine the students’ chemistry achievement.

The respondents of the research were form four students who sat the Penilaian Menengah Rendah (PMR) examination in the year 2002. They were from grade A secondary schools in Johor Bahru.

1.8 The conceptual framework

The conceptual framework of the study is shown in the following Figure 1.1
Level of cognitive thinking

Figure 1.1: Prediction of the relationship between the cognitive styles and the level of cognitive thinking and the chemistry achievement

It is assumed that the students’ chemistry achievement is influenced by various factors. Two of the factors have been identified, they are the cognitive styles and the level of cognitive thinking of the students. The study is to identify if there exist any relationships between these factors and chemistry achievement of the students.

1.9 Term definitions

Cognitive styles

Witkin et al. (1971) defines cognitive styles as the characteristic self consistent modes of functioning which individuals show in their perceptual and intellectual activities. The cognitive styles are categorized into three dimensions, the Field Independent (FI), the Intermediate and the Field Dependent (FD). In this study, the determination of cognitive styles is based on questionnaires, the Group Embedded Figures Test (GEFT) developed by Witkin, et al. (1971).

FI

An individual is considered a FI if the marks he obtained in the GEFT is between 13 and 18. These individuals are analytical in characteristic.

Intermediate
An individual is considered an intermediate if the marks he obtained in the GEFT is between 7 and 12.

FD

An individual is considered FD if the marks he obtained in GEFT is between 0 and 6. These individuals are categorized as persons who process things globally.

The level of cognitive thinking

The Group Assessment of Logical Thinking (GALT) developed by Roadrangka, et al. (1983) was used to determine the level of cognitive thinking of the students. This level of cognitive thinking based on Roadrangka, et al. (1983). Individuals who obtained 0-4 marks are said to be at the concrete level, 5-7 marks are at the intermediate level and 8-12 marks are considered at the formal stage.

Chemistry achievement

According to Donald and Ernest (1975), achievement test is an instrument to measure the skills and concepts that they have learned. In this research, the Chemistry Achievement Test (CAT) was used to test the students understanding of the mole concepts. Chemistry Achievement is referred to the marks the students obtained in the CAT. The test consists of 15 subjective open ended questions.
1.10 Conclusion

The aims of the research is to determine the cognitive styles, level of cognitive thinking and chemistry achievement among form four science students in Johor Bahru. The research is also aimed to determine if there exist any relationships between the variables. The research findings would be significant to those in the education sector, teachers in particular to make teaching of chemistry effective.
CHAPTER II

LITERATURE REVIEW

2.0 Introduction

The aims of the research is to determine the cognitive styles, the level of cognitive thinking and chemistry achievement among form four science students in Johor Bahru. The research is also aimed to determine if there exist any relationships between the variables.

This chapter discusses the various definitions and types of cognitive styles, the implications of cognitive styles to learning. The level of students’ cognitive thinking and some of the instruments used to determine the level of cognitive thinking were also looked into. While the last part of the chapter focuses on researches findings that are related to cognitive styles, level of cognitive thinking and chemistry achievement.

2.1 Definitions of Cognitive Styles

Each individual has his own way of organizing and processing information. The
differences between individuals are consistent and is called cognitive styles. The concept of cognitive styles came to view from differential psychology field, that is related to difference in the cognitive act. Some prominent individuals that were involved in the researches on cognitive styles were Witkin, et al. (1971), Kagan, et al. (1964) and Messick, et al. (1976). Witkin, et al. (1971) defined cognitive styles as the characteristic self-consistent modes of functioning which individuals show in their perceptual and intellectual activities.

There are two processes involved in the cognitive styles, that is how an individual perceived the information and how the information is processed. One of the cognitive styles dimensions that many researchers did was on the field dependent-independent. These dimensions have an impact on the personality, the intelligence and the social behavior of an individual (Witkin et al., 1972, 1977).

Riding and Cheema (1991) defined cognitive styles as a way an individual solves problems, thinks, perceives and remember. Whilst Messick, et al. (1976), explained that cognitive styles as the attitude and the usual style of an individual remembers, thinks or solves problems.

In conclusion, cognitive styles can be defined as a way an individual thinks and processes information, either globally or analytically in a given situation.

2.2 Types of Cognitive Styles

There are several types of cognitive styles as proposed by various researchers.

a) Field Independent (FI) versus Field Dependent (FD)
This cognitive styles was proposed by Witkin, et al. (1967). The cognitive styles identify an individual as analytic or global. For example, when an individual is given a simple geometric figure that is embedded in a complex figure, FI individual finds the task easy and able to do it faster than the FD individual. From the personality point of view, FD individual likes to socialize, whereas FI individual tends to do work independently.

b) Impulsivity versus Reflectivity

This dimension was introduced by Kagan et al. (1964). The cognitive styles is measured by Matching Familiar Figures Test (MFFT) which measures the rate at which an individual makes a decision in an uncertainty situation. Individuals can be categorized into two categories. Firstly, the cognitive impulse, an aspect on how fast an individual makes a decision, after a short explanation. The second category is the cognitively reflective where an individual makes decision after taking consideration of all choices.

c) Convergent-divergent thinking

The dimension was proposed by Guilford (1967). This dimension of doing reflection on one type of thinking and strategy is related to the type of thinking to solve a problem. An individual looks for a solution to a problem through exploration or closed thinking but with high concentration.

d) Holist-serialist thinking
Pask and Scott (1972) introduced the cognitive style as two competencies that showed the tendency of an individual to give feedback on a learning task through holistic strategy, or steps by steps strategy. In this research, FI and FD cognitive styles are used to show the importance of the cognitive styles in science education. Furthermore, this cognitive styles is the main characteristic in the field of learning (Witkin, et al., 1967).

2.3 Differences between FI and FD individuals

According to Saracho and Spodek (1981), the differences between FI and FD individuals are as follows:

FD individuals
a) Dependent on the authority
b) Like to socialize with people
c) Like to do group work.

FI individuals
a) Able to abstract item and solve problems in a different context.
b) Orientation towards active task
c) possess analytical skills
d) Love to work independently.

While Garger and Guild (1984) listed the characteristic of FD and FI individual as shown in the following Table 2.1.

Table 2.1: Differences between FD and FI individuals
<table>
<thead>
<tr>
<th><strong>FD</strong></th>
<th><strong>FI</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceive information globally</td>
<td>Perceive information analytically</td>
</tr>
<tr>
<td>Generalize concept</td>
<td>Specific concept</td>
</tr>
<tr>
<td>Social oriented</td>
<td>Individualistic</td>
</tr>
<tr>
<td>Dependent on others</td>
<td>Independent</td>
</tr>
<tr>
<td>Source of motivation from outside</td>
<td>Source of motivation from inside</td>
</tr>
</tbody>
</table>

### 2.4 Implication of cognitive styles on learning

Apparently, cognitive styles of a student will affect his tendency towards specific teaching technique. FD and FI students will not benefit from a lesson if their teachers’ cognitive styles is different from theirs. As such it is important for the teachers to consider the students’ cognitive styles before going into the class.

In general, the education institutions are responsible to structure the learning environment that suits to the students’ cognitive styles (Ehrhardt and Corvey, 1980). The understanding of cognitive styles is invaluable in academic and non-academic settings. Identification of cognitive styles of the student will enable them to make decision on their studying approach. This is especially important when the alternative learning method is not available.

FD individual tends to use others’ approach to understand a specific concept, whereas, FI students use hypothesis approach to understand the concept. Individuals will learn effectively if they have their own way of structuring information in learning. Thus, the identification of students’ cognitive styles and teaching approach will lead to effective learning.
In chemistry, learning materials that were presented to the students were not clear in structure and the students have to arrange by themselves to understand what the concepts that were being taught. Normally, FD students encounter bigger difficulties than the FI students. Witkin, et al. (1967) asserted that

“perhaps the most promising and exciting prospects for cognitive style approach lie in the field of education. While relatively little research has been done, compared to what is possible and needed, it is already clear that cognitive style is a potent variable affecting a number of areas: the students’ academic choices and vocational preferences, the students’ continuing academic development, how students learn and teachers teach and how students and teachers interact in the classroom.”

(Witkin et al., 1967:39).

It is clear that the student’s cognitive style is a factor that should be investigated because it could affect their career selection, the way they learn and interact with teachers and others in a classroom.

2.5 Level of Cognitive Thinking

Piaget (1964) stated that

“a child can receive valuable information via language or via education directed by an adult only if he is in a state where he can understand this information. That is, to receive the information, he must have a structure which enables him to assimilate this information. That is why you cannot teach higher mathematics to five year old. He does not yet have structures which enable him to understand.”

From the above statement, we can conclude that the teaching process should match the level of the students’ cognitive thinking.
Inhelder and Piaget (1958) stated that secondary students are able to abstract reasoning and able to use formal thinking. At this stage, students can use the concept, relationship, theory and symbol to state an idea. Whereas for cognitive operational students, they still need references and guidance. This indicates that only students at the formal operational stage were able to control a variable. Similarly, Gerald (2002) said that the learning of chemistry includes all the six Piaget modes of thinking (see section 2.5.1.1 for the six modes of thinking) that is tested as the Group Assessment of Logical Thinking (GALT).

### 2.5.1 Instruments to measure level of cognitive thinking

Four instruments could be used to measure the students’ level of cognitive thinking.

#### 2.5.1.1 The Group Assessment of Logical Thinking (GALT)

The instrument was developed by Roadrangka et al. (1983). This is a pencil and paper test. It consists of 12 questions in which 10 are multiple choice questions and 2 are open-ended subjective questions. Besides choosing the correct answers, respondents are also required to choose the best reasons for the answer they chose. This is to enhance the students’ thinking skills. The questions include all the six Piaget modes of thinking.

The six Piaget modes of thinking:

- a) Combinatorial reasoning
- b) Correlational reasoning
- c) Proportional reasoning
- d) Probability reasoning
- e) Eternity (Conservation) reasoning
f) Controlling of variables.

2.5.1.2 The Lawson Classroom Test of Formal Reasoning

This instrument was developed by Lawson (1978) to determine the students’ level of cognitive thinking. It measures the students’ ability to apply scientific reasoning in problem solving, doing prediction and general analysis for certain situation. There are 7 items in this pencil and paper test which tested on the proportional reasoning, probability reasoning and correlation reasoning. Kuder-Richardson (KR) reliability for this instrument was .78.

2.5.1.3 Longeot’s Reasoning Test (LRT)

The instrument was to measure Piaget cognitive development. It was first developed in French and translated into English by Sheehan (1970).

It consisted of 4 parts: part 1 included 5 classroom items, part 2 consisted of 6 logic proportional items, while part 3 consisted of 9 proportional reasoning items and part 4 consisted of 8 items on combinatorial analysis. The reliability coefficient for this test was .85 using KR-20.

2.5.1.4 Test of Logical Thinking (TOLT)
This instrument was developed by Tobin and Capie (1980) and had been translated to *Bahasa Melayu* by Siow (1993) with some modifications. The reliability for this instrument was .62 using KR-20.

The test consisted of 10 multiple choice questions that would determine the students’ level of logical thinking on proportional reasoning, probability reasoning, correlation reasoning, combinatorial reasoning and controlling of variables.

### 2.6 Research on Cognitive Styles, Level of Cognitive Thinking and Chemistry Achievement

Findings from Lourdosamy (1994) showed the importance of the level of cognitive thinking in determining students’ success in chemistry. Study by Staver and Jacks (1988) on 83 high school students found that formal reasoning had affected students’ achievement. They could not, however relate cognitive styles and the students’ achievement in chemistry. Earlier study by Chandran et al. (1987) too, found that cognitive styles did not play any role in students’ chemistry achievement.

Nevertheless, ability of formal thinking is vital. Research done by Gerald (2002) showed that cognitive styles had a significant relationship with achievement in solving chemistry problems and academic achievement. Further research was suggested to investigate ways to teach students to be more FI. According to Bou Jaoude and Giuliano (1994), research on the relationship between cognitive styles and the students’ academic achievement is very important, but only few had carried out on it.

Bender and Milakofsky (1982) showed the success of Piaget’s test and its relationship with students’ chemistry achievement and laboratory classroom. In
conclusion, they suggested that the students’ cognitive styles and the level of thinking and its relationship with chemistry achievement needed to be further investigated.

2.7 Conclusion

In this chapter, discussion has been made on the various definitions on the cognitive styles and the level of cognitive and its relationship with the students’ chemistry achievement. The different types of cognitive styles and level of thinking and the various ways of measuring these variables were also discussed. This research is especially important as its findings could enhance the teaching and learning process in chemistry.
CHAPTER III

METHODOLOGY

3.0 Introduction

The aims of the research is to determine the cognitive styles, the level of cognitive thinking and chemistry achievement among form four science students in Johor Bahru. The research is also aimed to determine if there exist any relationships between the variables.

This chapter discusses the research design, the data collection methods, the samples, the various instruments used in determining the various variables and the procedure of carrying out the research.

3.1 The research design

This research is a correlation study as it is to determine the relationship between the cognitive styles, the levels of cognitive thinking and chemistry achievement among form four science students. Three different types of questionnaires were administered to
the respondents to determine the cognitive styles, the level of cognitive thinking and their achievement in chemistry.

3.2 Preliminary survey

Preliminary survey was carried out at the Sultanah Zanariah library and the Faculty of Educations, UTM to gather information and references related to the research. These information and references include books, journals, theses, bulletins, newspapers, Ebscohost, ERIC and internet webpage on the cognitive styles, the level of cognitive thinking and the chemistry achievement.

3.3 The method of collecting data

Questionnaires were used as the primary data collection method. The three questionnaires were the Group Embedded Figures Test (GEFT), the Group Assessment of Logical Thinking (GALT) and the Chemistry Achievement Test (CAT) to measure the students’ cognitive styles, the level of cognitive thinking and the chemistry achievement respectively. The respondents were form four science students from grade A secondary schools in Johor Bahru. They were asked to answer the questionnaires and the reliability of the results was recorded.

3.4 The sample of research
The population in this research were grade A secondary schools form four science students in Johor Bahru. The sample size was determined using the Research Sample Determining Table proposed by Krejcie and Morgan (1970). Quota sampling was used in this research. 163 students were selected on random basis.

3.5 The instruments

Three instruments were administered to the respondents to assess the cognitive styles, the level of cognitive thinking and the chemistry achievement. They were the Group Embedded Figures Test (GEFT), the Group Assessment of Logical Thinking (GALT) and the Chemistry Achievement Test (CAT)

3.5.1 The GEFT

The GEFT, developed by Witkin et al. (1971) was translated into Bahasa Melayu to suit the local situations (see Appendix A). It was used to determine the students’ cognitive styles. The validity of the questionnaire was obtained from four lecturers at the Universiti Teknologi Malaysia.

The GEFT consisted of two example figures and 25 complex figures. The test was divided into three parts. Part I consisted of 7 items, Part II and Part III consisted of 9 figures each. At the back of the instrument, there were 8 simple figures to be identified by capital letters. For each complex figure, the respondents would have to find one simple figure that was similar to the one of the eight simple figures at the back of the instrument. The respondents were allowed to refer as much as they want during the test. The allocation of time for each part is showed in the following Table 3.1.
Table 3.1: GEFT: Allocation of time

<table>
<thead>
<tr>
<th>Parts</th>
<th>Number of item</th>
<th>Time allocate</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7</td>
<td>2 minutes</td>
</tr>
<tr>
<td>II</td>
<td>9</td>
<td>5 minutes</td>
</tr>
<tr>
<td>III</td>
<td>9</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>12 minutes</td>
</tr>
</tbody>
</table>

3.5.2 The GALT

The GALT, developed by Roadrangka, Yeany and Padilla (1983) was translated into *Bahasa Melayu* to suit the local situation (see *Appendix B*). The validity of the instrument was obtained from four lecturers at the Universiti Teknologi Malaysia. The GALT was chosen to measure the logical reasoning abilities of the students. Other instruments have been designed to measure logical thinking, however, the GALT is easier to administer, score and was a better fit for the population under study.

This instrument was designed to assess 6 logical operations: conservation, controlling variables, and four forms of reasoning combinatorial, probabilistic, proportional and correlational reasoning (Helgeson, 1994) showed that GALT is an instrument to measure 6 logical operations. The GALT consisted of 12 questions, of which 10 were multiple choice questions and 2 subjective questions. For every questions, the respondents were asked to provide reasons for the answers they had chosen.

3.5.3 The Chemistry Achievement Test (CAT)
This test consisted of 10 subjective questions to determine students’ understanding of the mole concepts (see Appendix C). The purpose of the instrument was to measure the students’ chemistry achievement.

Table 3.2 shows the distribution of chemistry question.

Table 3.2 : Distribution of chemistry questions

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>CONCEPTS</th>
<th>QUESTIONS NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mole</td>
<td>Mole relationships</td>
<td>1, 2, 8</td>
</tr>
<tr>
<td>Empirical formulas</td>
<td></td>
<td>7, 9, 10</td>
</tr>
<tr>
<td>Molecular formulas</td>
<td></td>
<td>4, 5</td>
</tr>
<tr>
<td>Balancing equations</td>
<td></td>
<td>3, 6</td>
</tr>
</tbody>
</table>

The questions were constructed and in accordance with the Integrated Curriculum for Secondary School Chemistry Syllabus. Views from experience chemistry teachers and lecturers in chemistry education at the Universiti Teknologi Malaysia were taken into considerations when constructing the test.

3.6 Pilot study

Pilot study was carried out to test the appropriateness and reliability of the instruments. It was carried out in July 2003 at one of the grade A secondary schools in Johor Bahru. The pilot study completed in two days. The CAT was administered to the students in day 1, while the GEFT and GALT were administered in day 2. The
questionnaires were administered by the researchers to ensure the students understood and followed the procedures of the different instruments.

25 students were involved in day 1, whereas 20 students were involved in day 2. Alpha coefficient was used to test the GALT and the CAT, while for the GEFT, a test-retest method was used. The GEFT test was administered for the second time to the students after a lapse of two weeks, as suggested by Gay (1996).

Assessment forms were also distributed to get feedback on the language used, understanding of the questions and the time allocation. Overall, the students gave positive response toward the questionnaires.

Analysis showed that reliability of the GEFT, the GALT and the CAT were .8770, .8000 and .8033 respectively. The instruments were now ready to be used in the proper study.

3.7 Data Analysis

Data obtained were analyzed using the SPSS version 10.0. The analysis were on cognitive styles, level of cognitive thinking and chemistry achievement and to determine the relationship between the cognitive styles, the level of cognitive thinking and the chemistry achievement for hypothesis testing purposes.

3.7.1 Cognitive styles analysis
The GEFT was used to measure the students’ cognitive styles. Each correct item in Parts II and III would be given 1 mark each. The maximum total mark is 18. The cognitive styles of the students were then categorized as follows:

Table 3.3: Categorization of cognitive styles

<table>
<thead>
<tr>
<th>Cognitive styles</th>
<th>GEFT marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>0-6</td>
</tr>
<tr>
<td>Intermediate</td>
<td>7-12</td>
</tr>
<tr>
<td>FI</td>
<td>13-18</td>
</tr>
</tbody>
</table>

3.7.2 The level of cognitive thinking analysis

The GALT was used to determine the level of cognitive thinking of the students. For each correct answers followed by a correct reason given by the respondents would be given 1 mark. The maximum mark was 12. The students were then categorized based on the range of marks as follows:

Table 3.4: Categorization of cognitive thinking

<table>
<thead>
<tr>
<th>Range</th>
<th>Stage of cognitive thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>Concrete</td>
</tr>
<tr>
<td>5-7</td>
<td>Transitional</td>
</tr>
<tr>
<td>8-12</td>
<td>Formal</td>
</tr>
</tbody>
</table>

3.7.3 The chemistry achievement test analysis
For each questions, the full marks was 6 marks. This was based on the analytical marking scheme proposed by the NCTM (1987). For questions 3 and 6, one mark will awarded for each correct answer given. The total marks for this test is 50. The guided marking scheme is discussed in the following section.

3.7.3.1 Analytical marking scheme

This techniques focused on the process of getting the solution, and not merely on the answers given. According to NCTM (1987), three phases of problem solving skills were required to solve a problem. Marks of 0, 1 and 2 were allotted based on the phases involved and were given as follows:

Phase 1: Understanding of the problem

Wrong understanding about the problem (0 mark)
Half of the problem misunderstood (1 mark)
Correct understanding of the problem (2 marks)

Phase 2: Planning to get the solution

No attempt (0 mark)
Planning is partially associated to getting the solution (1 mark)
Planning leads to getting correct solution (2 marks)

Phase 3: Execution of the planning

No answer or wrong answer (0 mark)
Error in calculation or partially correct solution (1 mark)
Correct label and solution (2 marks)

Based on the Malaysia Ministry Of Education guidelines on assessment, in which a score of 40% and above by a student in a test is considered as a pass, and the student is said to have high level of understanding on a particular subject. A student who scored marks of below 40% is said to possess low level of understanding of the subject. Thus, the students’ level of chemistry achievement was categorized into 2 categories, as follows:

Table 3.5 : Level of Chemistry Achievement

<table>
<thead>
<tr>
<th>Marks</th>
<th>Level of Chemistry Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td>Low</td>
</tr>
<tr>
<td>20-50</td>
<td>High</td>
</tr>
</tbody>
</table>

The descriptive statistic approach was used to obtain the frequency and the percentage of the cognitive styles, the level of cognitive thinking and the chemistry achievement. Inferential statistics were also used to conclude and analyze the data, while the Spearman rho was used to investigate the relationship between the students’ cognitive styles, the level of cognitive thinking and the chemistry achievement. The strength of the relationship would be based on the correlation values as proposed by Roundtree (1981)

The following Table 3.8 shows the correlation values between 2 variables
To address the last objective of the research, one way ANOVA was be used to determine if there existed any significant difference between the students’ chemistry achievement and the cognitive styles and the level of cognitive thinking.

### 3.8 Conclusion

In this chapter, 3 instruments, namely the GEFT, the GALT and the CAT were used to obtain data from the respondents. In the selection of the sample, quota sampling was used. All the data were analyzed using the SPSS version 10.0. The data were analyzed using the descriptive and inferential statistics, the frequency, the percentage and the one way ANOVA.
CHAPTER IV

DATA ANALYSIS

4.0 Introduction

This chapter presents the research data analysis. The data were analyzed using the descriptive and inferential statistics, the frequency, the percentage and the one way ANOVA. The data were analyzed using the SPSS version 10.0 for Windows.

A total number of 163 respondents were involved in the research. The 3 questionnaires were administered to the students after obtaining permission from the relevant authorities. Analysis was then carried out to measure the cognitive styles, the level of cognitive thinking and the chemistry achievement of the students. Analysis was also done to determine if there was any relationship between the students’ cognitive styles, the level of cognitive thinking and their chemistry achievement.

Discussion on this chapter is divided into four parts. The first part 4.1 discusses the respondents’ cognitive styles, the level of cognitive thinking and their chemistry achievement. Part 4.2 discusses the relationship among the cognitive styles, the level of cognitive thinking, and to determine if there was any significant difference between
cognitive styles, level of cognitive thinking with chemistry achievement of the students. Part 4.3 shows the analysis on the hypothesis testing and Part 4.4 concludes the chapter.

4.1 Analysis of the data

The following sections show the analysis of the respondents’ cognitive styles, the level of cognitive thinking and their chemistry achievement respectively.

4.1.1 Analysis of the cognitive styles

The following Table 4.1 shows the distribution of the cognitive styles of the respondents.

Table 4.1: Distribution of the cognitive styles of form four students

<table>
<thead>
<tr>
<th>COGNITIVE STYLES</th>
<th>FREQUENCY</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Independent</td>
<td>31</td>
<td>19.02</td>
</tr>
<tr>
<td>Intermediate</td>
<td>32</td>
<td>19.63</td>
</tr>
<tr>
<td>Field Dependent</td>
<td>100</td>
<td>61.35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>163</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Based on the table, it can be clearly seen that the majority of the students were Field Dependent (61.35%), followed by the intermediate cognitive styles and the Field Independent (FI).
4.1.2  Analysis of the level of cognitive thinking

Overall, most of the students were at the concrete level of cognitive thinking (55.21%), followed by the transitional (27.61%). Only 17.21% of the students were at the formal stage of cognitive thinking.

The finding on the level of cognitive thinking is summarized in the following Table 4.2.

Table 4.2: Distribution of the levels of cognitive thinking of form four students

<table>
<thead>
<tr>
<th>LEVELS OF COGNITIVE THINKING</th>
<th>FREQUENCY</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>90</td>
<td>55.21</td>
</tr>
<tr>
<td>Transitional</td>
<td>45</td>
<td>27.61</td>
</tr>
<tr>
<td>Formal</td>
<td>28</td>
<td>17.18</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>100.00</td>
</tr>
</tbody>
</table>

4.1.3  Analysis of the chemistry achievement

Majority of the students were categorized as low achievers (65.64%). Only 34.36% were considered high achievers. The level of the students’ chemistry achievement is shown in the following Table 4.3.
Table 4.3: Distribution of the levels of chemistry achievement of form four students

<table>
<thead>
<tr>
<th>LEVELS OF CHEMISTRY ACHIEVEMENT</th>
<th>FREQUENCY</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>107</td>
<td>65.64</td>
</tr>
<tr>
<td>High</td>
<td>56</td>
<td>34.36</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Overall, the students seemed to face difficulty in solving chemistry problems. They did not take extra precautions, especially on the units of the problem. They were weak in the mole concepts. They did not relate the knowledge of the concept when solving the problems. What they did was just to write the formula they have memorized and worked towards the solution.

The students were also weak in writing chemistry equations. This could not balance the given chemical equations. This could be due to their lack of understanding on the mole concepts.

4.2 The relationship between the cognitive styles, the level of cognitive thinking and the chemistry achievement

Spearman rho was used to investigate the relationship between the cognitive styles and the chemistry achievement, and the relationship between the level of cognitive thinking and the chemistry achievement. It was found that both relationships; the relationship between the cognitive styles and the level of cognitive thinking with the chemistry achievement indicated a very weak relationship. The interpretation was made based on Roundtree (1981).
The following tables 4.4 and 4.5 show the correlation value of the students’ cognitive styles and the chemistry achievement and the correlation value of the students’ level of the cognitive thinking and the chemistry achievement respectively.

Table 4.4: The correlation value of the cognitive styles and the chemistry achievement

<table>
<thead>
<tr>
<th>Spearman rho</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.048</td>
<td></td>
<td>0.418</td>
</tr>
</tbody>
</table>

Table 4.5: The correlation value of the level of cognitive thinking and the chemistry achievement

<table>
<thead>
<tr>
<th>Spearman rho</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.099</td>
<td></td>
<td>0.207</td>
</tr>
</tbody>
</table>

4.3 Hypothesis Testing

The hypotheses of the research are as follows:

Hypotheses 1

The null hypotheses

There is no significant relationship between the students’ chemistry achievement and their
a) cognitive styles
b) level of cognitive thinking
Hypotheses 2

The null hypotheses

There are no significant differences between students’ chemistry achievement and

a) the cognitive styles

b) the level of cognitive thinking.

The analysis of the hypotheses testing are shown in the following Table 4.6 and Table 4.7. The significant values obtained were .748 and .168 respectively. Therefore, the null hypothesis could be accepted. This means that there were no significant differences between the chemistry achievement and the students of different cognitive styles and between students of different cognitive thinking.

Table 4.6: One way ANOVA for the cognitive styles - the chemistry achievement

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>SIG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.756</td>
<td>.748</td>
</tr>
<tr>
<td>Within Groups</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7: One way ANOVA for the level of cognitive thinking – the chemistry achievement

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>SIG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1.408</td>
<td>.168</td>
</tr>
<tr>
<td>Within Groups</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4 Conclusion

This chapter discussed the data analysis of the distribution of cognitive styles in three grade A secondary schools in Johor Bahru. Overall, the dominant cognitive styles of form four students were the Field Dependent, followed by the Intermediate and Field Independent. Majority of the form four science students possessed concrete level of cognitive thinking, followed by the transitional. Only a few of them possessed the formal level of cognitive thinking.

Spearman-rho was used to determine if there was any relationship between the cognitive styles, the level of cognitive thinking and the chemistry achievement of the students. There was also a positive relationship between the two independent variables and the students’ chemistry achievement. Nevertheless, the relationship was very weak.

One way ANOVA showed that there was no significant relationship between the cognitive styles, the level of cognitive thinking and the chemistry achievement. Further explanations were discussed in the next chapter.
CHAPTER V

DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The aims of the research is to determine the cognitive styles, the level of cognitive thinking and chemistry achievement among form four science students in Johor Bahru. The research is also aimed to determine if there exist any relationships between the variables. 163 form four science students in grade A secondary schools in Johor Bahru were involved as sample in the research.

Three instruments were administered to the students. The Group Embedded Figures Test (GEFT) by Witkin et al. (1971) was used to determine the cognitive styles of the students, while the Group Assessment of Logical Thinking (GALT) was used to measure the students’ level of cognitive thinking. Students’ achievement in chemistry was determined by the marks they obtained in the Chemistry Achievement Test.

The collected data were analyzed using SPSS version 10.0 for Windows software. Descriptive statistics such as mean, frequency and percentage and inferential statistics such as one way ANOVA were used in presenting the findings of the research.

This chapter is devoted to the summary of the research findings, implications of the students’ cognitive styles and the level of logical thinking abilities on the learning of...
chemistry, recommendations on improving the students' cognitive styles and recommendations for further research in the related areas.

5.1 Summary of the research findings

The following sections discuss the findings according to the research questions and hypotheses of the research.

5.1.1 Research question 1

What are the cognitive styles of the form four science students?

Majority of the students are FD, followed by the intermediates and the FI respectively. Only 31 students are FI. This could cause concern to educators because FI cognitive styles are very important in the process of learning science. Witkin, et al. (1977) found that majority of the science students possessed FI cognitive styles. The difference in the findings could be due to the teaching approaches used by teachers in the classrooms. The ‘chalk and talk’ approach tended to produce students who are dependent on teachers thus showed characteristics of the FD cognitive styles.

5.1.2 Research question 2

What is the level of cognitive thinking of form four science students?

The analysis shows that most of the students were at the concrete, followed by the transitional and the formal (abstract) stages of the cognitive thinking. The students involved in the study were 16 years old and had not reached the formal cognitive thinking stage. And according to Piaget (1964), students of 16 years old and above
should had been at the abstract stage of cognitive thinking. Nevertheless, findings by Opper (1978) and Cheah (1984) showed similar results. This could be one of the reasons why form four science students were facing difficulties in solving chemistry problems and were getting low achievement in the CAT

5.1.3 Research Question 3

What is the level of chemistry achievement of the form four science students?

The finding of the research found that majority of the students obtained low level of chemistry achievement. The analysis also showed that the students were weak in the understanding the mole concepts. They were not able to apply the mole relationships, to determine the empirical and molecular formulae of chemical compounds and to balance chemical equations. Research by Low (1999) showed similar results. The finding suggested that the students’ chemistry achievement was limited only to that of the concrete stage.

The mole concepts are the basic concepts that students should grasp before proceeding further in the chemistry form four topics. Various steps should be taken by educators to improve chemistry achievement of the students. The teaching and learning process of the mole concepts should be appropriate and involve concrete objects and real situations so as to allow meaningful understanding take place.
5.1.4 Hypotheses 1

The null hypotheses

There is no significant relationship between the students’ chemistry achievement and their
a) cognitive styles
b) level of cognitive thinking

It was found that there was a weak relationship between the chemistry achievement and the cognitive styles and the level of cognitive thinking among the form four science students. Research by Alias Baba (1996) found similar results. However, findings by Bender and Milakofsky (1982), Low (1999), Gerald (2002) and Winnie Sim (2004) showed there were significant relationships between students’ achievement in solving chemistry problems and academic achievement and the cognitive styles and the levels of cognitive thinking of the students.

5.1.5 Hypotheses 2

The null hypotheses

There are no significant differences between students’ chemistry achievement and
a) the cognitive styles
b) the level of cognitive thinking.

The analysis of the data showed that that there was no significant difference between the students’ cognitive styles and their chemistry achievement. The significant value obtained in the one way ANOVA was p > 0.05, thus the null hypotheses was accepted. Researches by Chandran, et al. (1987) and Staver and Jacks (1988) showed similar results.
The analysis of one way ANOVA also showed that there was no significant difference between the students’ chemistry achievement and the level of cognitive thinking. The significant value obtained was $p > 0.05$, thus the null hypotheses was accepted. However research findings by Chandran, et al. (1987), Staver and Jacks (1988) and Winnie Sim (2004) showed that there was a significant difference between the two variables. They found that that the students’ formal reasoning affected their achievement in chemistry.

5.2 The implications of the cognitive styles and the level of cognitive thinking on chemistry learning

Research findings indicate that the FI cognitive styles is the least dominated among the form four science students. Therefore, the teaching and learning process should be planned appropriately so students are actively involved in problem solving activities. Students should be given homework which is related to the non-routine problems and the real life situation so that they could enhance their critical and analytical thinking skills. This would then lead them to the acquisition of the abstract thinking skills.

Teachers’ creativity is of utmost important. They need too be creative and to infuse such skills in their teaching activities. Students’ involvement in group work activities in the classroom could provide such opportunity for the students to engage in cooperative and communication activities. Helping students to become effective thinkers is one of the major concerns of the Malaysia Ministry of Education. According to Witkin, et. al (1977), assisting students to become FI would be one of the ways to facilitate them in the acquisition of the required critical and analytical thinking skills.

A better understanding of the students’ cognitive styles and the level of cognitive thinking may help educators to plan better and effective instructional methods.
in order to maximize the potential of the students and thus, facilitate the learning of chemistry.

5.3 Recommendations

The findings of this research indicated that majority of the students are FD. This could be due to the teachers’ teaching styles which focused on the teacher-centered activities (Dorothy and Diane, 1994). Teachers should execute activities that would cater the diverse cognitive styles of the students. Research by Ross (2001) suggested that teachers should be flexible with their teaching styles, and use diverse assessment to cater for the needs of the students.

Findings also showed that majority of the students were at the concrete stage of cognitive thinking. Teachers should be responsible in ensuring the level of the students’ level of cognitive thinking improved. They could inculcate the thinking skills in the classroom by stressing the importance of formal (abstract) thinking skills. This could be done by providing the students with thinking operations in their homework and classroom activities. The frequency of these activities would improve their level of cognitive thinking.

The students’ chemistry achievement was at the low level. The research finding showed that there was a weak relationship between the chemistry achievement and the level of cognitive thinking. It is recommended that teachers could improve the both variables by using concrete examples and real life situations when teaching the mole concepts. Learning would take place when meaningful understanding of the concepts had first been constructed. Lawson, Nordland and DeVito (1975) made similar recommendation.
5.4 Recommendations for further research

1) This research is a correlational study. It did not investigate a causal relationship. It is recommended that further research be carried out to investigate the causal relationship on the variables. Such investigation would enhance the understanding on the factors affecting the students’ achievement in chemistry.

2) Further research could be carried out by involving more data to verify the results.

3) Similar research could be done but on the different level of educations, such as on the primary and the university students. It is hoped that such comparative study would give clearer pictures on the variables and thus enhancing their potential in the learning of science.

4) A qualitative research to explore the students’ cognitive abilities is recommended. Research method involving interviewing of students and observing their learning activities would give an ‘insight’ of the students’ cognitive abilities.

5.5 Conclusion

The students’ cognitive styles and the level of cognitive thinking should be taken into account in the teaching and learning of chemistry. Teaching styles that matched the students’ cognitive styles could enhance the students learning. As a conclusion, teachers should reflect on their current teaching practices and match the needs of the students. More problem solving activities should be emphasized in the teaching and learning process.
Appendix A
RELATIONSHIP BETWEEN COGNITIVE STYLES, LEVELS OF COGNITIVE THINKING AND CHEMISTRY ACHIEVEMENT AMONG FORM FOUR SCIENCE STUDENTS

THE GROUP EMBEDDED FIGURES TEST (GEFT)

Instructions:

1. The aim of the test is to determine the students' cognitive styles.
   [Ujian ini bertujuan untuk menentukan gaya kognitif pelajar]

2. The test consists of 3 sections.
   [Ujian ini mengandungi 3 bahagian]

3. You are only given 15 minutes to answer all the questions. Please wait for further instructions before proceeding to the various sections.
   [Anda hanya diberi 15 minit untuk menjawab semua soalan. Sila tunggu arahan selanjutnya sebelum anda menjawab soalan-soalan]

4. All the information gathered in this test will be used solely for research purposes and will be kept confidential.
   [Semua maklumat yang diperolehi dalam ujian ini digunakan untuk kajian semata-mata. Semua jawapan yang anda beri akan dirahsiaikan]

5. Your kind cooperation is very much appreciated. Thank you.
   [Kerjasama anda amat dihargai dan diucapkan riah terima kasih]

MEOR IBRAHIM KAMARUDDIN
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This test paper consists of 15 printed pages including the cover page
Bahagian A

Maklumat diri pelajar:
Arahan: Sila isikan perkara-perkara di bawah

1. Nama Sekolah:

2. Jantina:

☐ 1 - lelaki
☐ 2 - perempuan

3. Gred bagi mata pelajaran matematik yang diperolehi dalam Peperiksaan Menengah Rendah:

☐ 1 - A
☐ 2 - B
☐ 3 - C
☐ 4 - D
☐ 5 - E

4. Gred bagi mata pelajaran sains yang diperolehi dalam Peperiksaan Menengah Rendah:

☐ 1 - A
☐ 2 - B
☐ 3 - C
☐ 4 - D
☐ 5 - E
Bahagian B

ARAHAH:

Ini adalah suatu ujian untuk menguji kebolehan anda untuk mencari satu bentuk mudah apabila ia disembunyikan di dalam suatu bentuk yang kompleks.

Rajah di bawah menunjukkan bentuk mudah yang ditandakan "X"

![Diagram of triangle]

Bentuk mudah "X" itu disembunyikan di dalam rajah yang lebih kompleks di bawah:

![Diagram of cube]

Cuba cari bentuk mudah itu di dalam rajah kompleks yang diebri dan tandakan bentuk "X" itu dengan pensel di atas rajah kompleks tersebut. Bentuk "X" yang disembunyikan itu adalah SAMA SAIZ, SAMA PANJANG SISI dan MENUJU ARAH YANG SAMA di dalam rajah kompleks.

Apabila anda sudah selesai, lihat muka surat sebelah untuk menyemak jawapan anda.
Ini adalah penyelesaian yang betul, dengan bentuk mudah di atas garisan-garis garisan rajah kompleks:

Perhatikan bahawa segitiga kanan adalah yang betul. Segitiga kiri adalah serupa, tetapi menuju arah yang berlawanan, maka ia tidak betul.

Sekarang cuba satu lagi masalah. Cari dan tandakan bentuk mudah "Y" di dalam rajah kompleks berikut:

Lihat muka surat sebelah untuk penyelesaian yang betul.

**Perhatian:**

1. **Lihat bentuk-bentuk mudah pada muka surat belakang seberapa kali yang dikehendaki.**
2. **PADAMKAN SEMUA KESILAPAN YANG MUNGKIN ANDA LAKUKAN.**
3. **Selesaikan masalah mengikut susunannya.** Anda hanya boleh tinggalkan suatu masalah apabila anda betul-betul tidak dapat menyelasaikannya.
4. **Tandakan SATU BENTUK MUDAH SAHAJA DALAM SETIAP RAJAH KOMPLEKS.** Anda mungkin lihat lebih daripada satu bentuk mudah tetapi tandakan satu sahaja.
5. **Bentuk mudah itu akan didapati di dalam rajah kompleks mengikut saiz yang sama, panjang sisi yang sama dan menuju arah yang sama seperti bentuk yang didapati pada muka surat belakang set kertas ini.**

*Jangan lihat muka surat berikutnya sehingga diberitahu.*
Penyelesaian

Masalah-masalah seperti di atas akan diberi dalam muka surat berikutnya. Pada setiap muka surat berikutnya, anda akan melihat suatu bentuk kompleks dan di bawahnya diberi huruf yang sesuai dengan bentuk mudah yang disembunyikan dalam dalamnya. Bagi setiap masalah, lihat muka surat di belakang set kertas ini untuk melihat bentuk mudah yang hendak dicari. Selepas itu, cuba tandakan bentuk mudah itu dengan pensel di atas rajah kompleks tersebut.

Perhatian:

1. Lihat bentuk-bentuk mudah pada muka surat belakang seberapa kali yang dikehendaki.
2. PADAMKAN SEMUA KESILAPAN YANG MUNGKIN ANDA LAKUKAN.
4. Tandakan SATU BENTUK MUDAH SAHAJA DALAM SETIAP RAJAH KOMPLEKS. Anda mungkin lihat lebih daripada satu bentuk mudah tetapi tandakan satu sahaja.
5. Bentuk mudah itu akan didapati di dalam rajah kompleks mengikut saiz yang sama, panjang sisi yang sama dan menuju arah yang sama seperti bentuk yang didapati pada muka surat belakang set kertas ini.

_Jangan lihat muka surat berikutnya sehingga diberitahu._
BAHAGIAN PERTAMA

1. Cari bentuk mudah “B”

2. Cari bentuk mudah “G”

3. Cari bentuk mudah “D”

LIHAT SERPIAH
4. Cari bentuk mudah "E"

5. Cari bentuk mudah "C"

6. Cari bentuk mudah "F"
Cari bentuk mudah "A"

Berhenti di sini. Tunggu arahan seterusnya.
BAHAGIAN KEDUA

Cari bentuk mudah “G”

Cari bentuk mudah “A”

Cari bentuk mudah “G”
Cari bentuk mudah “E”

5.

Cari bentuk mudah “B”

5.

Cari bentuk mudah “C”
7. Cari bentuk mudah “E”

8. Cari bentuk mudah “D”

9. Cari bentuk mudah “H”

Berhenti di sini. Tunggu arahan seterusnya.
BAHAGIAN KETIGA

1. Cari bentuk mudah “F”

2. Cari bentuk mudah “G”

3. Cari bentuk mudah “C”
4. Cari bentuk mudah “E”

5. Cari bentuk mudah “B”

6. Cari bentuk mudah “E”
Cari bentuk mudah “A”

Cari bentuk mudah “C”

Cari bentuk mudah “A”

Berhenti di sini. Tunggu arahan seterusnya.
7.

Cari bentuk mudah "A"

8.

Cari bentuk mudah "C"

9.

Cari bentuk mudah "A"

Berhenti di sini. Tunggu arahan seterusnya.
A  
B  
C  
D  
E  
F  
G  
H
Appendix B
APPENDIX B

UNIVERSITI TEKNOLOGI MALAYSIA
FAKULTI PENDIDIKAN

RELATIONSHIP BETWEEN COGNITIVE STYLES, LEVELS OF COGNITIVE THINKING AND CHEMISTRY ACHIEVEMENT AMONG FORM FOUR SCIENCE STUDENTS

THE GROUP ASSESSMENT OF LOGICAL THINKING (GALT)

Instructions:

1. The aim of the test is to determine the students' level of cognitive thinking.
   [Ujian ini bertujuan untuk mengenalpasti tahap pemikiran kognitif pelajar]

2. The test consists of 12 questions.
   [Ujian ini mengandungi 12 soalan]

3. Please answer all the questions. The duration of the test is 40 minutes.
   [Silahkan jawab semua soalan. Tempoh ujian ialah 40 minit]

4. All the information gathered in this test will be used solely for research purposes and will be kept confidential.
   [Semua maklumat yang diperolehi dalam ujian ini digunakan untuk kejadian semata-mata. Semua jawapan yang anda beri akan dirahsiaakan]

5. Your kind cooperation is very much appreciated. Thank you.
   [Kerjasama anda amat dihargai dan diucapkan ribuan terima kasih]

MEOR IBRAHIM KAMARUDDIN
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This test paper consists of 13 printed pages including the cover page
Arahan bagi soalan 1 hingga soalan 10:
Bulatkan satu jawapan yang tepat sahaja daripada pilihan A hingga E atau A dan B.
Bulatkan juga satu alasan untuk jawapan anda daripada alasan-alasan yang disenaraikan.

Soalan 1.

Panjang Bandul
Tiga utas tali digantung pada sebatang kayu. Tali #1 dan tali #3 sama panjang. Tali #2 pula lebih panjang daripada kedua-dua tali #1 dan #3. Karim meletakkan satu beban 5 unit di hujung tali #2 dan tali #3 dan satu beban 10 unit di hujung tali #1.

Rajah 1.

Karim ingin meneliti sama ada panjang tali mempengaruhi masa yang diambil oleh beban untuk membuat satu ayunan lengkap. Tali dan beban yang manakah yang boleh digunakan oleh Karim dalam ujikajinya?
A. Tali #1, #2 dan #3
B. Tali #1 dan #3
C. Tali #2 sahaja
D. Tali #2 dan #3
E. Tali #1 dan #2

Alasan:
1. Panjang tali sepertinya sama dan beban sepertinya berlainan berat.
2. Sepertinya dijui panjang tali yang berbeza dan beban yang berbeza.
4. Hanya tali yang terpanjang yang sepertinya dijui kerana ujikaji ini melibatkan panjang bukannya berat.
5. Semua faktor perlu sama kecuali panjang tali supaya dapat dilihat sama ada panjang tali yang berbeza mempengaruhi masa ayunan atau tidak.
Soalan 2.

Bola dan Landasan

Mei Lin mempunyai satu landasan melengkung yang di tengah-tengahnya diletakkan sebiji bola sasaran seperti dalam Rajah 2 (a) di bawah.

![Diagram Rajah 2(a)](image1)


![Diagram Rajah 2(b)](image2)

Mei Lin melepaskan bola yang ringan dari kedudukan yang rendah dan bola itu bergolek ke tengah landasan lalu melanggar bola sasaran. Bola sasaran tertolak naik ke bahagian yang bertentangan pada landasan. Mei Lin ingin menyelidik sama ada kedudukan di mana bola dilepaskan mempengaruhi jarak bola sasaran itu bergerak. Untuk mengujinya, bola yang manakah seharusnya dipilih oleh Mei Lin untuk dilepaskan dari kedudukan yang tinggi?
A. Bola yang ringan
B. Bola yang berat

Alasan
1. Oleh kerana Mei Lin bermula dengan bola yang ringan, jadi seharusnya dia menyelesaikan dengan bola yang sama.
2. Mei Lin telah menggunakan bola ringan untuk kali pertama, jadi seharusnya dia menggunakan bola yang lain pula.
4. Bola ringan yang sama seharusnya dilepaskan dari kedudukan yang tinggi supaya keputusan dapat dibandingkan dengan sewajarnya.
5. Bola yang sama mesti digunakan kerana berat bola tidak mempengaruhi ujikaji.
Sealan 4.

Bebola Tanah Liat
Chandran mempunyai dua bebola tanah liat yang sama saiz dan bentuk. Bila kedua-dua bebola tanah liat diletak di atas penimbang, didapati berat kedua-dua tanah liat itu sama.

![Diagram](image)

Rajah 4(a)

Kedua-dua tanah liat itu kemudiannya dikeluarkan dari ceper penimbang dan tanah liat 2 dileperkan.

![Diagram](image)

Rajah 4(b)

Manakah di antara kenyataan berikut benar?
A. Tanah liat yang leper lebih ringan.
B. Berat kedua-dua tanah liat itu masih sama.
C. Tanah liat yang bulat lebih berat.
D. Tanah liat yang leper lebih berat.
E. Berat kedua-dua tanah liat itu tidak sama.

Alasan:
1. Chandran tidak menambahkan atau mengurangkan berat kedua-dua tanah liat itu.
2. Apabila tanah liat 2 dileperkan, tanah liat itu mempunyai luas permukaan yang lebih besar maka lebih tumpat.
3. Bila sesuatu benda dileperkan, benda itu akan kehilangan sebahagian daripada beratnya.
4. Oleh kerana bentuk dan ketumpatannya, tanah liat yang berbentuk bola mempunyai lebih tanah liat di dalamnya.
5. Bentuk kedua-dua tanah liat berubah maka berat kedua-dua tanah liat juga akan berubah.
Soalan 3.

Tikus
Seorang petani telah membuat pemerhatian terhadap tikus-tikus di ladangnya. Dia mendapati bahawa ada tikus-tikus yang gemuk dan yang kurus. Tikus-tikus tersebut juga mempunyai ekor yang berwarna sama ada hitam atau putih. Petani itu berpendapat bahawa ada kemungkinan terdapat perkaitan di antara saiz tikus dengan warna ekor. Tikus-tikus tersebut ditangkap dan didapati tikus-tikus itu adalah seperti ditunjukkan dalam rajah di bawah:-

Rajah 3

Pada pendapat anda adakah perkaitan antara saiz tikus dengan warna ekor (iaitu, adakah kebanyakan tikus yang besar hanya mempunyai warna ekor yang tertentu dan sebaliknya) ?

A. Tiada
B. Ada

Alasan
1. \( \frac{8}{11} \) daripada tikus-tikus yang gemuk mempunyai ekor yang berwarna hitam dan \( \frac{3}{4} \) daripada tikus-tikus yang kurus mempunyai ekor yang berwarna putih.
2. Tikus-tikus yang gemuk dan kurus boleh mempunyai ekor berwarna sama ada hitam atau putih.
3. Tidak semua tikus gemuk mempunyai ekor berwarna hitam dan tidak semua tikus kurus mempunyai ekor berwarna putih.
4. 18 ekor tikus mempunyai ekor berwarna hitam dan 12 ekor tikus mempunyai ekor berwarna putih.
5. 22 ekor tikus adalah gemuk dan 8 ekor tikus adalah kurus.
Soalan 5.

Guli Logam
Ah Chong mempunyai dua buah bekas yang sama saiz dan bentuk. Setiap bekas disisihkan dengan air yang sama banyak.

![Diagram 5(a)](image)

Dia juga mempunyai dua biji guli logam yang sama isipadu. Satu daripada guli itu lebih ringan daripada yang satu lagi. Ah Chong memasukkan guli logam yang ringan ke dalam bekas 1. Ini menyebabkan paras air dalam bekas 1 naik.

![Diagram 5(b)](image)

Apakah yang akan berlaku jika guli berat dimasukkan ke dalam bekas 2?
A. paras air akan naik ke suatu paras yang lebih rendah daripada paras air dalam bekas 1.
B. paras air akan naik ke suatu paras yang lebih tinggi daripada paras air dalam bekas 1.
C. paras air akan naik ke paras yang sama dengan paras air dalam bekas 1.
D. paras air dalam bekas 2 tidak berubah.
E. paras air dalam bekas 2 tidak dapat ditentukan.

Alasan:
1. Kedua-dua guli logam mempunyai saiz yang sama jadi kedua-duanya memenuhi ruang yang sama besar.
2. Semakin berat guli logam itu, semakin tinggi paras air itu naik.
3. Semakin berat guli logam itu, semakin rendah paras air itu naik.
4. Guli yang lebih berat mempunyai tekanan yang lebih tinggi, jadi paras air dalam bekas 2 lebih rendah daripada paras air dalam bekas 1.
5. Oleh kerana berat guli-guli yang digunakan berlainan maka paras air tidak dapat ditentukan.
Soalan 6.
Bentuk-bentuk Segiempat dan Intan

Salmiah mendapati bahawa ada kepingan-kepingan berbentuk segiempat dan kepingan-kepingan berbentuk intan di dalam sebuah karung kain. Bilangan kepingan-kepingan itu adalah seperti ditunjukkan dalam Rajah 6 di bawah:

3 kepingan segiempat berbintik

4 kepingan segiempat hitam

5 kepingan segiempat putih

4 kepingan intan berbintik

2 kepingan intan hitam

3 kepingan intan putih

Rajah 6

Salmiah mendapati saiz dan bentuk kesemua kepingan segiempat itu sama. Kepingan-kepingan intan juga mempunyai saiz dan bentuk yang sama. Kalau satu kepingan dicabut keluar daripada karung kain, apakah kebarangkaliannya kepingan yang dicabut keluar adalah kepingan berbintik?

A. 1 daripada 3
B. 1 daripada 4
C. 1 daripada 7
D. 1 daripada 21
E. lain-lain

Alasan:
1. Terdapat 21 kepingan di dalam karung kain itu. Satu kepingan berbintik mesti dipilih daripada bilangan ini.
2. Satu kepingan berbintik perlu dipilih daripada sejumlah 7 kepingan berbintik.
3. 7 daripada 21 kepingan adalah kepingan berbintik.
4. Terdapat 3 set di dalam karung kain itu, 1 set daripadanya adalah berbintik.
5. $\frac{1}{3}$ daripada kepingan segiempat itu dan $\frac{4}{7}$ daripada kepingan intan itu adalah berbintik.
Soalan 7.

Saiz Gelas

Rajah 7 di bawah menunjukkan sebuah bekas besar dan sebuah bekas kecil. Di sebelahnya terdapat sebiji gelas kecil dan sebiji gelas besar.

![Diagram of beakers and glasses](image)

Rajah 7

Lotchumi memerlukan 15 gelas kecil air dan 9 gelas besar air untuk mengisi bekas yang besar. 10 gelas kecil air diperlukan untuk mengisi bekas yang kecil. Berapa gelas besar air diperlukan untuk mengisi bekas yang kecil itu?

A. 4  
B. 5  
C. 6  
D. 7  
E. Tidak dapat ditentukan.

Alasan :

1. Kurang daripada 15 gelas kecil air diperlukan untuk mengisi bekas kecil. Jadi kurang daripada 9 gelas besar air diperlukan untuk mengisi bekas yang sama.
2. Nisbah gelas kecil kepada gelas besar sentiasa 5 per 3.
4. Tiada cara untuk meramalkannya.
Soalan 8.

Penimbang

Johari mempunyai satu necara seperti di bawah :-

\[ \text{Rajah 8(a)} \]

Apabila Johari menggantungkan satu beban 10 unit pada titik D, neraca itu kelihatan condong seperti dalam Rajah 8(b) di bawah:

\[ \text{Rajah 8(b)} \]

Di manakah seharusnya Johari menggantung satu beban 5 unit untuk mengimbangkan neraca itu semula ?

A. pada titik J  
B. di tengah K dan L  
C. pada titik L  
D. di tengah L dan M  
E. pada titik M

Alasan :
1. Berat beban 5 unit separuh daripada berat beban pertama jadi seharusnya digantung pada jarak dua kali jarak beban pertama.
2. Pada jarak yang sama seperti beban pertama tetapi pada arah yang bertentangan.
3. Beban 5 unit itu digantung sejauh mana yang boleh untuk bersepaduan dengan saiznya yang kecil.
4. Titik hujung memberikan lebih daya untuk menjadikan neraca itu seimbang semula.
5. Semakin ringan beban itu, semakin jauh ia sepatutnya digantung.
Soalan 9.

Bentuk-bentuk Segiempat dan Intan

Di dalam sebuah kotak terdapat kepingan-kepingan berbentuk segiempat dan kepingan-kepingan berbentuk intan. Bilangan kepingan-kepingan itu adalah seperti ditunjukkan dalam rajah di bawah:

3 kepingan segiempat berbintik
4 kepingan segiempat hitam
5 kepingan segiempat putih
4 kepingan intan berbintik
2 kepingan intan hitam
3 kepingan intan putih

Rajah 9

Kesemua kepingan segiempat itu sama saiz dan bentuk. Kepingan-kepingan intan juga mempunyai saiz dan bentuk yang sama. Apakah kebarangkaliannya mengambil keluar 1 kepingan intan berbintik atau 1 kepingan intan putih?

A. 1 daripada 3
B. 1 daripada 9
C. 9 daripada 21
D. 1 daripada 21
E. lain-lain

Alasan:

1. 7 daripada 21 kepingan itu adalah kepingan intan berbintik atau kepingan intan putih.
2. \( \frac{1}{7} \) daripada kepingan berbintik dan \( \frac{3}{14} \) daripada kepingan putih adalah berbentuk intan.
3. \( \frac{9}{21} \) kepingan adalah kepingan berbentuk intan.
4. 1 kepingan intan perlu dipilih daripada sejumlah 21 kepingan dalam kotak itu.
5. Terdapat 9 kepingan intan di dalam kotak itu. 1 kepingan mesti dipilih daripada jumlah ini.
Soalan 10

Ikan

Chee Keong memelihara ikan di dalam sebuah akuarium. Sebahagian daripada ikan-ikan itu adalah ikan besar dan sebahagian lagi adalah ikan kecil. Sebahagian daripada ikan-ikan tersebut berjulur lebar pada badannya dan sebahagian lagi bergaris-garis halus pada badannya. (Lihat rajah di bawah)

Rajah 10

Adakah terdapat perkaitan di antara saiz ikan dengan jenis jalur yang terdapat pada badan ikan-ikan tersebut?

A. Tidak
B. Ya

Alasan:
1. Ikan yang besar atau yang kecil boleh mempunyai sama ada jalur lebar atau garis-garis halus.
2. \( \frac{3}{7} \) daripada ikan yang besar dan \( \frac{9}{21} \) daripada ikan yang kecil mempunyai jalur besar.
3. 7 ekor ikan adalah besar 21 yang lain adalah kecil.
4. Tidak semua ikan yang besar mempunyai jalur lebar dan tidak semua ikan yang kecil mempunyai garis-garis halus.
5. \( \frac{12}{28} \) daripada ikan-ikan itu mempunyai jalur lebar dan \( \frac{16}{28} \) daripada ikan-ikan itu mempunyai garis-garis halus.
Arahan:
Bagi soalan 11 dan 12, anda dikehendaki menulis jawapan yang tepat dan jelas di atas ruangan yang telah disediakan pada kertas jawapan.

Soalan 11.

Pusat Membeli Belah

Dalam sebuah pusat membeli belah yang baru dibina, terdapat 4 buah kedai yang akan diletak pada paras bawah (ground floor) bangunan tersebut. Empat buah kedai tersebut adalah sebuah kedai gunting rambut (G), sebuah kedai pajak gadai (P), sebuah kedai runcit (R) dan sebuah kedai minuman (M).

<table>
<thead>
<tr>
<th>G</th>
<th>P</th>
<th>R</th>
<th>M</th>
</tr>
</thead>
</table>

Rajah 11

Satu cara penyusunan yang mungkin bagi kedai-kedai tersebut adalah mengikut urutan GPRM. Ini bermakna kedai gunting rambut disusun dahulu, diikuti oleh kedai pajak gadai dan kedai runcit dan akhirnya kedai minuman. Senaraikan cara-cara yang lain supaya kedai-kedai itu dapat disusunkan dalam 4 lokasi yang berlainan. Jawapan anda hendaklah disusun mengikut contoh urutan seperti di atas iaitu GPRM
Selesai makan malam beberapa orang remaja bercadang untuk pergi menari. Terdapat tiga orang remaja lelaki iaitu Ahmad (A), Beng Teong (B) dan Chandran (C), dan 3 orang remaja perempuan iaitu Devi (D), Eng Ling (E) dan Fatimah (F).

![Illustration of characters]

Salah satu pasangan penari yang mungkin ialah A-F (Ahmad dengan Fatimah). Senarai semua pasangan penari yang mungkin. Diingatkan bahawa remaja lelaki tidak boleh berpasangan dengan remaja lelaki dan remaja perempuan tidak boleh berpasangan dengan remaja perempuan.
Appendix C
APPENDIX C

UNIVERSITI TEKNOLOGI MALAYSIA
FAKULTI PENDIDIKAN

RELATIONSHIP BETWEEN COGNITIVE STYLES, LEVELS OF COGNITIVE THINKING AND CHEMISTRY ACHIEVEMENT AMONG FORM FOUR SCIENCE STUDENTS

"THE CHEMISTRY ACHIEVEMENT TEST (CAT)

Instructions:

1. The aim of the test is to determine the students' understanding of the mole concepts
   [Ujian ini bertujuan untuk menentukan kefahaman pelajar dalam konsep mol]

2. The test consists of 10 questions.
   [Ujian ini mengandungi 10 soalan]

3. Please answer all the questions. The duration of the test is 40 minutes.
   [Sila jawab semua soalan. Tempoh ujian ialah 40 minit]

4. All the information gathered in this test will be used solely for research purposes
   and will be kept confidential.
   [Semua maklumat yang diperolehi dalam ujian ini digunakan untuk kajian semata-mata. Semua jawapan yang anda beri akan dirahsiakan]

5. Your kind cooperation is very much appreciated. Thank you.
   [Kerjasama anda amat dihargai dan diucapkan ribuan terima kasih]

MEOR IBRAHIM KAMARUDDIN
Fakulti Pendidikan
Universiti Teknologi Malaysia
Kertas soalan ini terdiri daripada 10 soalan yang berkaitan dengan konsep mol dalam mata pelajaran kimia. Sila jawab setiap soalan yang dikemukakan. SILA
TUNJUKKAN SEMUA JALAN KERJA YANG TERLIBAT. Jawapan anda adalah rahsia.

1. Adakah 9.0 g air mempunyai bilangan molekul yang sama banyak dengan 14.0 g gas hidrogen?
   [Jisim atom relatif: H, 1; N, 14; O,16; Ketumpatan air, 1 g/cm³; ketumpatan gas hidrogen, 0.00009 g/cm³]

2. Tanpa melakukan pengiraan terlebih dahulu, tentukan sama ada 10.0 g sulfur atau 10.0 g stanum mempunyai bilangan atom yang sama banyak. [Jisim Atom Relatif: S, 32; Sn, 119; Pemalar Avogadro: $6.02 \times 10^{23}$ mol⁻¹]

Seimbangkan persamaan berikut.

$$\text{Ca(OH)}_2 + \text{H}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + \text{H}_2\text{O}$$
4. Serotonin ialah satu sebatian yang boleh mengkonduksikan impuls saraf di dalam otak. Ia terdiri daripada 68.2% C, 6.86% H, 15.9% N dan 9.08% O. Jisim sebatian tersebut ialah 100g. Cari jisim bagi setiap komponen tersebut. Seterusnya, cari bilangan mol dan nisbah bilangan mol terkecil bagi sebatian tersebut. Jika jisim molar sebatian ini ialah 176 g/mol, apakah formula molekul bagi sebatian ini? [Jisim Atom Relatif: C, 12; H, 1; N, 14; O, 16; Pemalar Avogadro : $6.02 \times 10^{23}$ mol$^{-1}$]

5. Seorang pelajar telah menemui masalah mengira formula molekul bagi sesuatu jenis hidrokarbon. Hidrokarbon tersebut mengandungi 82.76% karbon mengikut jisim. Jisim sebatian ini ialah 100g. Jika jisim molekul relatif bagi hidrokarbon ini ialah 58, apakah formula molekul bagi hidrokarbon ini? [Jisim atom relatif : H, 1; C, 12]
6. Seorang pelajar telah menulis persamaan kimia bagi mewakili satu tindak balas yang telah dialakukan di makmal kimia. Persamaan tersebut adalah seperti berikut:
\[ \text{PbNO}_3 (\text{ce}) + \text{K}_2 (\text{SO}_4) (\text{ce}) \rightarrow \text{Pb(SO}_4) (\text{p}) + \text{KNO}_3 (\text{ce}) \]
*Kenal pasti kesilapan-kesilapan* yang telah dilakukan oleh pelajar tersebut.

7. Diberikan maklumat ialah ia:

<table>
<thead>
<tr>
<th>Sejenis sebatian molekul,</th>
<th>Jisim molar = 172 g mol(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berbau seperti limau,</td>
<td>Formula empirik = C(<em>3)H(</em>{10})O</td>
</tr>
</tbody>
</table>

Maklumat di atas merupakan ciri-ciri bahan kimia iaitu perasa tiruan limau yang digunakan dalam pembuatan kek dan biskut. [Jisim Atom Relatif: H, 1; C, 12; O, 16; Pemalar Avogadro : 6.02 × 10\(^{23}\) mol\(^{-1}\)] Nyatakan dua *maklumat* yang dapat ditafsirkan daripada formula empirik perasa tiruan itu.

8. P, Q, R dan S ialah empat sampel bahan yang berada pada keadaan suhu bilik.

| P – 24 dm\(^3\) gas nitrogen | Q – 8 g gas hidrogen |
| R – 20 g cecair bromin        | S – 12 g magnesium  |

Susunkan sampel-sampel P, Q, R dan S menurut urutan bilangan atom yang semakin bertambah. [Jisim Atom Relatif: H, 1; Mg, 24; Br, 80; Isipadu molar gas, 24 dm\(^3\) mol\(^{-1}\) pada keadaan suhu bilik]
9. Dalam eksperimen bagi penentuan formula empirik sebatian magnesium oksida, apakah hipotesis yang boleh anda bentuk bagi eksperimen tersebut. Bagaimanakah anda menguji hipotesis-hipotesis yang anda cadangkan? Apakah pemboleh ubah yang dikawal, dimanipulasi dan bergerak balas (bersandar)?

10. | Jisim mangkuk pijar + tudung | 212.60 g |
    | Jisim mangkuk pijar + tudung + serbuk Zn | 214.35 g |
    | Jisim mangkuk pijar + tudung + serbuk zink oksida | 215.03 g |

Jadual di atas menunjukkan keputusan bagi satu eksperimen di makmal. Berdasarkan kepada keputusan di atas, tentukan formula empirik bagi zink oksida [Jisim Atom Relatif: O, 16; Zn, 65]
REFERENCES


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