Pratidhwani the Echo
A Peer-Reviewed International Journal of Humanities & Social Science
ISSN: 2278-5264 (Online) 2321-9319 (Print)
UGC Enlisted Serial No. 48666
Impact Factor: 6.28 *(Index Copernicus International)*
Volume-VII, Issue-I, July 2018, Page No. 292-300
Published by Dept. of Bengali, Karimganj College, Karimganj, Assam, India
Website: http://www.thecho.in

An Experimental Study on Chunking Strategy to Teach Electron Configuration

Sushovan Koner
ABS Academy, Durgapur
Chiranjit Pal
Ramananda College, Bishnupur, Bankura, W.B, India

Abstract

These Chunk-based strategy and mnemonics have been developed to count ground state electron configurations of elements, which is a common questions for the higher secondary (11/12) level general chemistry students. To assimilate a better understanding of the nature of chemical reactions, an adequate knowledge of the periodic table of elements is mandatory. Valence shell electrons of elements participate in redox chemical reactions. Chemistry students thus must be able to write electron configurations correctly. Here we have explained a chunking tool for determining the electron configurations of elements having atomic numbers up to 120.

Introduction: There is no doubt that higher secondary education is the most important stage of the total education system. An educated nation carries consciousness that helps the country to develop properly. Therefore every country should takes steps to make its people properly educated. Therefore education is an important criteria for preparing stable nation and higher secondary education is the final stage of it.

Electron configurations of elements and ions serve as key features to the understanding of chemical reactions. Many of the tasks that are presented to students in the area of chemical bonding rely upon the correct assignments of electron configurations to the atoms or ions in a compound.

Problems of higher secondary science students to determine electronic configuration: Determination of electron configurations for the elements and ions is a routine exercise that few introductory, general, or inorganic chemistry students escape. In our usual classroom instruction, it is experienced that the students can easily write the correct electron configurations of elements having lower atomic numbers, but they face greater difficulties in determining electron configurations of elements of higher atomic numbers especially for transition and rare earth elements.

To solve the problem: Chunk-based strategy and mnemonics have been developed to write ground state electron configurations of elements, which is a routine exercise for the higher secondary (pre-university) level general chemistry students. To assimilate a better understanding of the nature of chemical reactions, an adequate knowledge of the periodic table of elements is mandatory. Valence shell electrons of elements participate in redox chemical reactions. Chemistry students thus must be able to write electron configurations correctly. Here we have explored a chunking tool for determining the electron configurations of elements having atomic numbers up to 120.

Previous methods to determine electronic configuration and to remember the process: A number of methods have been previously developed for determining ground state electron configurations of neutral, isolated poly-electron systems. These methods are based upon the Aufbau principle associated with increasing order of energy of the sub levels to predict electron configurations. The most widely accepted strategies of determining electron configurations of elements are collated in Figure 2. The strategies are very similar and follow the mnemonic scheme as first proposed by Yi (Figure 2A) in which electrons are fed into the sublevel diagonally with increasing energy. Later, Carpenter devised a strategy (Figure 2B) where electrons are placed into the orbitals vertically and then horizontally with increasing energy. Hovland derived a scaffolding technique by using the chessboard as a frame of reference for writing electron configuration (Figure 2C) where electrons are occupied into the orbitals left to right in a checkerboard with increasing energy of sublevels. Later, Parson constructed a left-to-right sequence of reading atomic orbitals (Figure 2D) for determination of electron configurations. In his scheme, the n number of s orbitals has been arranged vertically in numerical sequence in a right-justified column, and in the next column immediate to the left are the $(n - 1)$ number of p orbitals again in numerical sequence and so on for $(n - 2)$ number of d and $(n - 3)$ number of f orbitals. Here, electrons are put into the atomic orbitals from left to right sequence with increased energy. Most chemistry textbooks now teach a method where students produce electron configurations of elements using the periodic table. The arrangement of the periodic table provides a method for remembering the order of orbital filling. Beginning at the top left and moving across successive rows, the order is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, and so on. Our proposed methodology is a further investigation in this line that will assist the students to write electron configurations of elements accurately and quickly.

Recently proposed chunk method to determine electronic configuration: Chunking, a memorizing tool is often used for taking individual units of information and grouping them into larger units. By grouping disparate individual elements into larger blocks, information becomes easier to retain, recall, and recognize. The chunking strategy minimizes cognitive overload and thereby increases the student’s mental storage capacity. In terms of chunking, memory has been classified into two categories, namely short-term memory (STM or working memory) with limited capacity and long-term memory (LTM) with unlimited capacity. A schematic model of learning in terms of STM and LTM is shown in Figure 1.The STM acts as a temporary zone for activities such as reasoning, mental mathematics, and problem solving by processing the information from the LTM. In the LTM, the information is stored in connected pieces that can be retrieved by a single act of recognition. These pieces are designated as chunks. A chunk can then be defined as "a collection of elements having strong associations with one another, but weak associations with elements within other chunks". Chase and Simon and later Gobet, Retschitzki, and de Voogt showed that chunking could explain several phenomena linked to expertise in chess. Several successful computational models of learning and expertise have been developed using this idea such as EPAM (elementary perceiver and memorizer) and CHREST (chunk hierarchy and retrieval structures). Chunking has also been used with models of language acquisition and symbol sequences. Application of chunking strategy has been well documented in the literature of chemistry education covering areas such as chemistry problem solving, schemes, chemical equations, etc.

Objective of the study: We will teach students in two methods 1. Traditional method 2. Chunk- based method. But our aim is to observe which one a student can remember in better way between two methods.

Hypothesis: Provide the basis for reporting the conclusion of the study. The Hypothesis enables the investigator to select logically known facts to intelligent guesses about an unknown condition.

A Hypothesis determines the link between the problem and its proper solution. On the basis of review of related studies, the discussions held with express in the field and research's experiences the following hypothesis were framed.

- There is significant difference to remember (Rural Students) the determination of electronic configuration between traditional method and chunk based method
- There is significant difference to remember (Urban Students) the determination of electronic configuration between traditional method and chunk based method

Statement of the problem:

- The problem under study is –
- Students face greater difficulties in determining electron configurations of elements of higher atomic numbers especially for transition and rare earth element.

Area: Borsul High School in Purba Burdwan (Rural) District of West Bengal and Chandannagar Banga Vidyalaya (Urban)

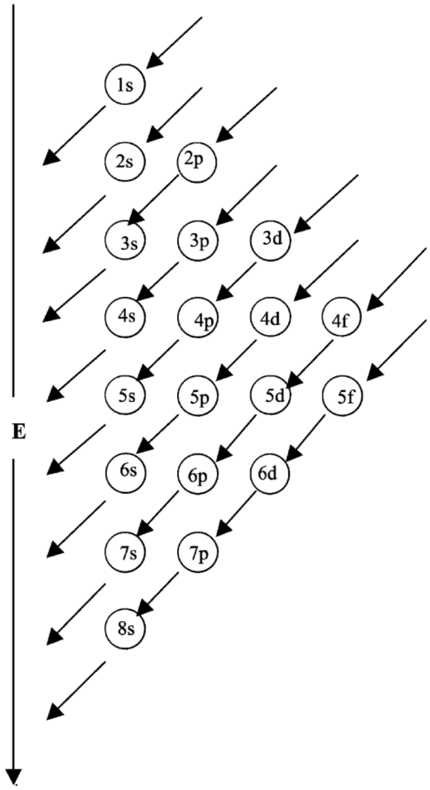
No of sample - 84

Design of the study: In descriptive research a researcher may analyse the data he has collected and discover the difference variables are related. The relationship between the variables can be interpreted in several ways. The researcher interprets his findings in one way and faces difficulty in eliminating possible alternate explanations of his findings because of the lesser control over the factor studied.

Experimental method on the other hand provides for much control and therefore establishes a systematic and logical association between manipulated factors and observed effects.

The researcher defines a problem and proposes a tentative answer and hypothesis. He tests the hypothesis and accepts or rejects it in the light of the controlled variable relationship that he has observed.

Control group: Students were selected as control group. They were taught in traditional method. The method is as follows:



Experimental Group: Students were selected as experimental group. They were taught in new method – chunk based method. This method is as follows:
The Aufbau building principle may be written in the following way, as a chunk-based mnemonic:
school school public school public school dawn public school dawn public school follow dawn public school follow dawn public school
(1)

Here, the phrase "school school" represents a chunk. Similarly, the phrase "public school public school" represents another chunk, and so on. The second chunk is framed by inserting the term "public" before each word "school", and the third chunk is generated by inserting the term "dawn" before each phrase "public school". In the same manner, the fourth chunk is made by placing the term "follow" before each term "dawn public school". In each chunk, there is a repetition of same terminology. For example, in chunk one, "school" is used two times; in chunk two, "public school" is used two times; in chunk three, "dawn public school" is used two times; and, same as before, in chunk four, "follow dawn public school" is used two times.

Step-1: Consider only the first letter of each word, and the above mnemonic phrase

Table 1. Shell Number and Assignment of Orbitals

Shell Number	Assignment of Orbitals			
1		1*s*		
2	2*s*		2*p*	
3	3*s*	3*p*	3*d*	
4	4*s*	4*p*	4*d*	4*f*
5	5*s*	5*p*	5*d*	5*f*
6	6*s*	6*p*	6*d*	
7	7*s*		7*p*	
8		8*s*		

becomes a chunk of appropriate orbital letter as follows:

sspspsdpsdpsfdpsfdps (2)

Step-2: Assign the orbitals by inserting numerals in increasing order before each orbital letter. Note that there are eight s orbitals in eq. 2, and they are assigned unique s orbital numbers from 1−8 (Table 1). As a result, the first chunk becomes 1s 2s. Again, there are six p orbitals in the above equation, and each p orbital is assigned unique p orbital numbers from 2−7. Hence, the second chunk becomes 2p 3s 3p 4s. In the same manner, the d orbital begins with 3, and the f orbital begins with 4. Therefore, we can easily say that the third chunk becomes 3d 4p 5s 4d 5p 6s, and the fourth chunk becomes 4f 5d 6p 7s 5f 6d 7p 8s. As a consequence, eq. 2 turns into

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p (3)

This is actually Aufbau's building-up principle written on one line. The expression (eq. 3) is the most reliable master skeleton for electron configurations of all the elements present in the periodic table.

Step-3: Now electrons are fed in each orbital by following the +4 rule (2, 2 + 4 (= 6), 2 + 4 + 4 (= 10), 2 + 4 + 4 + 4 (= 14)) for s, p, d, and f orbitals, respectively.
This means that the s orbital is occupied by a maximum of two electrons, the p orbital is occupied by a maximum of six electrons (2 + 4), the d orbital houses a maximum of 10 electrons (6 + 4), and the f orbital's maximum occupancy is 14 (10 + 4) (Table 2).

Step-4: Rearrangement of electron configurations for systematic and sequential presentation

Table 2. Maximum Number of Electrons That Orbitals Can Accommodate

Orbital	*s*	*p*	*d*	*f*
Max. no. of electrons	2	6	10	14

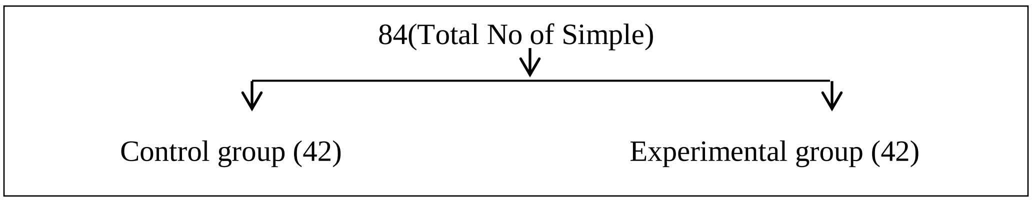
of outermost sub shells.
The use of our proposed chunking strategy for assigning electron configurations of elements may be understood clearly from the following examples.
Example 1: Electron configuration of 37Rb (s-block element).
Step-1: Consider the chunking topology:
ss p s p s d p s d p s f d p s f d p s.
Step-2: Assign the orbital numbers as mentioned. This results the skeleton as
1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f6d 7p 8s.
Step-3: Now electrons are fed in each orbital by following +4 rule, that is, the maximum occupancy for s, p, d, and f orbitals are 2, 6, 10, and 14 electrons, respectively. This results in the electronic configuration of $_{37}$Rb as $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6 5s^1$

Administration of questionnaire and collection of data

After instruction, learning outcomes have been quantified by applying an achievement test consisting of 10 problems on writing electron configurations of the elements. The students were allowed 40 min to answer the problems.

Presentation of data

It is often said that it is much easier to learn and remember that it is to think and investigate. The data is systematically classified and tabulated, scientifically analysed. The first system is presentation is the classification. The researcher in order to study the hypothesis frame for the present study, classified the total 84 sample into control group and experimental group.



Sample	Control Group			Sample	Experimental Group		
	Scores (X_1)	x_1	x_1^2		Scores (X_2)	x_2	x_2^2
1	7	1	1	1	9	1	1
2	5	-1	1	2	9	1	1
3	4	-2	4	3	7	-1	1
4	9	3	9	4	7	-1	1
5	5	-1	1	5	8	0	0
6	8	2	4	6	8	0	0
7	9	3	9	7	10	2	4
8	5	-1	1	8	5	-3	9
9	6	0	0	9	10	2	4
10	6	0	0	10	5	-3	9
11	4	-2	4	11	9	1	1
12	6	0	0	12	10	2	4
13	6	0	0	13	9	1	1
14	5	-1	1	14	5	-3	9
15	4	-2	4	15	7	1	1
16	9	3	9	16	10	2	4
17	9	3	9	17	10	2	4
18	7	1	1	18	9	1	1
19	5	-1	1	19	7	-1	1
20	6	0	0	20	7	-1	1
21	5	-1	1	21	7	-1	1
22	5	-1	1	22	6	-2	4
23	4	-2	4	23	8	0	0
24	5	-1	1	24	10	2	4
$\sum X_1 = 144$ Mean (M_1) = 6.0		$\sum x_1 = 32$	$\sum x_1^2 = 66$	$\sum X_2 = 192$ Mean $(M_2) = 8$		$\sum x_2 = 34$	$\sum x_2^2 = 66$

Chandannagar Banga Vidyalaya

$$S.D\ (\sigma_1) = \frac{\sum f(x_1^2)}{N} = \frac{66}{24} = 2.75;\ S.D\ (\sigma_2) = 2.75$$

$$t = \frac{M_1 \sim M_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}} = \frac{2}{\sqrt{0.315 + 0.315}} = \frac{2}{\sqrt{0.630}} = 2.52$$

From **t test** we get **t value**= 2.52 which is significant at 0.01 level.

BORSUL HIGH SCHOOL

Sample	Control Group			Sample	Experimental Group		
	Scores (X_1)	x_1	x_1^2		Scores (X_2)	x_2	x_2^2
1	8	1.5	2.25	1	7	-1	1
2	7	0.5	0.25	2	8	0	0
3	8	1.5	2.25	3	9	1	1
4	4	-2.5	6.25	4	10	2	`4
5	7	0.5	0.25	5	6	-2	4
6	8	1.5	2.25	6	7	-1	1
7	5	-1.5	2.25	7	8	0	0
8	5	-1.5	2.25	8	8	0	0
9	6	-0.5	0.25	9	6	-2	4
10	6	-0.5	0.25	10	6	-2	4
11	5	-1.5	2.25	11	8	0	0
12	8	1.5	2.25	12	9	1	1
13	4	-2.5	6.25	13	8	0	0
14	6	-0.5	0.25	14	6	-2	4
15	7	0.5	0.25	15	9	1	1
16	8	1.5	2.25	16	9	1	1
17	8	1.5	2.25	17	10	2	4
18	7	0.5	0.25	18	10	2	4
$\sum X_1 = 117$ Mean $(M_1) = 6.5$		$\sum x_1 = 22$	$\sum x_1^2 = 34.5$	$\sum X_2 = 144$ Mean $(M_2) = 8$		$\sum x_2 = 20$	$\sum x_2^2 = 34$

$$S.D\ (\sigma_1) = \frac{\sum f(x_1^2)}{N} = \frac{34.5}{18} = 1.91;\ S.D\ (\sigma_2) = \frac{\sum f(x_2^2)}{N} = \frac{34}{18} = 1.88$$

$$t = \frac{M_1 \sim M_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}} = \frac{1.5}{\sqrt{0.2026 + 0.1963}} = \frac{1.5}{0.63} = 2.38$$

From **t test** we get **t value**= 2.38 which is significant at 0.01 level.

Presentation, Analysis and Interpretation of Data

The response detained from 84 students of Borsul High School in Burdwan (Rural) and Chandannagar Banga Vidyalaya (Urban) of West Bengal were systematically tabulated and analysed properly.

There is significant difference to remember the determination of electronic configuration between traditional method and chunk – based method.

Analysis Hypothesis: There is significant difference to remember (Both Rural and Urban) the determination of electronic configuration between traditional method and chunk based method.

References:

(1) *Adhikary,C; Sana,S; Chattopadhyay, K.N. Chunking Strategy as a Tool for Teaching Electron Configuration. J.Chem.educ.*

(2) *Miller, G. A. The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. Psychol. Rev.1956, 63, 81−97.*

(3) *Afflerbach, P.; Pearson, P. D.; Paris, S. H. Clarifying Differences between Reading Skills and Reading Strategies. Reading Teach. 2008, 61 (5), 364−373.*

(4) *Reid, N. A. Scientific Approach to the Teaching of Chemistry. What Do We Know about How Students Learn in the Sciences, and How Can We Make Our Teaching Match This to Maximize Performance? Chem. Educ. Res. Pract. 2008, 9, 51−59.*

(5) *Johnstone, A. H. Chemistry Teaching□Science or Alchemy? J.Chem. Educ. 1997, 74, 262−268.*

(6) *Baddeley, A. D. Essentials of Human Memory; Psychology Press:East Sussex, UK, 1999.*

(7) *Gobet, F.; Lane, P. C. R.; Croker, S.; Cheng, P. C. H.; Jones, G.; Oliver, I.; Pine, J. M. Chunking Mechanisms in Human Learning. Trends Cognit. Sci. 2001, 5, 236−243.*

(8) *Chase, W. G.; Simon, H. A. Perception in Chess. Cognit. Psychol. 1973, 4, 55−81.*

(9) *Gobet, F.; de Voogt, A. J.; Retschitzki, J. Moves in Mind. The Psychology of Board Games; Psychology Press: Hove, UK, 2004.*

(10) *Lah, N. C.; Satt, R. M.; Hassan, R. Cognitive Strategy in learning Chemistry: How Chunking and Learning Get Together. Malays. Online J. Educ. Sci. 2014, 2 (1), 9−15.*

(11) *Pearson, W. H. A General Chemistry Laboratory Experiment Relating Electron Configuration and Magnetic Behavior. J. Chem. Educ.2014, 91, 116−118.*

(12) *Bonneau, M. The Quantum Shoe Store and Electron Structure. Appl. Analogies 1991, 68, 837.*