

Cognitive Strategy In Learning Chemistry: How Chunking And Learning Get Together

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ABSTRACT

The study explores chunking strategies applied in Short Term Memory (STM) by upper secondary students of mixed chemistry learning abilities. The aim of the study is to observe variations in chunking strategies utilized by these students when learning the Periodic Table of Elements in the Form Four Chemistry syllabus. Findings show that students applied varied chunking strategies, of which, three patterns prevailed at STM level: similar chunking, mixed chunking, and characteristic chunking. Secondary school teachers in guiding their students through the Chemistry learning process should remain mindful of presenting didactic materials in a way that not only accommodates the students' various chunking strategies abilities needs, but at the same time hone the students' learning skills.

Keywords: *chunking strategies, cognitive strategies, Short Term Memory*

INTRODUCTION

Chunking strategy is a cognitive strategy applied to enhance mental performance (Afflerbach et al., 2008). It involves the reorganizing of bulk information into various smaller chunks without adding or subtracting the quantity of new information being acquired. Reorganization of information occurs at the pattern finding level within the set of items to be stored in STM. The items are then grouped together based on perceptual principles such as similarity or proximity to make them more meaningful (Gilchrist & Cowan, 2012). In our case, the information was grouped based on similar characteristics which could easily, comfortably and confidently be identified at the retrieval level. Three chunking strategies were identified in this study: mixed chunking, similar chunking and characteristic chunking. Mixed chunking entails an information reduction process which sees large piece of information reduced into smaller and more manageable information chunks containing different numbers of elements. Similar chunking consists of separating information into similar elements, whereas characteristic chunking is influenced by elements of similar pronunciation or other characteristics providing strong connection to each other.

Chunking Strategy in Learning Process

Chunking is a significant learning strategy aimed at overcoming Short Term Memory (STM) limitations. Miller (1956) characterized chunking as a process of combining different items into a meaningful larger unit that facilitates item storage in STM. The chunking strategy reduces cognitive overload therefore increasing the learner's mental storage capacity. For instance, in learning how to spell *H-O-R-S-E*, five storage unit in the STM are required. However, if a learner associates the meaning of 'HORSE' to the animal itself, he or she would only need one storage unit. The strategy moves up to a higher assistive rank if the learner conjures up a schema, or associates the word with background knowledge of the animal.

According to West, Farmer, and Wolff (1991), chunking strategy is a mental process grouped into three categories: linear chunking, taxonomic and multipurpose. Linear chunking is information arranged into time, space or process as controlled by the history chronology. Taxonomic chunking is the process of arranging information as observed in Bloom's Taxonomy for cognitive domain, whereas the multipurpose chunking involves the mechanism of arranging based on either the volume or the lack of information learned.

Chunking strategy according to Banikowski and Alison (1999) is significantly different from that of Miller (1956). In Banikowski and Alison, a 24 numbers unit was chunked into six smaller unit of numbers, with the apparent conclusion that the six small chunk units were easier to recall. Nonetheless, they came to the same conclusion as Miller, that a smaller storage unit at the STM level was needed to execute this mental process. Banikowski and Alison (1999) also found that learners of less cognitive ability tended to have very limited STM. In this case, they highlighted the teachers often made the mistake of regularly providing large units of information in short periods of time disabling the learners' ability to process the information at STM level. A more recent study by Zhou (2005) illustrates how chunking strategy involving the breaking up of large information or concepts into smaller segments, enable learners to manage the smaller segmented information and therefore improve Chinese language learning. Zhou's study is in line with the chunking strategy presented by Banikowski and Alison (1999).

The chunking strategy importance in the teaching and learning process led us to this specific study which undertakes an in-depth study of the chunking strategy at STM level by form four Chemistry Students of mixed learning abilities.

METHODOLOGY

This is a qualitative data collection technique study involving six mixed ability learners via purposive sampling. Three data collection techniques were utilized with the main data obtained from interview and supported data gained from observation and document analysis. In this study, the document analysis was carried out using the learner's own journal.

Data Collection and Analysis

Thirty-six verbatim transcriptions were collected from six participants, Maula and Joy representing high achievers, Amirah and Carol are the average achievers, and Adrieana and Nadirah are the low achievers. All the names used are not the student's real names to protect their privacy and anonymity. The data analysis was based on the use of chunking strategy variations employed by the six learners in completing their assignments; labelled as cognitive strategy task (cost).

Cost 1 - Assignment to memorize and understand twenty elements in the Periodic Table with reference to their proton number.

Cost 2 - Assignment to memorize and understand forty elements in the Periodic Table referring to periodic table location.

Cost 3 - Assignment to memorize and understand forty monatomic ions.

Cost 4 - Assignment to memorize and understand cations and anions with different charges.

Cost 5 - Assignment to memorize and understand fourteen common polyatomic ions.

Cost 6 - Assignment to memorize and understand Metal Reactivity Series and Electrochemical series.

From the collected data, codes and categories were identified and a theme began to emerge. Each participant underwent six assignments on stages and based on thirty six sets of interview transcriptions, the coding process was done until the resilient theme emerged. Excerpt 1 illustrates how Adrieana used cognitive strategies, to assist her installing information in the STM.

Excerpt 1:

- Adriana: I have to **read out** everything first, then **repeat the elements myself**.
- Researcher: How many times?
- Adriana: Until I did it.
- Researcher: Any idea how many times?
- Adriana: Ten or more.
- Researcher: you repeat the whole list and repeat it again?
- Adriana: I started with **hydrogen first**, then **Helium, Lithium**, so I memorize in the chunks of three, then after I memorize **fourth positions Beryllium**, I did **Boron and Carbon**.
- Researcher: Boron and Carbon only?
- Adriana: after that **nitrogen, oxygen together because of the 'gen' behind**. Proton number 9 and 10 belongs to Chlorine and Neon...
- Researcher: Okay.

Rehearsal strategies were clearly observed during the interview, however, this strategy is not discussed in detail in this writing. Eight element names were chunked into smaller unit of information which consisted of five clustered of one, two, one, two, two information units. The unit one, two, one, two, two representing (Hydrogen), (Helium, Lithium), (Beryllium), (Boron, Carbon) (Chlorine, Neon). Characteristics chunking revealed by classifying nitrogen and oxygen together because of similarity on sound. Whereas Chlorine and Neon are associated with its proton number and Beryllium is associated with the position in the Periodic Tables. The data were analyzed and the overall findings are discussed in detail.

FINDINGS

The study has identified three main categories of chunking strategies amongst the six learners. These are mixed chunking strategy, similar chunking strategy and characteristic chunking strategy. The mixed chunking strategy required learners to group a large unit of information into several smaller chunks of different number of units. For example, if there are 12 units of information to be remembered, learners will group this 12 units into small groups of (5)(5)(2) or any combination of different but equivalent units to that of the original 12 units of information. Similarly, if there were 16 units of information to remember, learners will group these 16 units into small groups of (5)(5)(4)(2) or any other equivalent but different units that equals to that 16 unit of information. The similar chunking strategy differs slightly from the mixed chunking strategy in that when learners groups a set of 'large' units of learning into several smaller ones, the smaller groups have equal number of units. So, for example if there are 20 units of information to remember, learners will group the 20 units into small groups of (5)(5)(5)(5) or (4)(4)(4)(4)(4). The third main chunking strategy identified is the characteristic chunking strategy which was used by learners who grouped a 'large' unit of information into smaller groups based on similar characteristics such as name, formula, metal reaction to water and such like.

Mixed Chunking Strategy

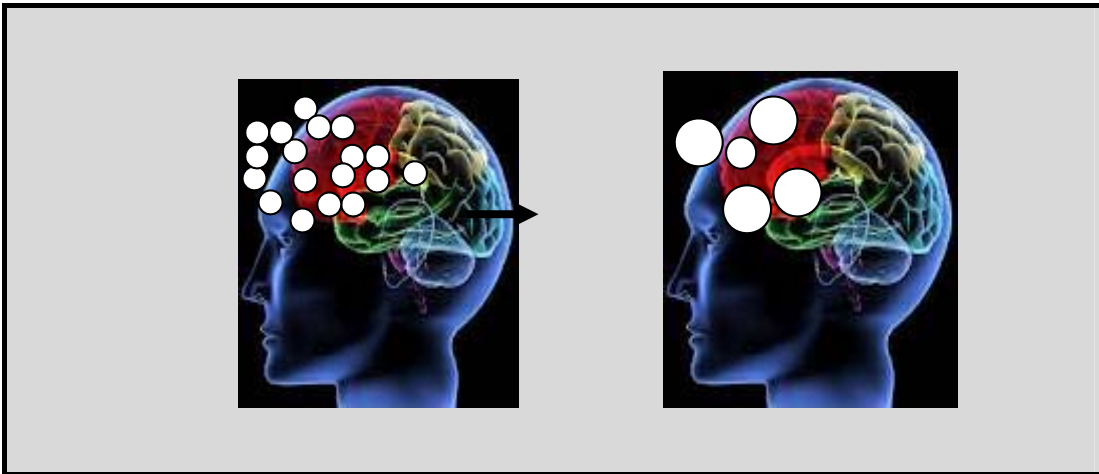


Figure 1. The chunking of 18 units of information to smaller units of (4)(4)(4)(4)(2).

From the 18 units of information learned, Joy, a high-achiever learner, grouped the information into five small chunks as illustrated in Figure 1. She used the mixed chunking strategy in which each of the small chunk had a chunk component of 4, 4, 4, 4 and 2 elements. In this case, the first small chunk consisted of *lithium, beryllium, boron* and *carbon*, the second chunk consists of *nitrogen, oxygen, chlorine* and *neon*, the third chunk consisted of *sodium, magnesium, aluminum* and *silicon*, the fourth chunk consisted of *phosphorus, sulphur, chlorine* and *argon* and the fifth chunk unit consisted of two elements *potassium* and *calcium*. Maula, another high-achiever, grouped 12 units of information into three sets of smaller chunks of (5)(2)(5) as illustrated in Figure 2. An interesting observation is the mixed chunking strategy applied by Adrieana, in the low-achiever learner category, which still applies the chunking strategy, although the 'large' unit of information to be recalled consisted of only six units, which were divided into three sets of (3)(1)(2) of much smaller chunks, as illustrated in Figure 3.

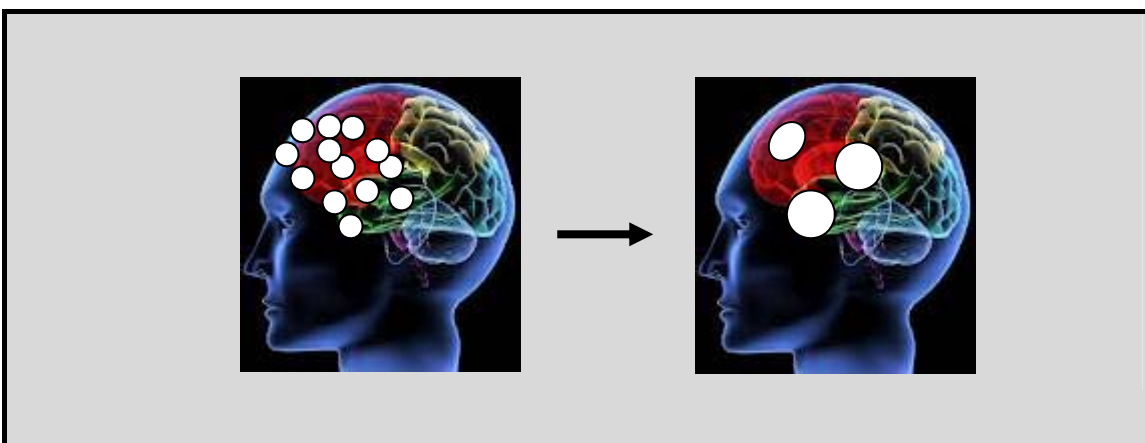


Figure 2. The chunking of 12 units of information to smaller units of (5)(2)(5).

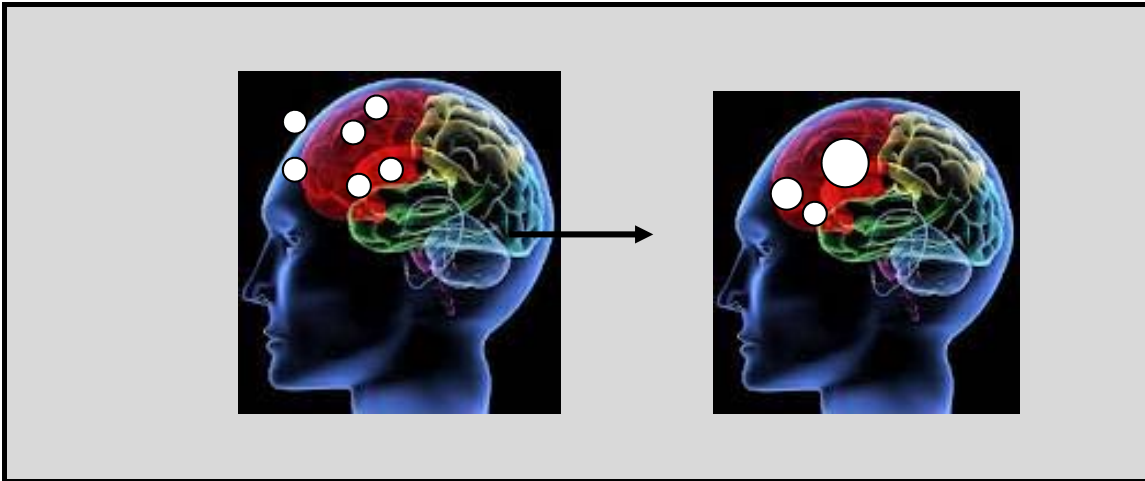


Figure 3. The chunking of 6 units of information to even more smaller units of (3)(1)(2).

The findings clearly demonstrate that the learners' use of mixed chunking strategy in order to enable themselves to remember the 'large' unit of information required to be recalled. This appears to be the learners' way of increasing their cognitive performance in their attempt to increase the transfer of more information at the STM level to LTM.

Similar Chunking Strategy

The similar chunking strategy is not much different from the mixed chunking strategy except for the learners chunking the larger unit of information into smaller groups of equal number of learning units, for example, chunking 15 units of information to three small of groups of (5)(5)(5). In this study, Maula, a higher-achiever learner, grouped a 20 units information chunk into ten small groups consisting of (2)(2)(2)(2)(2)(2)(2)(2)(2)(2). Maula claims that when he remembers the name of the first element, he can easily remember the name of the second element in the same small chunk. For example, in the small chunks of *hydrogen-helium*, when Maula remembers *hydrogen*, he automatically remembers *helium*. He describes the process that he goes through during the study as follows:

Mungkin kebiasaannya saya ingat secara berpasangan macam, hidrogen-helium, lithium-beryllium; bila saya ingat yang pertama, dengan sendirinya saya ingat yang kedua.

[Translated as: Maybe, as usual I tend to remember in pairs, like *hydrogen-helium*, *lithium-beryllium*; so when I remember the first (element), I naturally remember the second.]

The similar chunking strategy is further illustrated in Figure 4.

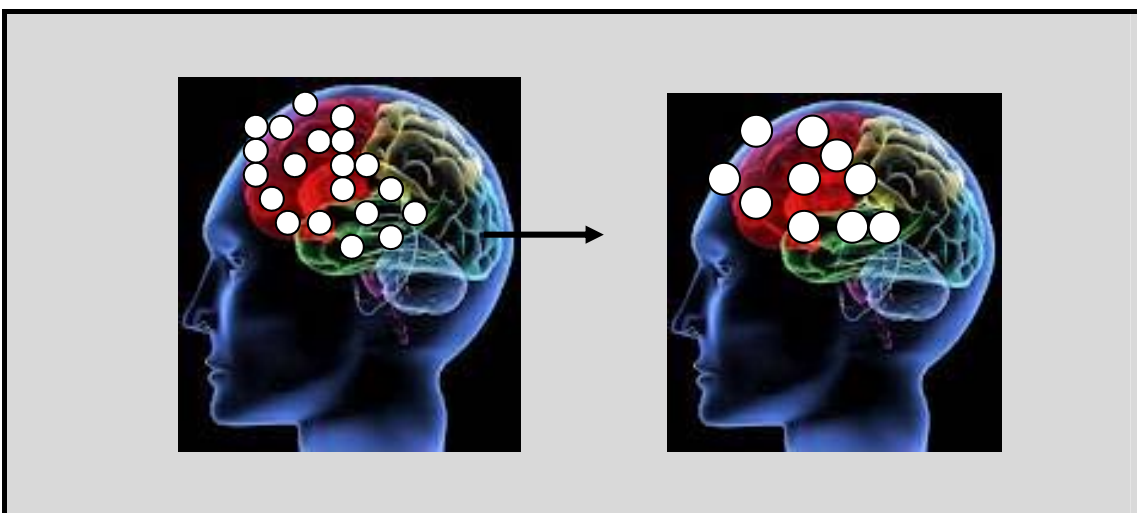


Figure 4. The chunking of 20 units of information to smaller units of (2)(2)(2)(2)(2)(2)(2)(2)(2)(2).

Characteristic Chunking Strategy

The third chunking strategy identified in this study is the characteristic chunking strategy. The first characteristic chunking strategy is based on the same charge ions. In the case of *argentum* and *copper*, Maula and Joy, both are high-achievers, grouped the two metals together because both have the same cation charge +1. The learners' journals also indicate that while doing Cost 5 assignment, both, Maula and Joy grouped the ion with one charge together, while ions having more than one charge are chunked in different groups. Both learners indicated that their strategy (characteristic chunking) helps them to store the information at LTM level.

The second characteristic chunking strategy is identified as based on similar (or near similar) name and formula. Amongst ions that fall into this category are *oxide ion* (O^{2-}) and *peroxide ion* (O_2^{2-}) which are placed in the same group. The study also identifies the third characteristic chunking strategy which shares the same name ending. In this context, *hydrogen*, *helium*, *lithium* and *beryllium* are placed in the same group because they (except for hydrogen) share the same 'ium' ending, whereas *chlorine*, *bromine* and *iodine* are placed together in another group because of their 'ine' ending. Based on the study, all learners from all mixed ability groups indicated that each of the chunking group that they have created had its own meaningful connection.

The fourth chunking strategy is characterized by metal reactivity with water. *Lithium*, *sodium* and *potassium* are grouped together because all three metals dissolve in water. This specific characteristic enables learners to retrieve the information from LTM when required. Another characteristic chunking strategy identified is based on the characteristics of metal. Maula (one of the high-achievers) placed *platinum*, *gold* and *mercury* together based on the fact that all three are metals. This information is helpful for Maula during the retrieval process. The study also found that some learners combine two chunking strategies, for example, the characteristic and similar chunking strategies, in their attempt at better information retrieval from LTM.

Figure 5 captures all the three main chunking strategies encountered in this study; the mixed chunking strategy, the similar chunking strategy and the characteristic chunking strategy.

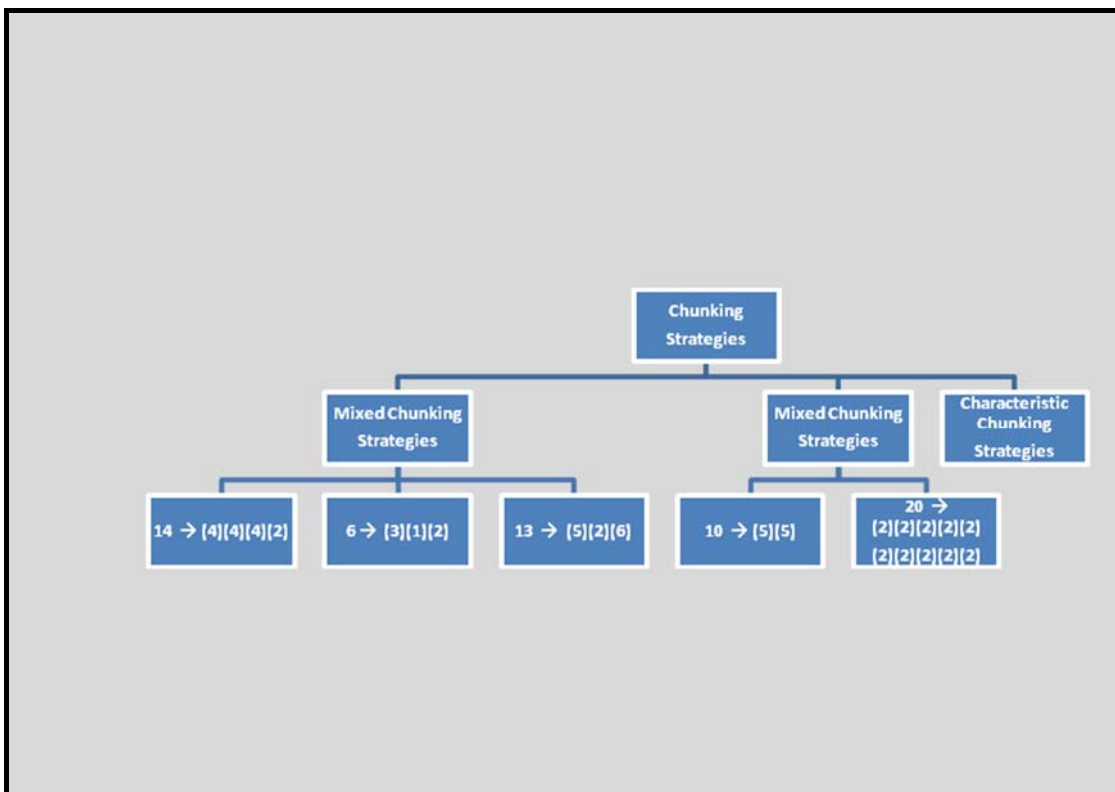


Figure 5. Three main chunking strategies at STM level.

DISCUSSION

The study finds that based on the three main chunking strategies, high-achiever learners (Maula and Joy) tend to utilize all the identified chunking strategies. They also indicated other positive characteristics such as less time taken in applying the chunking strategies compared to their average and lower-achiever counterparts. These findings seem to align with Mori (2010) which demonstrated that high-achiever learners are able to use time wisely as well as more actively and constantly monitor their own learning performance. The chunking strategies used by the average and low achievers tend to be slightly different from the high-achievers in which they still use the chunking strategies even though the quantity of information that needs to be remembered is little. This can be traced back to when Adriana, one of the low-achievers, still needed to chunk six units of information into (3)(1)(2). This finding is in line with Miller's (1956) assertion that the chunking of large unit of information to several smaller ones helps to reduce learners' cognitive load in the learning process.

IMPLICATIONS AND CONCLUSIONS

In this study, three types of chunking strategies were identified in the learning process of six Form Four participants. The findings are significant in understanding how learners learn, and further assists teachers in selecting the most appropriate teaching strategy that enables students of various cognitive levels to learn and practice effective cognitive strategies.

From a practical point of view, awareness of the chunking strategies utilized by students will also assist teachers to guide their students to optimize their learning in the often limited face to face time frame. From a theoretical perspective, this study is expected to enhance the understanding of other researchers in the fields of educational science on human cognitive systems in general, and specifically the understanding of how learners learn using various cognitive strategies effectively. Thus, the condition which evolves in the human mind during the learning process can be better understood.

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