Journal of Research, Policy & Practice of Teachers &
Teacher Education
Vol. 6, No. 2, December 2016, 45-59

Mental models of the concept of carbon cycle via self-generated visualisation among matriculation college science students

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Among the objectives of this study was to identify and explain matriculation college science student's mental models generated from self-visualisation of the concept of the carbon cycle. Five students were purposively sampled and the study was carried out in a naturalistic setting qualitative approach. Data was collected through a visualisation task and followed by interviews. The constant comparative qualitative technique was used to analyse differences and similarities that led to patterns in their mental visualisation. Findings showed two patterns of mental models; namely pictorial and graphical mental models. These students visualised themselves from their own experiences and made relationships to their prior and new knowledge. Keyword selection coincided with the concept used for the generation of visualisation. This study expects to help formulate a framework for teaching and learning to guide students to generate a significant mental visualisation of abstract science concepts.

Keywords: Self-generated visualisation, science abstract concept, cognitive visual, information processing, science education.

Introduction

Research in science education, globally at the college level over the past 30 years has been mostly focused on teaching and learning in introductory courses for science majors (McClary & Talanquer, 2010). In fact, science education system in Malaysia is still facing some issues primarily concerned with the pedagogical methods as the teaching practice is still based on the conventional, one-way learning and passive (Maria, 2014). This issue does not only involve the teaching of teachers in imparting knowledge on certain concepts (Tengku Zawasi, Ramlee & Abdul Razak, 2009), but there are issues involving problems of students in the mastery of abstract concepts of science (Esther, 2002; Maria, 2003; Roszelina, 2011). This matter still continues with research done by Lilia (2013) that 35% students in Malaysia failed to master the concept of the abstract.

Studies by Esther (2002) and Maria (2003) found that among the factors that led to the difficulties in learning and teaching was due to the failure of students to 'see' and

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describe precisely the concepts they are learning particularly the abstract concept. The continuing weakness caused the students to give up until they decided to memorize facts and details without fully understand the abstract concepts. Furthermore, a failure to understand and master this abstract concept often invited to misconceptions on these topics. According to Collins (2003), the misconception was an important factor that affects student learning. Until now, students learned topics abstract concept in science subjects such as Cell Division, still suffered from misconceptions and consider this topic is difficult (Elangovan & Zurida, 2013). Studies conducted by researchers who have conducted research on the topics of abstract concept also recognize that students experiencing misconceptions. Among the topics were abstract Genetics (Tekkaya, 2002; Elrod, 2007), Photosynthesis, Ecology, The Circulatory System (Tekkaya, 2002) and The Expression of Biological Information (Yeoh, 2013).

Background of the study

Teachers, as mentors to students, must address this issue with various strategy and one of them is to use the ability to generate visualisation. Recognizing this, Mnguni (2014) suggested that teachers make a paradigm shift in their teaching methods. Attention should be given to the process of generating mental visualisation to help students master the concepts of the good and effective abstract. Visualisation skills are necessary that students are able to "see", understand and master the abstract concept of study. In fact, when students learn science concept in this meaningful way, they build mental models of it, just as scientists do (Glynn, 1997). This opinion is in line with the statement by Schwartz (1993) found that understanding will lead to an increase in memory to the concept. However, Abu Talib (2005) suggested that the constructed mental models need to be accurate and correct according to the abstract concept learned.

The purpose of this study is to help students to develop insight during their learning in an abstract concept, to retrieve information stored in memory, to generate conclusions, solve problems and make decisions. For the teachers, this study will provide guidelines or model for them to be more creative in diversifying the design, technique or teaching method which involve visual as a teaching aid so that the information processed by the thinking of students can be better understood and kept in long-term memory. It is undeniable that there are many relevant kinds of literature on visualisation, but the results are not consistent (Mnguni 2009) especially those in local studies on the using of cognitive science learning is still less attention (Norma, Rohaida, & Ruhaya, 2013). There is a need to investigate what type of mental models generated from self-visualisation on the abstract concept of science. This study will also help educators to adjust their teaching strategies to a cognitive level of students to visualise abstract concepts in science subjects.

Self-generated visualisation

Visualisation in teaching and learning is a thinking process because it involves thought processes that use images, diagrams and mental simulation (Reiner, 2008). Encoding information received by the students can be triggered, generate and build mental models they consciously and so can transmit and create knowledge (Bilbokaite, 2008; Reiner, 2008). Visualisation requires individual effort in producing, selecting and build their self-image in order to help understand a concept thus fundamental to the process of active thinking, reasoning, creation, and problem-solving related to science education (Kosslyn, Pinker, Smith, & Schwartz, 1982). The ability to generate a visualisation should be given more attention and increased efforts in finalizing the structure and cognitive science in the minds

of these students. This is consistent with reports by Schwartz (1993) that if students are given the opportunity to build its own visualisation and experienced utility to describe, they can adopt strategies of visualisation as a general study to understand more complex information. Visualisation involving cognitive functions such as recognition process, learning and memory (Anderson, 1999). However, to enable the visualisation of raising students' self-applicable, it starts from the teachers who teach these subjects. Teacher imparting knowledge through visualisation and presented to the students (Rowell & Guilbert, 1996). Thus, the ability of students to self-generate accurate visualisation and is compatible with the proper guidance to enable students to absorb knowledge and knowledge is flowing to the maximum level.

Self-generated visualisation is an individual effort to produce, choose and build a mental picture of themselves to help achieve an understanding of a concept thus fundamental to the process of active thinking, reasoning, creation, and problem-solving related to science education (Kosslyn et al., 1982). In dealing with abstract concepts, students have to think and make a picture, thus the students need to generate constructive visualisation. Ashcraft (1989) emphasised that the construction of a mental representation of the visualisation process act as a constructivist and many researchers interested on how visualisation is valid. Learning about abstract concepts enable students to remember facts of the concept in the long run because it involves the understanding in the more complicated cognitive individual, for example, to understand the meaning of the concept, how it connects people who want to get gouged by the keywords contained in the abstract concept, how individuals identify strategies that can be used to understand concepts and overall, how individuals resolve questions if there are questions from the abstract concept. Self-generated visualisation in understanding and mastering the abstract concept is a critical competency for the students (Mnguni, 2014). Develop a visualisation system on abstract data is a challenging task as it requires finding the appropriate visual for information and concepts represented by these data. These systems should provide an overview of abstract data, even for large volumes, to support users in carrying out cognitive activities such as holding information in the data, identifying the characteristics and patterns that exist in the data, verify data, make decisions and others. Only visualisation system can work as an efficient external assistance to improve the cognitive abilities of users to work with data in the abstract. Therefore, students need effective strategies to generate their visualisation of abstract concepts and this could be as evident when a lot of research in this decade focused on the cognitive structure of how to restructure student knowledge learned (Hsieh & Cifuentes, 2006; Mnguni, 2007, Sadiah, 2007, Gilbert 2008; Gilbert, Reiner & Nakhlekh, 2008). One of the ways is by drawing mental models where it can benefit students in all science disciplines because the process helps students to consolidate information about a concept, visualising their own thought (Alerby, 2000) and identify misconceptions (Glynn, 1997).

Mental model in self-generated visualisation

According to the theory of mental models, in solving problems, humanly depends on the mental picture built and this construction depends on the information contained within the scope of the problem. The resulting mental picture might be in the form of imagery (Gilbert, 2008) or mental models (Johnson-Laird, 1980). Imagery is the image either in single or in groups and isolated from the other images. For example, a person needs to imagine a house. Home has envisaged the possibility of the house, single house, several houses or homes that have different shapes. This picture is an imagery. This is because the images produced have no relationship with each other as well as no specific concept that relates to each other.

While the mental model is generated images in a mental image, but the resulting images have a narrative as the concept explained the relationship. A mental model represents a small scale as desired and deemed appropriate by the idea. Mental models are the basis of one or more visual images, but some of them represent a situation that can not be seen. From the viewpoint of processing, the theory of mental models of Johnson-Laird (1980) distinguishes three different operations in the generation of this visualisation. In the construction phase, reasoners build a mental picture that depicts information from the long-term memory. In phase inspection, the resulting visual reviewed to find new information that is not clearly provided by the individual memory while the phase changes, the individual will try to build an alternative model of mind that denies the alleged conclusions. Therefore, individuals need to generate and build a mental model generated from a precise, accurate visualisation (Abu Talib, 2005). This method opens a window into students' minds, allowing teachers to examine students' mental models of science concept (Glynn, 1997).

The main idea of the theory of mental models (Johnson-Laird, 1980) is an analogy of the structural mental model to a situation being modelled. Sometimes a model records what is normally detected by senses, in all different ways and in any possibility that may have occurred during the experience passed by the individual. However, sometimes, some reasoners cannot describe the whole set of mental images generated. Thus, there is a chance that the person will focus on a subset of the mental model that could lead to incorrect conclusions and decisions which could not be logical. Generating visual work serves as a useful guide to getting information, as such, determine what concepts students understand, and what knowledge gaps they may have (Glynn, 1997). Constructivist learning requires teachers to identify the visualisation generated by the students and confirming understanding with students to provide feedback and clarification in teaching. This is because the understanding of students, whether there are misconceptions or the like can be explored through an understanding of their mental model (Greca & Moreira, 2000). A mental model is possible to determine if students are fully knowledgeable about all concept's features and how those features fit together (Glynn, 1997).

Research methodology

The aim of this study was to develop a model of self-generated visualisation on science abstract concept among students of matriculation college in Malaysia. Among the objectives to be achieved in this study is to analyse and describe the mental models that result from the self-generated visualisation on the science abstract topics: carbon cycle.This is a preliminary study involving five matriculation college science students(Zafira, Aziana, Sha, Khai and Fiqah). These students were selected by purposive sampling as they have studied the ecology of sub-topics, namely the carbon cycle and will give the best possible access to the process of successfully implementing the qualitative study (Sbraini, Carter, Evans & Blinkhorn, 2011).

A simple task but able to elicit student thinking about an abstract concept has been constructed as a research instrument. Carbon cycle visualisation tasks only require students to draw on what they understand the concept. Drawing mental models is a diagnostic tool for probing the depths of students' understanding of a subject (Glynn, 1997). In this study, the researchers expect the respondents to produce a document graphic sketch of the mental picture. According to Sadiah (2007), drawing students' understanding in graphic form to make it more useful as an explicit knowledge structure and error and students easy alternative concept in effect. This statement was supported by Esther (2013) and Glynn (1997) that drawing is a natural way to help the students to build mental models of key concepts. Furthermore, drawing is a hands-on and minds-on activity that inherently

constructive and motivating for any students. During the task, the respondents were not disturbed even if they had done some errors because this method is to help them integrate their knowledge into a mental model (Glynn, 1997). The time allocated is for 20 minutes and all students were able to complete the task without any problems.

As for getting the information about the visual cognitive in more detail, the researcher used open-ended interviews for probing questions. Each student who has completed the task must undergo the interview. This interview was conducted in an hour (Sbraini, Carter, Evans & Blinkhorn, 2011). The respondents were interviewed in a discussion room in the school's library as it is a convenient place to them. The interviews were used to collect data using descriptive sentences were raised by the respondents so that the researchers can study how they develop responses interpretation of a work study (Bogdan & Biklen, 2007). Interview protocol questions were based loosely on the sketches document tasks. Among the questions in the protocol is to ask the students to explain why they drew the model the way they did (Glynn, 1997). The interviews were audio recorded, professionally transcribed and members checked to test the reliability.

Collecting and analysing data in this study need to be run concurrently. This is because the main features of this method are the comparison of data by categories that arise through the collection and analysis of data simultaneously. The analysis is done by creating categorization information on mental visualisation of the form that has been sketched and transcripts of interviews with students as well as reinforced by the findings of the analysis of audio recordings and researchers memo. These findings were triangulated with researchers memo, mental picture sketch and observations during the generation process occur. This method allows researchers to generate more information on the data collected from the sample (Strauss & Corbin, 1990) and to generate theories based on collecting data to be analysed systematically (Charmaaz, 2000; Fraenkel & Wallen, 2003). Constant comparison technique and coding in analysing data used to track new ideas and themes arising from what the study respondents and the categorization of the visualisation (Strauss & Corbin, 1990).

Research findings

The matriculation college science students have successfully completed the tasks given by the researchers timely. The analysis was performed on a sketch of the assignment document and supported by excerpts from the students' interviews. Findings in terms of similarities and differences as well as the pattern emerged. Self-generated visualisation is defined as a mental model built by students that indicates a relationship of mutual relevance of concepts such as comparison, sequence, and chronology. Visualisation can be presented in the form of drawings, diagrams, charts, plants, tables, graphs, a pyramid, a chain of cause and effect, timeliness, etc. (Hsieh, 2003). Visualisation generated by the students is the result of that thinking is done as a result of stimulation of the senses to abstract concepts and will demonstrate their understanding of the connection between the elements contained in the concept. This preliminary study has identified patterns of self-generated visualisation on the basis of the carbon cycle concept amongst the matriculation college students.

The study found that two out of five respondents generated pictorial mental models of their cognitive. The others had graphical mental models particularly concept mapping in which the students write the names of concepts and their subcategories, draw lines to connect them and label relationships between them as shown in theses respondents'mental models. Findings have shown that the students have generated a visualisation of their own to enable them to understand the whole concept. Some related episodic personal experienced, or whether through reading and vision help these students to describe the situation and relate

it to the concept studied. The episodic experiences are essential in developing self-visualisation as this information are already stored in long-term memory and can be retrieved (Atkinson & Shiffrin, 1968). Thus, the keywords identified, guided the students to retrieve and elicit the information needed to make a logical relationship. This relationship helps them to make the connection between prior and new knowledge and consolidate their understanding and memory towards this concept. These findings are elaborated in themes as followed.

Pattern: Graphical Mental Models

a) Word emphasization

In sketching mental picture, Zafira, Syafiqah and Wany showed the details of the difference in giving meaning to the concept. For example in Figure 1, Zafira's sketch showed some words that are not rounded. These details are distinguished by the details of words circled. When the researchers asked about the details of the Zafira purposely do so to show the differences in the use of word processing. For example, photosynthesis, decay, respiration, fossilization, deposition, diffuse and combustion processes are needed in the exchange of carbon cycle. Continued analysis of this sketch shows that these students simply state the basic concepts that we've ever learned are roughly the student does not show detailed information in the description of this understanding of the carbon cycle. For example the use of carbon by organisms such as algae, cyanobacteria, and terrestrial plants. The sketch also does not specify what happens to the carbon in the form of exchange and elaboration of this concept is not described in detail.

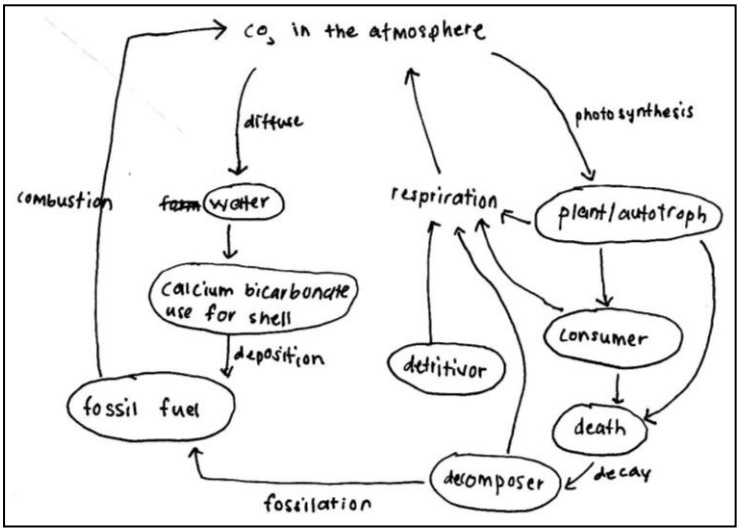

Figure 1. Zafira, carbon cycle

b) Self-learning

The analysis was carried out on an interview with them, the researchers were able to identify the use of visualisation in students' self-produce their mental images. Syafiqah, for

instance has been using visualisation during her self-learning to obtain an understanding of the carbon cycle as shown in Figure 2 and the generation of self-visualisation is the first stage in the process of considering this concept as stated in the interview follows:

Before going to memorize, I will understand this cycle. I imagine a cloud, plant, palm. After that, I make this cycle. This is my first stage to understanding and I did this during my study time.

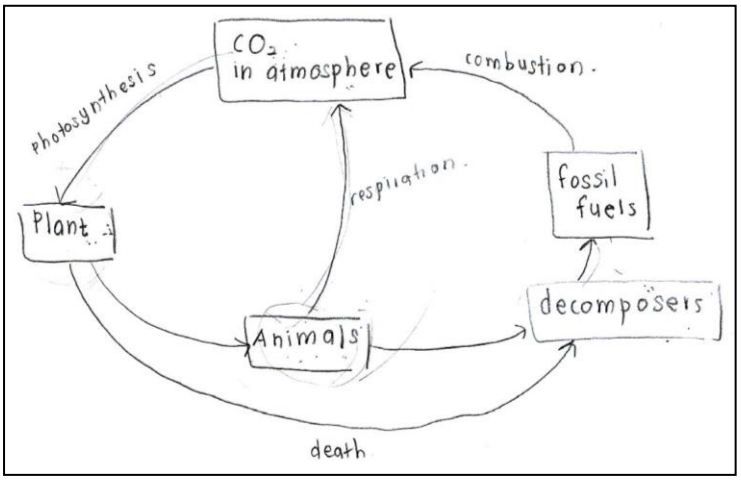

Figure 2. Syafiqah, carbon cycle

c) Keywords

In the process of generating the visualization, the student mind acts like watching television or camera that enabled them to see the shadow of their mind. Everything you've watched or through his experience in life, as a generation source. The resulting visualization is not a single image but the images are combined. The mental picture of this so called mental models (Johnson-Laird, 1980). However, the first thing figured in mind is the understanding of the words that appear on the task, for example carbon. The choice of the keyword guided the respondents to visualize, however transfer them in a form of words. These findings are from the following Figure 3 and Wany's interview,

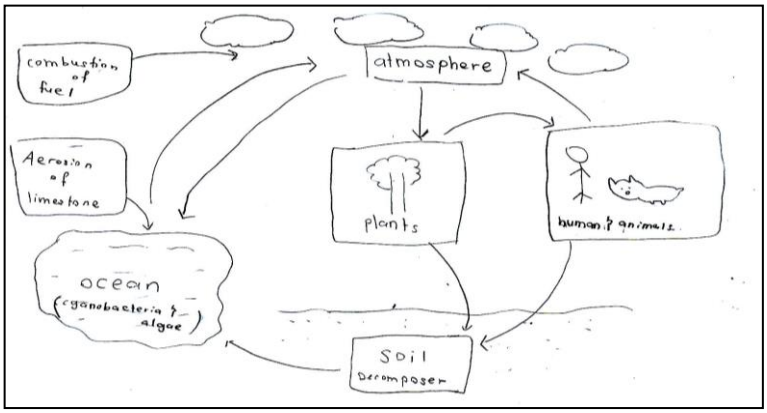

Figure 3**.** Wany, carbon cycle

At first, when I saw the word carbon dioxide, I can see the atmosphere. It was like I am in the air and there are cameras that show all that ...

excerpt of interview; *Wany.*

Next word in the assignment is the carbon cycle. All the girls then imagines a cycle that involves the use of carbon by organisms such as plants, animals, and decomposers. Generated visualization is a shadow moving as it involves the transformation of carbon by these organisms. Thus, the researcher's memo, picture like this give a rough and simple as showing no explanation for carbon transformation in detail. Is this a way to facilitate students' understanding of this concept? However, Zafira acknowledges that picture is created as a result of observation, experience, interaction with the environment and the combination of knowledge gained from the past. For example, observations on the plant during her trip to the smoky pre-university college. The reflex mind is carbon dioxide, the memory is stored in long-term memory and used when needed, for example in generating a visualization of the carbon cycle.

Pattern: Pictorial Mental Models

Sketches of both respondents showed significant similarities in terms organisms-organisms involved, namely animals, plants, and bonfires. This sketch highlighted to demonstrate the processes involved are like a tree that is associated with photosynthesis, bonfires with the production of carbon dioxide and animals that are associated with respiration. According to Paivio (1989), these images are easily visualised as they came from concrete words. This correlation can be made because it is a prior knowledge of students as the respondents in this excerpt:

It is in my knowledge. I learned it before
(Khai, ms 3/7)

Macro-organisms commonly viewed with the naked eye. However, animal art such as bacteria, the parser (a decomposer) is not drawn. This is because microorganisms don't clearly visible to the naked eye, thus does not exist in the minds of the respondents. Interview participant explained as follows:

..decomposer and detritivores are small creatures..it can barely see with eyes.. it is very hard to visualise, so I just write down the words

(Sha, ms 4/7)

a) Additional notes

Though the visual cognitive mental model presented in a pictorial form, the respondents of this study also included writing the word, especially when it involves processes such as photosynthesis, combustion and so on. This is because, according to Johnson-Laird (1980), visual images is iconic, however, icons that are abstract and cannot be visualised can be represented and in this case, Khai preferred words to represent the processes that cannot be visualised in details. The reasons given by respondents of the interview is as follows:

I can't see them in my mind..therefore it is hard to draw them..
(Sha; ms 4/7)

..such as fossilization.I don't see the process..so, I just write the word at the bottom of this line..in that case I knew that it happens underground..

(Khai; ms 4/7)

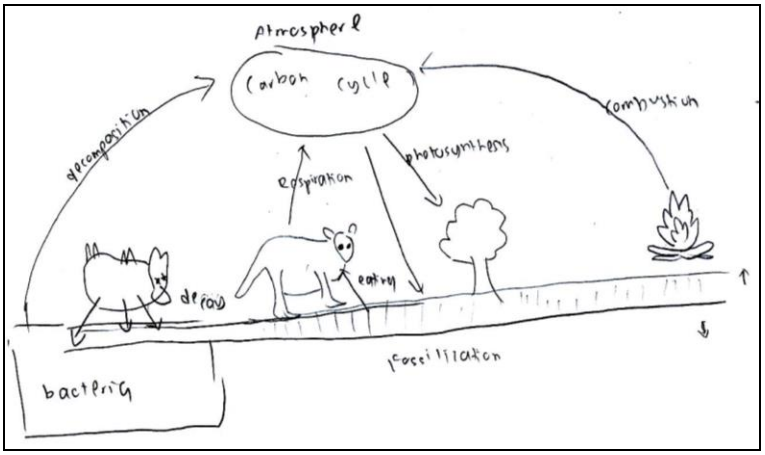

Figure 4**.** Khai, carbon cycle

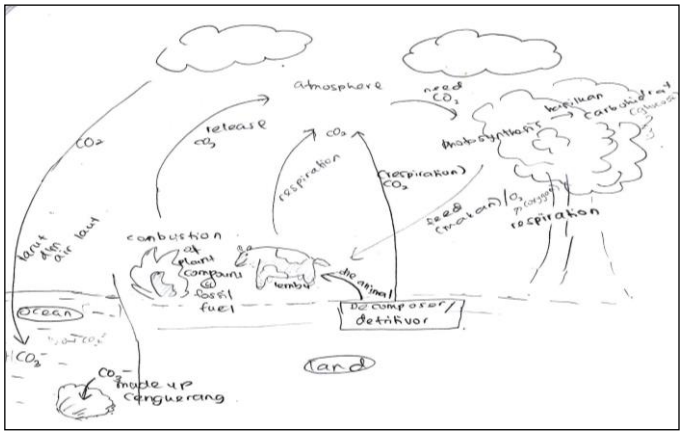

Figure 5. Sha, carbon cycle

b) Comparisons

There are some common elements which have been shown in the respondents' cognitive visual sketches, but there are also some major differences showns. Their sketch of mental models are quite simple. They rather draw what precisely what are the processes that relate to each other and very straight forward. However, according to Gynn (1997), students' initial mental models are simple representations of a concept but as students learn more, their mental models evolve and become more complex. From the data, Khai has a very simple idea in sketching while sketches drawn by Sha is more comprehensive because it involves carbon cycle that occurs on land and sea. For Khai, what is important is his understanding of the carbon cycle. Drawing simple but this participant admitted his understanding and his memory of the carbon cycle. Relations in the mental model described by logic as in the excerpts:

I hold the knowledge to myself..and I can see the relationships of these processes.It seems very logic and relevant to the carbon cycle...It looks more complicated in the internet or books. At first, I used these reference as I need to understand the concept after done with those, I prefer to generate my own visualisation according to what I have understood.

This is contrasted Sha that focused more to references such as the internet that she has seen before. Sha is more according to what's been seen compared with her own thoughts on the carbon cycle. However, according to Glynn (1997), the drawings of mental models should be original, as the resulting drawings would not reflect students' mental model and whatever was learned in this rote fashion would not be meaningful to the students. Sha viewed, copied and repeated what she had seen on the internet in order to understand the concept of the carbon cycle. Such references helped her make self-visualisation in understanding abstract concepts. The exceptions of the interview is as follows:

In my study time, I refer to books and the internet.I copy what I have read and made some additional notes.Without any pictures, I will be very slow in generating my own vision...

Similarities between graphical and pictorial mental models

a) Mapping the concept

These respondents mapped the abstract concept in the way they understand.The mental pictures of these girls were shown in the form of mapping. This is because the drawing has an arrow that makes the relationship between a process with other processes (Hsieh, 2003). Mapping the concept seems to be telling the whole process are interconnected with each other that will eventually find the end of the cycle of the atmosphere. Concept mapping is one of the visualisation technique commonly used by learners for knowledge construction (Hsieh & Cifuentes, 2006). This technique is the process for representing the concept and their relationships in graphical form, providing students with a visually rich way to structuring their knowledge in a particular concept.

A mental model is a concept that shows the relationship of the representative images generated in the brains of individuals (Jonassen & Henning, 1999). Sketches showing the concept of carbon related to each organism with other organisms and involves processes related to these relationships. Study respondents build a mental model to structure his knowledge of the carbon cycle may be delivered to the researcher (Esther, 2013; Jonassen & Henning, 1999). Students who draw mental models of concepts do much more where they actually sketch mental pictures of science concepts (Glynn, 1997) as shown by the two respondents; namely Khai and Sha. In this discussion, the researcher discusses the mental model that has been sketched a picture in cognitive visual sensitivity of the carbon cycle in matriculation college students.

b) Superficial

The findings show that the carbon cycle concept presented by all the respondents is a rough and very brief even though in pictorial mental models where in depth understandings of the concept is expected to be shown. This can be seen as their mental models did not explain clearly at the micro level as shown in Figure 4 and Figure 5. This is because the descriptions of the micro are only mentally buried deep in thought and should not be painted or sketched into the concept. These excerpts mentioned as below:

Researcher: Why is carbohydrate is not in the picture?
Respondents: Because it is in the tree..it doesn't need to sketch. I just know that it is in the leaves. I didn't draw because I felt that it is not a necessity.I already knew about it.

(Sha, page 3/7)

Respondents: I just need to write a keyword..after that I just need to describe according to the keyword... I don't want to write too long because I've understood the process..so it saves time

(Khai, page 4/7)

Discussion, suggestion, and conclusion

In this study, most students tend to use memorization techniques as a way of learning and preparation for the exam. Students denying them the ability to explore the concept of thinking and so on using mental images as structures of knowledge in explaining the concept. Researchers believe this action is an unhealthy culture that has long been practised by the students and the educational system in the country. This is clear when the mental

model generated by the students failed to reach the goal of full marks as in the scheme provided by the pre-university teachers. Inefficiency in generating mental images while parsing and explaining in detail, indicating their answer based on a past superficial knowledge, but does not involve knowledge at the micro level. The self-generated visualisation uncovered two patterns of mental models generated in the respondents. The correct keywords in any subjects such as Science (Maria, 2003) and Mathematics (Samsudin, 2004) has guided the students' learning, particularly in the generating of mental images. Although the mental picture is an individual right (Greca and Moreira, 2000), students need to understand the structure of the display through the correct mental picture and meet the abstract concepts learned. Teachers as mentors to students need to tackle the problem in the teaching and learning with multiple strategies and one of them is to use the visualisation capabilities. Teachers are the source of student's self-generated visualisation. This is because the teacher imparting knowledge through visualisation and delivered to the students (Rowell & Guilbert, 1996). Visualisation skills should be honed and nurtured so that the student's ability to see, understand and master the abstract concepts learned. Teachers need to identify the visualisation generated by students and confirming understanding with students to provide feedback and clarification in the next lesson identify if there are misconceptions through mental model they (Greca & Moreira, 2000). Thus, the students' ability in producing self-correct visualisation and is compatible with the proper guidance to enable students to absorb knowledge and knowledge is flowing to the maximum level. Teachers should nurture and train their students to have the attitude to explain the details of any processes that are relevant to a practice in the description of the structure of knowledge. As such, they would increase their motivation as this component of cognition plays an important caharacter in conceptual change, critical thinking, learning strategies and science learning achievement (Maria, Mohamed & Abdullah, 2016).

Self-generated visualisation possible weaknesses in their due time limits in the classroom (Hsieh & Cifuentes, 2006). However, understand and strengthen the concept of learning is more important and useful in achieving the goals in science education. Thus, researchers suggest self-generation visualisation as part of the practice of teaching and learning in science education, especially when dealing with abstract concepts. Instead, teachers should give space and opportunities for students to maximize their abilities and skills that involve the visualisation so that they can understand and remember the concept instantly during class sessions. Self-generated visualisation may need much time in doing so, but if students can hone their skills and practice in teaching and learning, teachers will be satisfied with the changes in their students. This technique is a thinking skill that must be nurtured and trained to become a generation of students who are able to face the challenges of thinking and cognitive ability to challenge (Roszelina, 2012). Hence, this practice should be emphasized in the classroom, especially in learning to abstract concepts.

One of the problems faced by students in Malaysia is the inability to capture and understand abstract concepts to any field. Sheer memorization without building concept leads to misunderstandings in perceiving the abstract concept. Self-visualisation is a technique of generating constructivist and critical competency to understand and master the abstract concept especially for the educational community. Creating visualisations of abstract concepts allows students to improve their memory because it involves construe meaning to the concept. So students need to generate visualisation them effectively, properly and appropriately to address this issue. Self-generation visualisation techniques can be an effective teaching technique in science because it allows students to understand the abstract concept. It is hoped that teachers can provide space and opportunities for students during the teaching and learning process to maximize their abilities and skills in self-generation visualisation so that they can understand and remember abstract scientific concepts such as

this. Self-generated visualisation technique can be very effective in teaching science because the students would have ample time to understand the whole concept of the carbon cycle. Students are able to create a mental picture of relevant, sketch, and associates about the experiences of the past. However, most students are likely to make memorization as a technique to answer questions in the examination. This showed that the students denied their ability to draw and use their mental picture in explaining the concept. The researcher believes this action is an unhealthy culture that has long been practised by the students and the education system in this country. This has become evident when the students' mental models failed to score to the carbon cycle, based on the revised scheme answers provided by the matriculation college teachers. Inefficiency in generating visualisations while parsing and explaining in detail, causing their answers to be ranged from about prior knowledge to superficial and does not involve knowledge at the micro level.

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