Does Creative Illustration Able to Enhance Students' Understandings in Science Learning?

Nur Syafiqah Azlan & Tajularipin Sulaiman

Abstract Various teaching and learning strategies were introduced in accordance to the change of the century in which the current century put a great emphasize on 21st century learning. The strategies undergo evolution from century to century in order to meet the needs of the younger generations in respective century. In today's world, the youngsters are known as people who are technology savvy. They use electronic devices for almost every second daily as the gadgets, along with available networks are convenient and useful in searching for additional information for their homework or assignments. Creative illustrations such as scientific illustrations, animations, and electronic comics are some of the information available. The youngsters today found that that kinds of information are much more enjoyable and comprehensible to learn a science concept. Therefore, in response to this statement, the writing of this paper is focused on the use of creative illustrations to enhance students' understanding in science learning.

Keywords – Animations, Comic, Creative Illustration, Educational, Scientific & 21st century

I. INTRODUCTION

With the advancement of technology and evolution of learning in this current world which is emphasizing the 21st century learning, various teaching and learning strategies were being introduced or re-introduced, and researched. It was all to meet the needs of today's young generations who are mostly depend on their gadgets and mainly, the world wide web (www) to search for additional information to complete a task given, or to improve their understanding of a subject matter. The www - byname the Web - provides its users with the access to a wide range of documents (Gregersen, 2019) on from how to learn foreign languages to the detail information of an organism's cell's structures, and even of human innards.

The information of the previously mentioned examples; structures of the cell and human innards, are always presented and perceived using illustrations in which may come in many creative forms such as scientific illustrations, animations, and even in the form of comic strips.

It is as Hannus and Hyönä have once stated in their article: "Illustrations are an integral part of modern instructional textbooks" (1999), as illustrations may help in the process of learning a subject matter; especially in learning science. Furthermore, the scientific knowledge in science subject is a product of human creativity and imagination, in which one of the fundamentals of science nature (Al-Abdali & Al-Balushi, 2015). Therefore, it can be said that illustrations are primarily an important element in science learning in order to explain what cannot be seen with humans' naked eyes as the use of written or text explanation alone on, for example, an animal's cell structures is insufficient. If there is no illustration accompanies the text, it would surely become a burden to a student's working memory as he or she does not know the appearance of the said cell.

In response to the above information, the writing of this paper will be focused on using the concept of creative illustrations in science learning in order to enhance students' understandings; and ultimately, promote their motivations to engage themselves more in the learning of science. The latter is generally the wish of every science teacher on this earth. Besides, it was long ago proven that illustrations are the effective cognitive devices, and the best choices to present a concept (Blystone, 1989). Hence, the concept of creative illustrations that will be discussed here are scientific illustrations, animations, and also educational comics (these three are considered as teaching strategies). Before diving further into these types of illustrations, the definition of creative illustrations would be explained first. Then, the background of study for this concept of creative illustrations; as well as the implication(s) of employing this concept, will also be discussed.

1.1 Creative Illustration in Science

Referring to Cambridge Dictionary, creative can be defined as "producing or using original and unusual ideas" (2020), whilst illustration can be defined in various perspectives; depending on how it is significant to the person who describes it. For example, Roberts, an artist, defined illustration as he would any other type of visual medium; be it traditional graphic design, typographic, or even human interface design (Jackson, 2018). The next definition is the one the author took interest in: "… illustration is a piece of work that is meant to explain, interpret, decorate, or accompany a concept or a piece of writing." (Zimmerman;

Nur Syafiqah Azlan, Universiti Putra Malaysia, Malaysia (Email address: syafiqah1elite2@gmail.com)
* Tajularipin Sulaiman, Universiti Putra Malaysia, Malaysia (*Email address: tajulas@upm.edu.my)

Jackson, 2018). If these definitions of illustration are to be combined together, and then together with the definition of creative, they can produce another definition: Creative illustration in science is hence, a piece of visual work which is creatively produced in order to explain or interpret a concept of something in subject science, visually. The following quote by a British writer Doyle (1859 –1930) through his fiction character, Hayes, Holmes & Wilson, (2012), may also be defined as learning science without illustrations:

"To let the brain work without sufficient material is like racing an engine. It racks itself to pieces."

1.2 Scientific Illustration in Science Learning

"*Scientific illustration takes the viewer to the often unobservable - from molecules and viruses to the universe, from depiction of the internal anatomy of arthropods and plants to geologic cross sections and reconstruction of extinct life forms, ranging from realistic to abstract portrayal*." (The Guild Handbook of Science Illustration; cited by Perilli, 2019).

1.2.1 Brief History of Scientific Illustration

According to Belknap, the role of images in science publishing has not changed much over the past 150 years (2019). The thing that undergoes a shifting in presenting scientific illustrations is its tools (Belknap, 2019). The earlier centuries may use charcoal or self-made pigments or other traditional equipment to produce an illustration; but in the current century, artists mostly use digital devices to make the visual evidence more precise as "precision was centrally important" (Belknap, 2019) to explain or interpret a science concept precisely (and accurately too). For example, the illustrations presented in today's science textbooks are mostly digitalized. The contents of the textbooks such as Understanding Physics◊ (Mansfield & O'Sullivan, 1998), Biology: Concepts and Investigation (2nd ed., Hoefnagels, 2012), and Principles of General, Organic, & Biological Chemistry (Smith, 2012) were all presenting the concepts of science in comprehensible texts in which accompanied by illustrations to aid readers' working memories; and subsequently, enhance their understandings. In addition, even though in the early ages of the world still have no digital devices or gadgets, the drawings of animals in the Chauvet-Pont-d'Arc caves in France that date back 30 000 years, were accurate enough for researchers to identify at least 13 of the species depicted (Keyles, 2017).

1.2.2 Scientific illustration and Its Contribution in Science Learning

The sketches of anatomy of human's brain by Leonardo da Vinci (Liddelow, 2011) may be the earliest work of scientific illustration in describing human anatomy. He started the sketching on 1489, or in the 15th century. However, his works of those sketches were only rediscovered and slowly published from 19th to 20th century; where these works of his became inspiration to people over the centuries, and became a major contribution in neuroscience field (Fessl, 2019), one of the scientific studies in science field. In addition, his research into the brain led him to discoveries in neuroanatomy (the study of nervous system structures and how they relate to function) and neurophysiology (the physiology of nervous system) (Pevsner, 2002) which were prominent and fundamental elements in today's neuroscience field. Furthermore, the approach employed by da Vinci in which along with his sketches of human's brain (and skull), he was also describing the brain's ventricular (four cavities located within the brain) function in mechanical terms: movement, weight, force, and percussion (Pevsner, 2002). This approach of his in which integrating physics knowledge into the study of neuroscience innately showed the importance of using scientific illustration to further enhance one's understanding. It also showed the element of 21st century skills: critical and creative thinking by the integration of different disciplines in science to explain a concept of, in this context, human's brain and skull.

1.3 Animations in Science Learning

Animations may be presented in various ways - videos; animated images or two dimensional (2D) motion graphics; three dimensional (3D) animations in which require a high level of accuracy and more realistic; whiteboard animations by drawing images on whiteboard and record it; et cetera. These sources were widely used today as 21st century offers an advancement in technology to be utilized for many purposes, especially for science learning in educational field by bringing humans into the world of illustrations; where the unseen chemical process or law of physics or even the unseen human innards and anatomy, were animated and visualized. The use of these sources will be able to aid one's working memory as he or she knows what the description of a science concept was talking about because the texts were accompanied with animated illustration, instead of trying to comprehend the texts alone. Moreover, the use of animations in science subjects may help "teachers to solve one of the most aching problems: students perceive science as boring subject" (F.Learning Studio, 2020).

1.3.1 Animation in Research Studies and Its Effectiveness

Recent study that was conducted by Mita Wulansari et al. (2020) has proven that animation in science learning was able to improve students' learning outcomes. In another study, it has also been proven that the use of (flash) animation for biology learning was able to help students to become "problem solvers with integrated thinking" and improve their learning outcomes (Utomo et al., 2020). Furthermore, a study conducted by Akaygun (2016) indicated that students in chemistry classes were able to construct more processes of condensation in chemical terms when using animation tools. In addition, the use of 2D animation was able to improve students' achievement in mathematical contents of economics, in which can be applied in the teaching of mathematically related science subjects such as physics and chemistry (Ejimonye et al., 2020). Plus, in a study conducted by Wishart, the result showed that almost everyone; especially students, enjoyed making animations in school and hence, enhance their understandings in learning the concept of science (2014). Here, the 21st century skills such as communicating and collaborating were seen to be utilized as the students in the study have to work in groups and do the discussions among themselves; and lastly, presenting their works in front of everyone. Wishart (2014) noted those students' teachers' thoughts who were intending to use animations as a teaching strategy in their classroom; as the students have to think about how to, for example, make the proteins shape to look like 3D structures.

Next, there was a significant difference between students' performance in science learning who were exposed to cartoon style multimedia (2D animation) with those conventionally taught; with the former has higher t-calculated (analyzed using t-test) compared to the others (Thomas & Israel, 2013). Last but not least, Karisson and Ivarsson (2008) concluded in their paper that animations could help create the illusion that a complete process is being illustrated, compared to static images. However, misinterpretations or misconceptions by students may be occurred; or if there was text presented along with the animation in the video, it would cause the students to split their attention into two to comprehend both animations and texts (Karisson & Ivarsson, 2008). Thus, Karisson and Ivarsson (2008) suggested so that teachers provide instructional guidance, either written or narrative in order to ensure the students are on the right track of comprehending the presented information. For example, 'Kurzgesagt - In a Nutshell' (2020) YouTube channel presented a concept of climate change in an interesting way; the greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were represented as scary monsters, and the animation video was completed with narration. The way the animation video was presented in which narrating instead of inserting the texts to explain the contents, was likely able to attract viewers' attention fully to the video and subsequently, enhance their understandings on the concept of greenhouse gases effects.

1.4 Educational Comics in Science Learning

In the current world where new media are constantly emerging, comic books reading remain a popular activity among children and adults (Jee & Anggoro, 2012). Jee and Anggoro (2012) remarked that there has been an explosive increase in the creation of educational comic books in recent years, in which including many about science. One of the famous educational comic in comics' world is Cells at Work!, or prominently known as in its original name: Hataraku Saibou (はたらく さいぼう) ♦, the work of Japanese comic artist; Shimizu Akane- san (2015). The comic illustrated the function(s) of cells within human body in which introduced as human characters who have their own roles to be played and jobs to be done. Because of its educational contents in science field, especially biology, the comic was adapted into 2D animations under similar name as the comic. Even the "real-life" doctor from United Kingdom commented that the show was brilliant (Dr Hope's Sick Notes, 2018) because of the ways the concepts of cells' functions in human body were presented. Trnova et al. (2013) noted that the graphical form of comics is suitable for the current generations who are well visually literate; and thus, cartoons or comics are effective in supporting students to understand science concept.

•Refer to Appendix for the screenshots of the animations.
♦ Refer to Appendix for some of the comic's contents.

1.4.1 Use of Comics to Engage Students into Science Learning

In recent years, there were a lot of researches on the use of comics to attract students' interests into learning science. In a study conducted by Lin et al. (2014) on public learning of nanotechnology, the use of comics significantly promoted laypeople's knowledge of and attitudes towards nanotechnology. The study proved that comics were able to increased participants' interests in and enjoyment of learning, as well as securing potential to develop their ongoing interests and enjoyment for learning science through comics (Lin et al., 2014). Trnova et al. (2013) reported that the use of comics in science learning may help students to understand the science concept better. In another study, educational comics on basic human anatomy were able to help medical students in improving their course grades, while high school students and premedical students who read the comics were able to deepen their comprehensions or understandings of the subject (Kim et al., 2016).

In an article written by Jee and Anggoro (2012), they gave some examples of educational comics that help in enhancing learning and interest in academic novels such as Clan Apis, a comic about bee behavior (Hosler, 2000); Dignifying Science, a comic about famous women in science (Ottaviani, 2003); Optical Allusions in which provided an appealing alternative to standard science textbooks (Hosler, 2008); all cited in Jee and Anggoro (2012). Furthermore, Jee and Anggoro (2012) also wrote in their article that comics (i) make scientific concepts and principles more concrete, (ii) capitalize on the benefits of spatially contiguous text and images, (iii) invoke schemas that influence comprehension/understanding, (iv) can invoke personification of nonhuman entities, and (v) comics could influence metacognitive judgements about science understanding. Moreover, researches reviewed by Farinella (2018) on use of comics in science learning suggested that that full of illustration and text books have great potential for engaging wide and diverse audiences with STEM subjects.

In addition, Koutniková (2017) proved through her study that comics were very helpful in aiding preschool children to comprehend or understand more about science concepts as the concepts were presented in interesting ways. Next, Spiegel et al. reported that comics - one of the innovative materials - about science may be an effective means to engage teenagers whom with low science identities (2013). Moreover, a study conducted by Fernandez and Lina in which their participant was a 14-year-old high school boy who suffered from severe anxiety during math tests; reported that the creation of comic strips by the boy was beneficial for him as he had to externalize his problematic thinking processes, which were then utilized for cognitive restructuring and behavioral modification (2019). Even though the study was focused on math subject, it may also be applied in science subjects in which related to mathematical thinking such as physics and chemistry.

II. BACKGROUND OF STUDY

As previously mentioned in Introduction, the focus of this writing is on the use of concept of creative illustrations to enhance students' understandings in science learning. As what have been wrote previously, the three types of creative illustrations concepts that are being focused are scientific illustration, the static scientific images or illustrations that can be found in most science textbooks; animations that may come in 2D or 3D animated illustrations; and comics that are educational and possessing scientific themes. These three types of creative illustration have their own strengths and weaknesses. Based on the literature review, science teachers were strongly recommended to employ any of those three creative illustrations as their teaching strategies in classrooms. Teachers have to be flexible when to use and how to utilize them as youngsters today are well visually literates.

2.1 Conceptual Framework of Creative Illustration

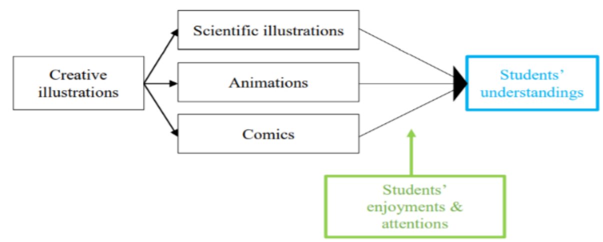


Figure 1: A proposed model for students' understandings in the concept of creative illustrations

The figure above shows a proposed model for students' understandings or comprehensions when the concept of creative illustrations is to be employed. In this proposed model, "students' enjoyments and attentions" becomes the mediator that is affected by those three teaching strategies: scientific illustrations, animations, and comics. It suggests that the employment of creative illustrations concept in teaching strategies are not directly affecting students' understanding in science learning, but are mediated by the enjoyments they experienced and the attention they gave (id set students' emotional reactions) during teaching and learning session. Therefore, in order to reach the final product of this model, teachers have to use the proper sources and the quality ones before deploying them into teaching strategies so that they are able to attract students' attention as well as give them the feeling of enjoyment when learning science.

2.2 Models and Strategies Used in Teaching Science Via Creative Illustration

As aforementioned, strategies that are going to be used in teaching science through the concept of creative illustrations are (i) scientific illustrations, (ii) 2D or 3D animations, and (iii) educational comics. A teaching model that can be utilized to use those strategies in science classes is brain-based learning and teaching model. Brain-based learning is one of the strongest applications of research in psychology, neuroscience, and cognitive science (Shukla, 2019).

In general, brain-based learning refers to teaching methods, lesson designs, and school programs in which basing on the latest scientific research about how the brains learns (Great School Partnership, 2013). It includes such factors as cognitive development; how students learn differently as they age, grow, and mature socially, emotionally, and cognitively. Brain-based learning involves specific strategies for learning which are designed based on how human attention, memory, motivation, and conceptual knowledge acquisition works (Shukla, 2019). Akyürek and Afacan (2013) made a remark in their article that brain-based teaching involved the implementation of carefully-designed principles with due consideration of their impact before, during, and after each lesson. Following is the 12 principles of brain-based teaching approach in which developed by Caine & Caine (1991, 2003; cited in Arun & Singaravelu, 2018):

1. The brain is a parallel processor.
2. Learning engages the whole physiology.
3. The search for meaning is innate.
4. The search for meaning comes through patterning.
5. Emotions are critical to patterning.
6. The brain processes wholes and parts simultaneously.
7. Learning involves both focused attention and peripheral perception.
8. Learning always involves both conscious and unconscious processes.
9. We have at least two types of memory: A spatial memory system and a set of systems for rote learning.
10. We understand and remember best when facts and skills are embedded in natural, spatial memory.
11. Leaning is enhanced by challenge and inhibited by threat.
12. Each brain is unique.

A result of a study conducted by Mita Wulansari et al. (2020) showed that the use of creative illustration concept - in the research, animation strategy was used - along with brain-based teaching and learning models were able to improve students' learning outcomes in science learning.

2.3 Theories Involved

There are several theories that may be involved when teaching science using the concept of creative illustrations on students' understanding in science learning. Following are the theories:

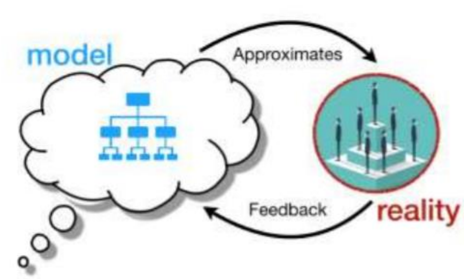
2.3.1 Mental Model Theory

Mental models in science learning can be represented in various forms, including static drawing or scientific illustrations, and animated illustrations or animations (Akaygun, 2016). According to Scott, mental model theory presumes that "people do not innately rely on formal rule of inference; but instead, rely on their mental models which are based on their understanding of the premises and their general knowledge" (2015). In a simpler sentence, mental models are what have been represented in mind about real or imaginary situations (Scott, 2015). Craik (1943) defined mental models as personal constructions of reality and created as a result of people's imagination, interaction, perception, and comprehension (Akaygun, 2016). As the nature of mental models are known for its complexity, written or verbal explanations or drawings are suggested to be utilized in order to elicit mental models of students (Akaygun & Jones, 2013; Domin & Bodner, 2012; Kelly & Jones, 2007; Kelly, 2014; cited in Akaygun, 2016). Akaygun wrote in his article that researchers suggested to use drawings in order to understand the conceptualization of a concept made by students as the drawings offer in-depth understanding of mental models (Davidowittz et al., 2010; Nyachwaya et al., 2011; cited in Akaygun, 2016).

In a study conducted by Gadgil et al, it was found that students who were comparing their flawed mental models to an expert model, acquired a correct mental model later on and deeper understanding (2012). This means that the misconceptions of those students on a science concept were able to be changed using creative illustrations. Therefore, considering the dynamic nature of a science concept, creative illustrations prepared by students can be more informative to convey their understandings (Akaygun, 2016). As Flemm (2020) wrote in his blog:

"Storage of any piece of information in our brain is done in the form of models. Learning is comparing these mental models with reality or with other models and processing the feedback we get from it. We process the feedback and use it to adapt our mental model."

In short, mental models are at the core of knowledge and learning (Flemm, 2020).



The illustration above illustrated how mental model theory work (image by Flemm and Ingham; Flemm, 2020).

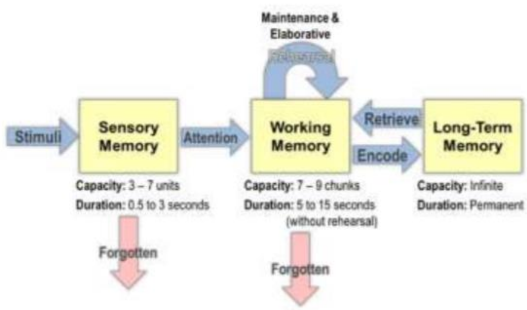
2.3.2 Information Processing Model (IPM) Theory

Literally, the information processing model (IPM) theory illustrates how humans process information. In another word, it describes how experience and information are processed and stored using computer as an analogy (Eggen & Kaucahk, 2006). The model is composed of three major components in which:

1. **Information stores**, where information is held and can become analogous to computer's main memory and hard drive. The stores are comprised of sensory memory, working memory (WM; or known as short-term memory), and long-term memory (LTM).
2. **Cognitive processes** that include attention, perception, encoding, and retrieval. They are like the programs that process information in computers.
3. **Metacognition**, the mechanism one uses to monitor his or her learning.

(Eggen & Kauchak, 2006).

Following is the illustration of the model:



The sensory memory in the above illustration is where the part of human's cognitive system briefly holds information until he or she attend to it (Mayer, 1998; cited in Eggen & Kauchak, 2006). For example, people would not be able to understand a sentence or make sense of it if they did not retain the words in the beginning of the sentence in their sensory memory.

Next, the WM is where information is organized and understanding is constructed (Eggen & Kauchak, 2006). This WM is known for its limitations or limited capacity. This means that it is able to process only a small amount of information at a time where if a person faces with too much information, some will be lost or ignored in an effort to reduce the load; which is known as cognitive overload. Therefore, "in order to promote learning and transfer, cognitive load is best managed in such a way that cognitive processing irrelevant to learning is minimized and cognitive processing germane to learning is optimized, always within the limits of available cognitive capacity" (van Merrienboer et al., 2006; cited by Sweller, van Merrienboer & Paas, 2019). For example, it was proved in an experiment (a topic on "The Bone Remodeling Process") that multimedia learning, or 2D animated illustration, in which concise, coherent, and coordinated aids students' explanation recall and problem solving transfer (FurtherEdagogy, 2016). This means that a simple but meaningful and understandable materials presented by a teacher is much more receivable and easier for students to comprehend.

LTM is human's permanent information store (Eggen & Kauchak, 2006). How information is stored in LTM determines whether one will be able to find it when he needs it (retrieval) as well as his ability to apply the information into different situations (transfer) (ibid.).

III. IMPLICATION(S) OF EMPLOYING THE CONCEPT OF CREATIVE ILLUSTRATION

After reviewing scholarly evidence and opinions, many agree on the employment of concept of creative illustration in terms of scientific illustrations, animations, and educational comics in enhancing students' understanding in science learning. By employing one or all of those three strategies in science classes, the elements of 21st century in which creative thinking, critical thinking, communication, and collaboration, were able to be integrated. For example, students have to think creatively and critically on how to produce animated illustrations or educational comics or their own scientific illustrations. They also have to communicate among themselves and collaborate with each other to produce those piece of works of theirs. In addition, to produce those works, students have to possess a deep comprehension or understanding toward a concept of science. As written in the previous section, the employment of brain-based learning and teaching strategy by science teachers to teach the concept of science using creative illustrations is able to help students to acquire a deep understanding about the concept. Therefore, the effects of utilizing the concept of creative illustrations on students in science learning is big - students will be able to enjoy their learning session. For example, if their science teacher uses comics to impart knowledge about a science concept, they may be happily to enjoy and actively participate in the science lesson as comics typically use a simpler words and not too many jargon.

In addition, the use of this concept by science teachers will also turn them into creative persons, as they have to be creative and critical when selecting and sequencing the lesson plan for their students. They have to think on how to attract their students' attentions toward their lessons. Sometimes, even though the teachers use the already-available scientific illustration in science textbooks, some students are still feel bored or not interested in the lesson.

This may be due to the colouring of the images which are dull and not attractive, or because they have seen the illustrations every day and every time they turn their textbooks. Consequently, they are unable to understand what should be understood. If this situation is happening, teachers have to be flexible by employing the other strategies - teachers produce their own scientific illustrations on blackboard using different colors of chalks, or "cartoonize" the illustrations so that students' attention are able to be grabbed. If science teachers are able to do this within their ability scope, they will be indirectly become creative and critical thinkers, too.

Furthermore, as mentioned previously, the use of illustrations will be able to reduce the load in human's WM as the concept of science is presented in a simpler and enjoyable way. Plus, an advanced schema in the cognitive structure will be able to be produced as his/her understanding is organized in a more comprehendible way and not using too much of WM's capacity. In term of mental model, one's understanding on a science concept will be able to be enhanced as he/she has to produce his/her understanding visually. This way, it will be easier for science teachers to assess their student's comprehension on a science concept. If the teachers think that their student is experiencing misconceptions, they may be able to help him/her to change his/her conceptualization of a concept to a better.

IV. CONCLUSION

In conclusion, based on the scholarly evidences and opinions, it can be concluded that creative illustration is able to enhance students' understandings in science learning. Scientific illustrations, animated illustrations in 2D or 3D, and educational comics are some of the strategy examples in the concept of creative illustrations. These strategies were proved to be able to increase students' interests and enjoyments as well as attract their attentions to learn science in which subsequently, led to deep understanding of a science concept.

APPENDIX

♦ Scientific illustration in Understanding Physics by Mansfield and O'Sullivan (1998).

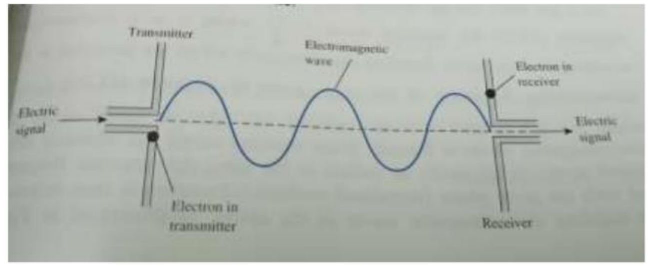


Figure 1: Generation and reception of radio waves by antennae (p.341).

♦ Scientific illustration in Biology: Concepts and Investigation (2nd ed.) by Hoefnagels (2012).

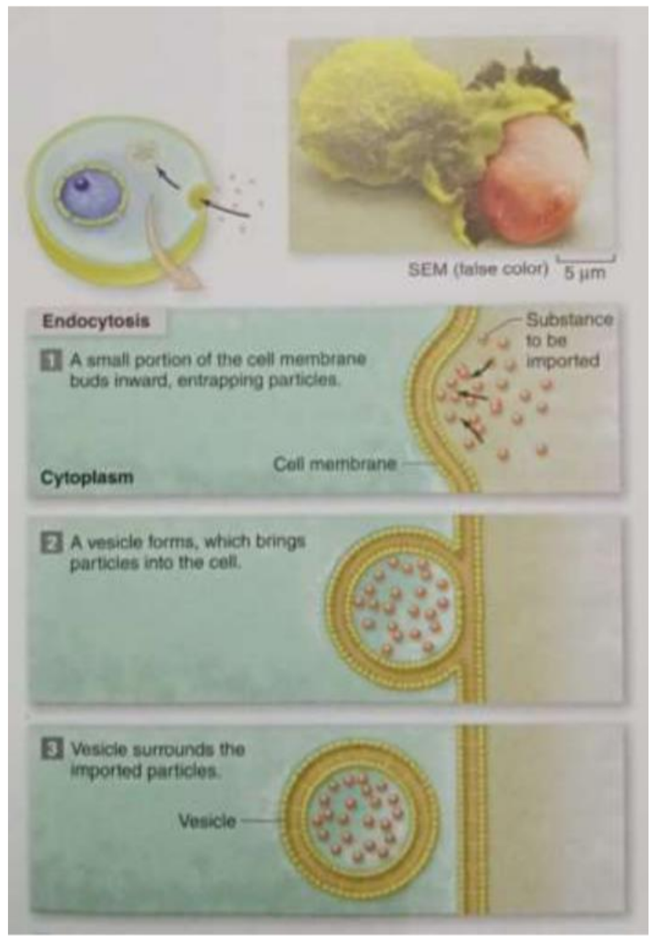


Figure 2: The Process Of Endocytosis (A Process Of Engulfing Fluids And Large Molecules By A Cell To Be Brought Into The Cell). The Inset (Top Right) Shows A White Blood Cell Engulfing A Yeast Cell By Phagocytosis, A Form Of Endocytosis (P.83).

♦ Scientific illustration in Principles of General, Organic, & Biological Chemistry by Smith (2012).

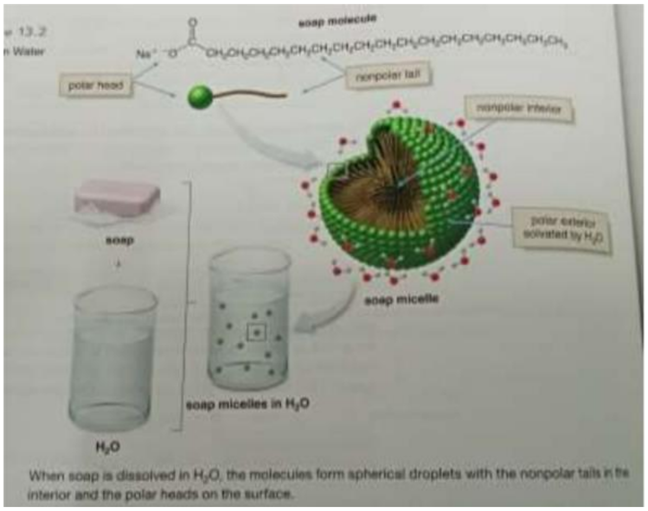
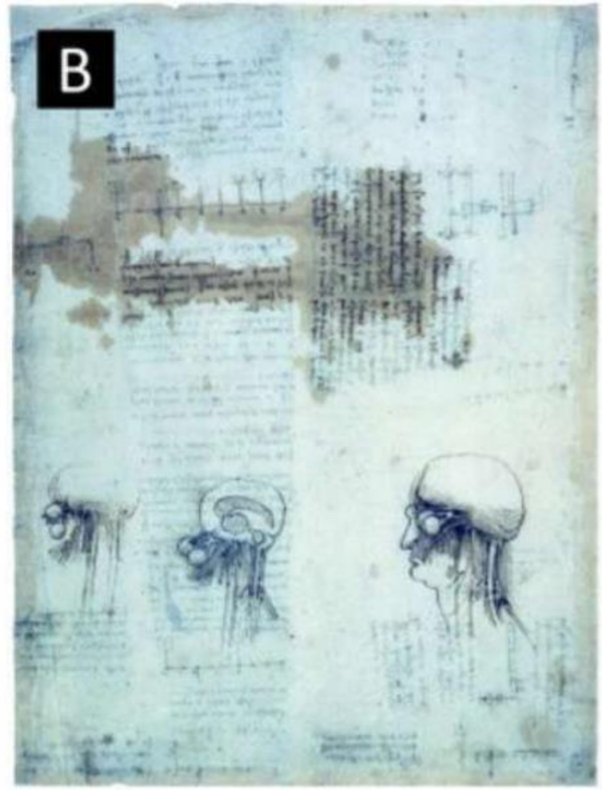
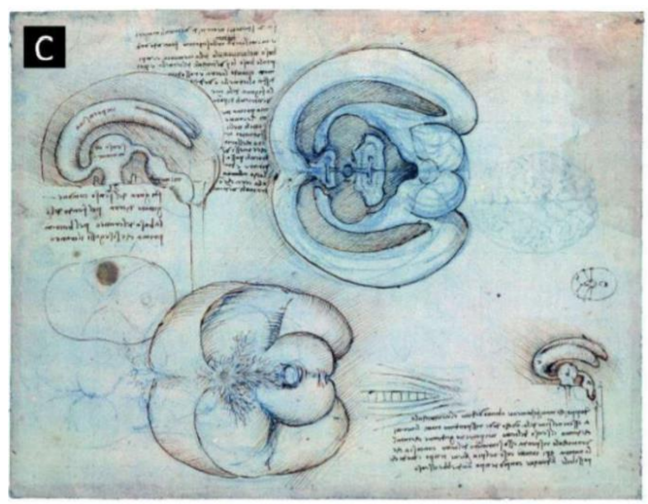


Figure 3: illustrated the process of dissolving soap in water (p.400).

*Sketches by Leonardo da Vinci on the anatomy of human's brain (Liddelow, 2011).





A. The layers of the scalp compared to an onion (1489) The earliest drawings by da Vinci on the ventricles of the brain show them to be connected to the eye and moving backwards, into the brain. In this drawing he also likens the meninges of the brain to the layers of an onion (left hand side of image).
B. Studies of the eyes and brain (1508). Later studies by da Vinci on the neuroanatomy of man display a better understanding of the ventricles of the brain and of nerves permeating to peripheral areas. This

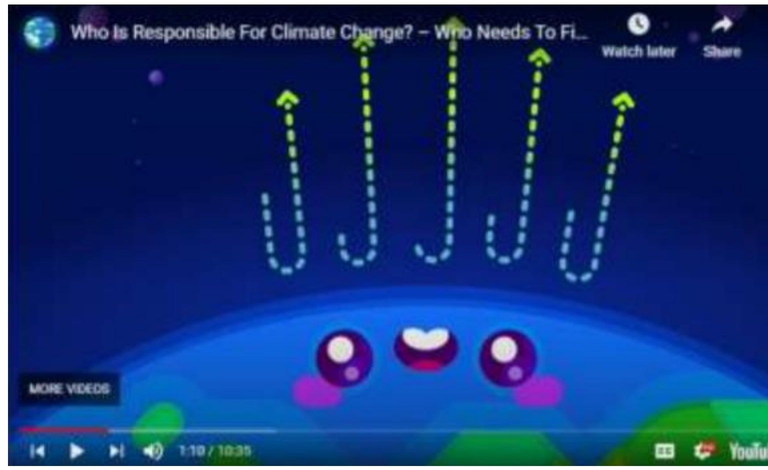
increase in understanding is likely due to the use of wax casts made of the ventricular system of other 'lower' animals, such as the ox (see C).

C. The cerebral ventricles of the brain of an ox (unknown date: 1508 - 1510). Here da Vinci describes the methodology of injecting warmed wax into the ventricular system of the ox, allowing it to cool, then visualizing and sketching the mould that is made. Though not describing explicitly the use of bovine species, we can assume that da Vinci has by the presence of the bovine equivalent of the circle of Willis, the rete mirabilis, in the lower image.

Figure 4: All images are reproduced by gracious permission of Her Majesty The Queen, from the Royal Collection © 2010, Her Majesty Queen Elizabeth II.

• Screenshots of animations video content of climate change concept (Kurzgesagt - In a Nutshell, 2020).

Greenhouse gases were represented as scary floating monsters (from left: CO_2, CH_4, and N_2O).



Earth's expression when it was in good condition.

These two expressions (include the above) of Earth were closely related to humans' expressions and emotions; thus, increase viewers' understandings of why it was bad to let the emission of greenhouse gases in an abundant quantity.

Earth's expression when it was in bad condition.

This expression of the Earth may influence the viewers' emotions to pity the Earth.

Figure 5

♦Some of Cells at Work!’s contents, written and illustrated by Shimizu (her work started on 2015 and is still ongoing).

The cells in human body were introduced as human characters who have their own jobs to do.

The depiction of red blood cells (erythrocyte) job in which delivering oxygen and carbon dioxide gases.

Page showed the illustration of white blood cells' (neutrophil) role in which killing pathogens that infected human body

Figure 6

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