Students’ Information Processing Skills for Each Learning Style on Cell Biology Lectures

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Abstract: Information processing skills are one of the skills students need to have. These skills are included in the lifelong learning standards. This study investigated the learning preferences (visual, aural, read/write, kinesthetic) and comparing differences of information processing skills in each learning style on structure and function of cell membranes concept. Students’ learning styles were analyzed from the-VARK-questionnaire version 7.8. Students' information processing skills were analyzed from the students’ worksheet when learning using VARK approach. Students’ worksheets are prepared according to information processing standards. The result showed that there are fourteen learning styles are grouped into four categories, namely unimodal (9,09%), bimodal (40,91%), trimodal (31,82) and quadmodal (18,18%). Information processing skills of the students who have multimodal is better than unimodal ones. Information processing skills of the students with bimodal learning styles are better than the students with other learning styles. Information processing skills of the students with bimodal learning styles in five sub-concept (phospholipids stucture, cholesterol structure, membrane protein, passive transport, and active transport) are better than the students with other learning styles, except for the sub-concept of cell membrane structure, students with trimodal learning styles are better than the others.

1 INTRODUCTION

Currently teaching thinking skills is a topic that receives a lot of attention. One reason is that changes in society are increasing so quickly, that it is difficult to predict precisely what content should be taught to students if we define content as factual knowledge (Marzano & Arredondo, 1986). Some information produced by the community has risen to such a level that individuals cannot control more than a small part of it. The information available to us doubles every ten years (Luckner, 1990). Especially now in the 21st century, the rapid development of technology that contributes to information sources. Based on these facts, it is necessary to have skills that can process information.

According to cognitive psychology human mind creates meaning through the stages of input which is processing the information it receives, the output that is developing responses, and how in turn output can influence the next input (David, Miclea, & Opre, 2004). In cognitive learning theory this is called information processing theory. This theory discusses how information is processed in the mind and how information is presented so that it can be processed in working memory (Luckner, 1990).

According to information processing theory when students learn, their brains bring information in, manipulates it, and stores it ready for future use. As shown in Figure 1, in information processing theory, when students receive information, the information is first stored briefly as sensory storage; then it will be moved to short-term memory or working memory; and then forget or moved to long-term memory, such as: semantic memories (general concepts and information); procedural memory (process); and pictures. Thus when students learn, they are actually showing information processing skills.

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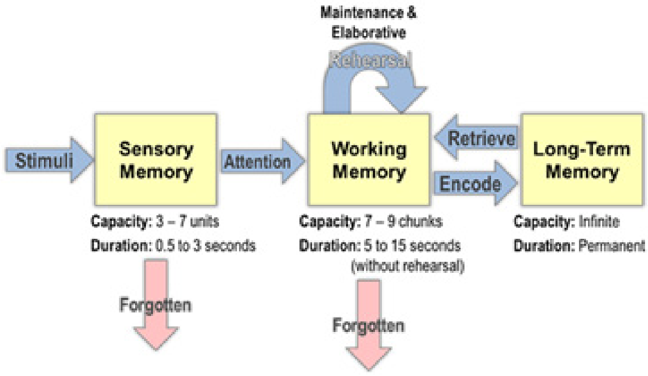

Figure 1: Information Processing Model
https://lo.unisa.edu.au/mod/book/view.php?id=610988&chapterid=120209

Information processing skills are one of the five categories of lifelong learning standards, these skills can be used in many situations through a person's lifetime (Marzano, Pickering, & McTighe, 1993). In this study information processing skills were measured according to the four categories. The four categories in the information processing standard, that is; identification of information components; interpret and synthesize information; assess the relevance of information; use information to solve new things (Marzano et al., 1993).

Individual learning style refers to style or learning methods used in the process of learning (Othman & Amiruddin, 2010). The learning styles of each person are certainly different and it is important to know to improve their learning abilities (M. Renuga and V. Vijayalakshmi, 2013). Students process incoming information in different ways, hence lecturers need to vary their methods of teaching to ensure that all students learn. While alternative approaches to learning can be used successfully, it is thought that students will learn more quickly and easily if they are able to utilise their preferred style. Learning strategies used in cell biology lectures are VARK strategies.

Table 1: The Vark Learning Styles

Learning Styles	Characteristics
Visual	Preference for using visual resources such as diagrams, pictures and videos. Like to see people in action.
Aural/Auditory	Need to talk about situations and ideas with a range of people; enjoy hearing stories from others.
Read/Write	Prolific note-taker; textbooks are important; extensive use of journals to write down the facts and stories.
Kinesthetic	Preference for hands on experience within a 'real' setting and for global learning.

VARK learning style, consists of four different learning styles, namely Visual, Aural / Auditory, Read / Write and Kinesthetic, where the VARK system is proposed by Neil Flemming (Renuga & Vijayalakshmi, 2013). The four characteristics of learning preferences used in VARK can be easily identified by students. These features allow students to critically reflect on their field work experience to improve learning as described in Table 1 (Robertson, Smellie, Wilson, & Cox, 2011). This study investigated the learning preferences (visual, aural, read/write, kinesthetic) and information processing skills for each learning style in cell biology lectures on the subject matter of the structure and function of cell membranes. Two reasearch questions were developed to investigated the research problem:

1. What are students' learning preferences (VARK learning style: visual, aural, read/write, kinesthetic)?
2. How are differences between information processing skills in each learning style on structure and the function of cell membranes concept?

2 METHODS

This study used one-group posttest only design. The participants were 22 Biology undergraduate students who enrolled in cell biology lectures at Universitas Islam Negeri Syarif Hidayatullah Jakarta, even semester of the academic year 2017/2018. Their ages ranged between 20-21 years. There were 18% (n=4) males and 82% (n=18) females.

Two instruments were used for data collection in this study:

1. The VARK questionnaire (Version 7.8) was administered to the students to categorise the different learning style and to give each individual an idea of their perceived favoured learning-style. The main reason the VARK questionnaire was chosen was because it is well recognised, straightforward and quick toperform, and its results are easy to understand. The instrument consists of 16 multiple choice questions with four alternative answers. Each alternative answer represents one of four modes of perception. each person can choose more than one answer for each question, which is needed to identify modes of perception and learning (Shah, Ahmed, Shenoy, & N, 2013). The VARK questionnaire is available in vark-learn.com.
2. Student's worksheet was administered to the students to measure information processing skills. there are four skills categories referring to information processing standards, to assess student worksheets by using an assessment rubric.

In the first stage, the students were asked to take up the VARK questionnaire. The second stage, the students attended cell biology lectures on the subject of cell membrane structure and function, where lectures used VARK strategies.

VARK strategies applied in learning Cell Biology were delivered in four learning steps to facilitate visual, aural, read/write, and kinesthetic learning style. The learning steps used in this study can be seen in the Table 2.

Visual strategies used were presenting 2-dimensional (2D) and 3-dimensional (3D) images, and showing animated videos, the aural strategies used were explaining the concepts discussed, In the read / write stage, students were asked to read and to make a brief summary of the structure and function of cell membranes. The kinesthetic strategy used that students conducted simple experiments related to the function of cell membranes. The third stage, the students were asked to fill out student worksheets, where students answered a number of questions developed based on indicators from information processing standards.

Data of learning style were reported as percentages of students in each category of learning style preference. The number of students who preferred each mode of learning was divided by the total number of responses to determine the percentage. Data of information processing skills were reported as values on a scale of 0-100, with categories for each value range 80-100 (very well), 66-79 (good), 56-65 (medium), 40-55 (poor), 0-39 (failed).

Table 2: VARK learning steps used in the structure and function of cell membranes concept

Learning Step	Activities carried out by lecturers
Visual	a. Presenting 2D and 3D images of Davson & Danielli cell membrane models and Robertson models
	b. Presenting 2D, 3D, and animation of cell membranes of the Singer & Nicolson model (fluid mosaics), and asking the students to identify the structures that make up the cell membrane
	c. Presenting images of the stages of frozen-fracturing techniques that prove the Singer & Nicolson model, then asking the students to mention the stages of the freeze-break technique.
	d. Presenting 2D images of membrane lipid structures, and asking the students to differentiate structures that cause phospholipids to be hydrophilic and hydrophobic
	e. Presenting 2D images of phospholipid movements, and asking the students to mention four types of movement of membrane lipids (flip-flops, lateral diffusion, rotation, flexion).
	f. Presenting 2D images of cholesterol molecular structure, and asking the students to identify the part of cholesterol structure and its location in phospholipids.
	g. Presenting 2D images of phospholipid membranes, and asking the students to compare the properties of unsaturated and saturated hydrocarbon chains, determining which hydrocarbon chains can cause membrane fluidity. Ask questions:

Learning Step	Activities carried out by lecturers
	1) What is the condition of phospholipids at low temperatures? 2) What is the condition of phospholipids at body temperature? 3) What structure maintains the fluidity of the cell membrane at low or high temperatures?
	h. Presenting 2D and 3D images of membrane protein structure, and asking the students to identify the structure of membrane proteins in cell membranes. Ask questions : 1) Does the protein on the membrane have the same structure? Based on the picture, how many types of membrane proteins are there? 2) Does the type of membrane protein determine the function of cell membranes? 3) Are membrane proteins amphiphatic, as is in phospholipids? 4) How do membrane proteins associate with lipid bilayers? (integral & peripheral)
	i. Presenting 2D and 3D images mixing mice hybrid cell membrane proteins with humans. Ask questions: 1) What evidence can be obtained from the experiment? 2) Can membrane proteins move in lipid bilayers? (parallel rotation diffusion, perpendicular rotation diffusion, lateral diffusion)
	j. Presenting 2D image of the membrane carbohydrate structure, and asking the students to mention the structure of any carbohydrates present in the membrane (glycolipids, glycoproteins, transmembrane proteoglycans)
	k. Presenting 2D images of asymmetric deployment of phospholipids and glycolipids, and asking the students to compare the types of phospholipids that make up the inner and outer monolayers.
	l. Asking the students to make conclusions about the structure of cell membranes that follow the fluid mosaic model. Asking the students to explain again the meaning of the word mosaic and the word fluid
	m. Asking the students to observe the permeability chart of lipid bilayers. Asking the students to identify, molecular classes that can and cannot pass through lipid bilayers.
	n. Presenting diagrams and animations of substance transport mechanisms. Ask questions : 1) What distinguishes *channel protein* and *carrier protein* ? 2) What is the difference between active and passive transport? 3) What is the difference between primary and secondary active transport?
	o. Presenting diagrams and animations of macro molecular transport through membranes. Requesting students to distinguish between endocytosis and exocytosis.
Aural	a. Explaining differences in Davson & Danielli cell membrane structures, Robertson models and Singer & Nicolson models.
	b. Explaining the structure of membrane lipids, the type of motion of lipid membranes, the fluidity of lipid bilayers.
	b. Explaining the structure of the membrane protein, the type of motion of the membrane protein, the types of membrane proteins and their function.
	c. Explaining the membrane structure of carbohydrates and the function of glycocalyx (peripheral regions outside the carbohydrate-rich membrane).
	d. Explaining the principles of active and passive transport, differences in channel and carrier protein types, differences in primary and secondary active transport, differences in endocytosis and exocytosis
Read / Write	a. Asking the students to read plasma membrane material in textbooks
	b. Asking the students to make a short resume regarding the structure and function of cell membranes
Kinesthetic	a. Asking the students to group (5 groups), and asking the students to conduct experiments related to membrane transport (diffusion and osmosis). Give problem questions: 1) How can solutes cross the cell membrane? Example in the case of soaking a

Learning Step	Activities carried out by lecturers
	piece of potato inside colored solution. Asking the students to make a hypotheses and their reasons. 2) What happens to plant cells stored in hypertonic and hypotonic environments? Asking the students tomake a hypotheses and their reasons . 3) Does the temperature have an effect on the substance content in soluble substances ?

3 RESULTS AND DISCUSSION

Twenty-two students, 4 males (18%) and 18 females (82%) completed the VARK questionnaire. The responses were tallied and assessed for learning style preference. As shown in Table 3, fourteen types of learning preferences emerged from this study. All fourteen learning styles are grouped into four categories, namely unimodal (9,09%), bimodal (40,91%), trimodal (31,82) and quadmodal (18,18%). This result indicates that most of the students prefer more than one learning style. It is understood that almost all the students belong to multimodal learning style.

Table 3: Descriptive Statistics Showing Students' Learning Style (N = 22)

VARK mode	Frequency	Percent
Unimodal		
Visual (strong)	1	4,55
Aural (mild)	1	4,55
Total	**2**	**9,09**
Multimodal		
Bimodal		
Aural & Kinesthetic (AK)	3	13,64
Aural & Read/Write (AR)	1	4,55
Aural & Visual (AV)	1	4,55
Read/Write & Aural (RA)	1	4,55
Read/Write & Kinesthetic (RK)	1	4,55
Kinesthetic & Aural (KA)	2	9,09
Total	**9**	**40,91**
Trimodal		
Aural, Read/Write & Kinesthetic (ARK)	2	9,09
Aural, Read/Write & Visual (ARV)	1	4,55
Read/Write, Kinesthetic & Aural (RKA)	2	9,09
Kinesthetic, Aural & Visual (KAV)	2	9,09
Total	**7**	**31,82**
Quadmodal		
Read/Write, Aural, Kinesthetic & Visual (RAKV)	1	4,55
Visual, Aural, Read/Write & Kinesthetic (VARK)	1	4,55
Total	**2**	**18,18**

In the bimodal learning style, from the 7 students (78%), one of their learning styles is aural. In trimodal learning styles, from the 7 students (100%), one of their learning styles is aural. In quadmodal learning styles, from the 2 students (100%), one of their learning styles is aural. thus it can be said that aural is the most dominant learning style possessed by students who attended cell biology lectures.

In conducting information processing, the students were asked to work on student worksheets consisting of six questions related to the subject matter of the structure and function of cell membranes, and it was done within twenty-five minutes. Table 4 shows the differences in students' information processing skills based on learning styles.

Based on the data in table 4, it can be seen that the first, information processing skills of students who have multimodal is better than unimodal ones, this is consistent with previous research that students will achieve the maximum benefit from a combination of approaches to learning (Dyne, Taylor, & Boulton-Lewis, 1994).

Table 4: The Differences in Students' Information Processing Skills Based on Learning Styles

VARK mode	Indicator of Information Processing Skills				Average
	A*	B*	C*	D*	
Unimodal	64	40	17	18	35
Bimodal	72	73	44	37	56
Trimodal	72	71	31	27	50
Quadmodal	70	58	8	26	41

*A : Identification of information components
*B : Interpretation of information
*C : Relevance of information / relations between information
*D : Use information to solve new things

The second, Information processing skills of the students with bimodal learning styles were better than the students with other learning styles. Although the value obtained was still in the medium category. The Third, In indicators A and B, it can be seen that values of the student with bimodal and trimodal learning styles was in good categorized. From the data obtained it is shown that learning styles have a profound impact on learning (Robertson et al., 2011).

In table 4, we can also obtain information that for 2 indicators of information processing skills, namely C and D, all students in the unimodal, bimodal, trimodal and quadmodal learning style groups had low scores. These results indicate that students have difficulty in finding the relevance of the information components they have discovered from the object being observed. Likewise in using the information that has been obtained to solve new problems.

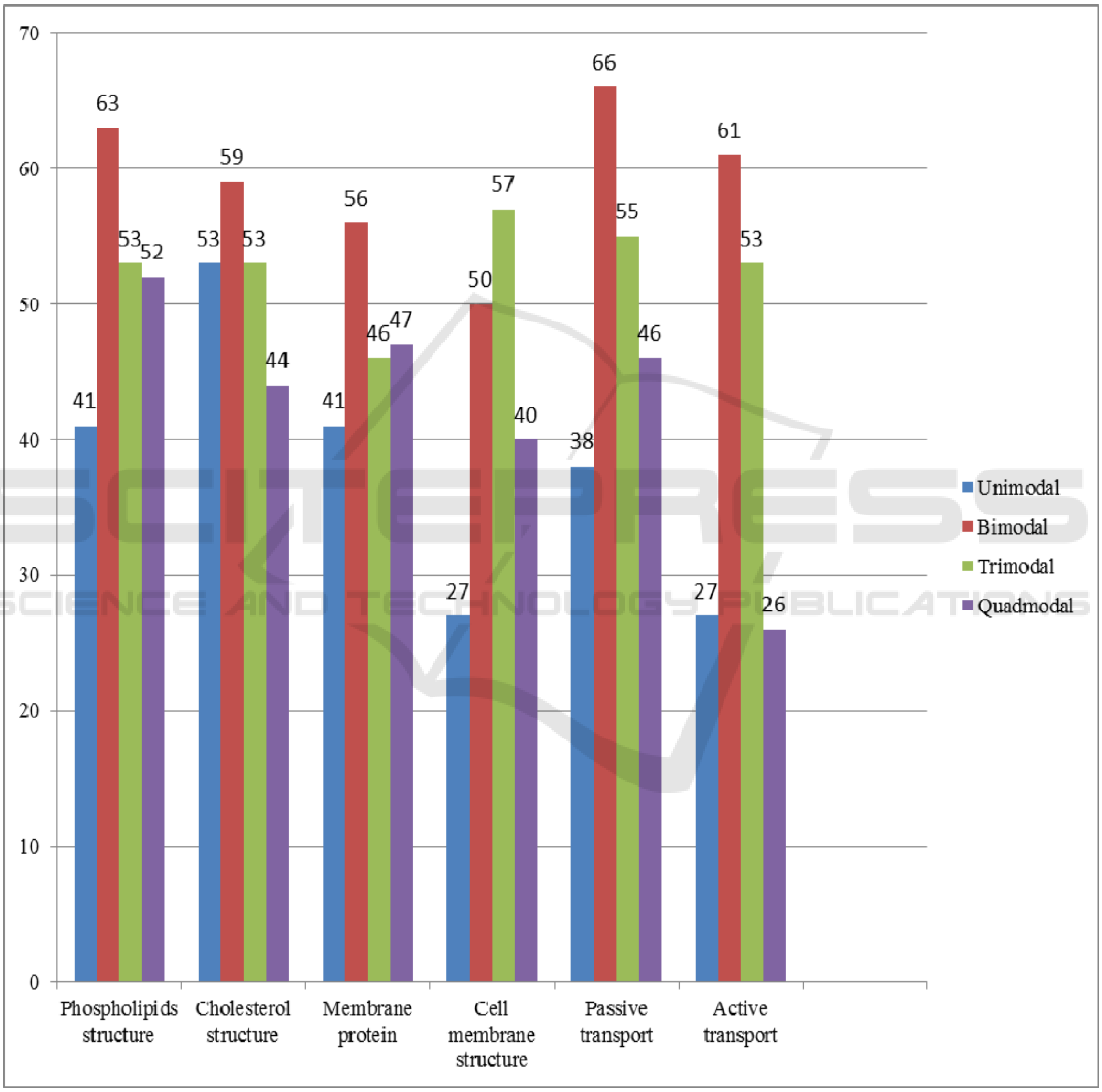

Figure 2: The Differences of Students Information Processing Skills Based on Learning Styles in Each Sub Concept.

Based on the data in Figure 2, it appears that information processing skills of the students with bimodal learning styles in five sub-concept (phospholipids stucture, cholesterol structure, membrane protein, passive transport, and active transport) were better than the students with other learning styles, except for the sub-concept of cell membrane structure, the students with trimodal learning styles were better than others.

The data in Figure 2 shows that in general students' information processing skills are still categorized as poor (40-45) and failed (0-39). The reason that is suspected to be the cause of low information processing skills is the incompatibility of the characteristics of concepts learned with student learning styles. As previously known that the most dominant learning style is aural (see Table 3), while the characteristics of the cell membrane's structure and function concept are visual. The point of visual here is that to understand the concept of cell membrane structure and function must be through image observation or animation when it relates to a process. So when students with an aural learning style are asked to process information from pictures, they will face difficulties. Thus it can be said that the cognitive system of students is burdened with tasks, as stated by Sweller that if in a learning there are tasks that burden the cognitive system of students it will cause cognitive load (Sweller, 1988). If we connect it to information processing, then when students process information related to the concept of structure and function of cell membranes, in student working memory or short-term memory (short-term memory can only accommodate seven pieces of information at a time) received excess information. There is a limit to the amount of information that students can follow and process effectively. When too much information is presented at one time, our short-term memory becomes overwhelmed and unable to process it (Luckner, 1990).

In accordance with cognitive load theory, total cognitive load consists of three components of cognitive load, namely intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL). ICL is related to the burden of processing information received (Rahmat & Hindriana, 2014). This component has simultaneous interconnections with working memory in constructing cognitive schemes (Moreno & Park, 2010). Thus information processing skills in this study can simultaneously show the ICL of students.

The results of this study indicate that even though students have been facilitated with learning that is appropriate to the learning style with VARK strategy, the ICL of students is still high; it is indicated by the value of information processing skills which is generally poor and failed categorized. ICL is a cognitive load formed due to the complexity of high teaching material and the material has a high interconnection (Sweller & Chandler, 1994).

On the subject of the structure and function of cell membranes, students are expected to be able to analyze each structure of the cell membrane components, and relate it to its function. then connect the function of each component to the function of the cell membrane. seeing the complexity of this subject matter, it is thought to be the cause of the low information processing skills.

The implication of the results of this study is that other efforts are needed to further simplify the presentation of the structure and function cell membrane concept, so that later it can more easily receive information, process, store, and recall the concepts learned in this case information processing skills can be better. Some possible strategies that can be done in learning the structure and function cell membrane concept are, the first, present a small amount of information and facilitate students to practice after each section, so that what we teach can be processed in working memory. The second is reviewing or summarizing the main points of information being studied. The third extensive practice and frequent reviews are needed after the material is first learned (Luckner, 1990).

4 CONCLUSIONS

There are fourteen learning styles grouped into four categories, namely unimodal (9,09%), bimodal (40,91%), trimodal (31,82) and quadmodal (18,18%). It is understood that almost all the students belong to multimodal learning style. Information processing skills of the students who have multimodal is better than unimodal ones. Information processing skills of the students with bimodal learning styles are better than the students with other learning styles. Information processing skills of the students with bimodal learning styles in five sub-concept (phospholipids stucture, cholesterol structure, membrane protein, passive transport, and active transport) are better than the students with other learning styles, except for the sub-concept of cell membrane structure, the students with trimodal learning styles are better than others.

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