Using Information Search Strategy to Reconstruct Students' Biology Prior Knowledge

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Abstract

This study aimed to determine changes in students' prior knowledge of preconception reconstruction results using information-seeking strategies in learning. A total of 26 student-teacher candidates at an Islamic university in Surabaya, East Java, were involved voluntarily in this survey research. At the beginning of the lecture, students take part in the pre-test, learning using information searching strategies for seven weeks, and post-test at the end of the lecture. Data analysis was performed using content analysis and t-test understanding analysis to determine changes in student preconceptions. The results showed that there were very significant differences in students' understanding of science due to conceptual changes after learning using information searching strategies. The percentage of students who maintained correct preconceptions was greater than those with incorrect preconceptions. That is what changes the preconception from false to true. The implication is that information searching can help students make decisions to maintain or change their preconceptions.

Keywords: Information Search Strategy, Conceptual Change, Prior Knowledge, Science Preconception

INTRODUCTION

The term "*tabula rasa*" in education refers to the human condition as a blank paper. Locke argues that the mind is a blank white paper that can be filled with experience (Myat & Hlaing, 2020). Experience comes from two sources, namely sensation and reflection. The sensation is a person's understanding of the outside world, while reflection is awareness of what has been done. Human knowledge comes from experiences and perceptions during life (Subhani & Osman, 2011). A person's experience is a source of knowledge. Someone who only relies on experience or factual knowledge involving the senses, including reading the web on the internet, will produce limited knowledge (Myat & Hlaing, 2020). In addition to the sensory process, knowledge can be obtained through reasoning and creative and reflective thinking. Knowledge gained through experience followed by in-depth thinking through reflective thinking will result from incomplete knowledge. Understanding is done by combining simple ideas into a complex concept. John Locke's metaphor describes the process of thinking as changing the mind from being empty to being filled. The metaphor means that students who previously did not know a particular concept became aware after the learning process. This expression also refers to the writing process, which is changing a blank page into a written page (Eddy, 2018).

Students before taking basic science lectures have studied biology from elementary to high school level in the learning process, so it is not like a blank paper. This knowledge is known as students' initial knowledge obtained through experience and the learning process. This initial knowledge can be used to obtain further knowledge (Brod et al., 2013)

The intellectual transformation of humans in the middle ages was due to empirical work. Humans do not only rely on thought and experience but also involve empirical factors. Learning that involves students doing experiments has a bigger impact when compared to reading or listening to lecturers' explanations (Wakhidah, 2016b). Nowadays, reading information to increase knowledge is easy because all information is easily accessible from the internet. The use of the internet as a source of information changes the knowledge pyramid because the internet provides all the information students need to learn to solve problems (Jennex, 2017). As a result, internet information sources determine human knowledge. Interesting features have been provided by the internet for learning and

conveying new information (Small *et al.*, 2009).

Science learning students have three possibilities, namely (1) they do not have previous knowledge so that learning provides new knowledge; (2) have correct but incomplete prior knowledge, so that learning is complementary to previous knowledge (enriching acquisition); (3) have ideas that are contrary to the concepts being studied (Ozdemir & Clark, 2007). Learning sometimes does not add new knowledge or complement incomplete knowledge but changes wrong knowledge to be true (Ozdemir & Clark, 2007).

The preliminary research results indicate that students have varied initial knowledge because they come from various high schools. Students' initial knowledge is low on bacteria and viruses, protozoa, moss, pollution, ferns, photosynthesis, digestive system, reproductive system, excretory system, respiratory system, and mutation (Wakhidah, 2016a). For example, in the respiratory system concept, students experience confusion about substances needed to breathe and substances that are released during expiration. Students are unable to distinguish between carbon dioxide and carbon monoxide. Students know the function of the transport network in plants, but in the context of life, they cannot apply it in grafting

activities (artificial vegetative reproduction). Initial knowledge needs to be constructed in the learning process so that incorrect concepts can be corrected. Learning is a process of reconstruction and construction of the initial knowledge that students have. The result is scientific concepts that students have. These concepts are essential for students as science teacher candidates. Students' understanding of these materials can be improved through basic science courses and continued with biology-based lectures.

The prior knowledge before college changed because of the information received. Initial knowledge is a learning motivator because it is related to curiosity (Wade & Kidd, 2019). The internet contains applications that can be used for various purposes (Jiang et al., 2020). Smartphones are most widely used to find information on online learning (Bezgodova et al., 2020). A person can access information quickly because of information technology. This type of information comes from news, blogs, journals, articles, research results, books, or social media. The quality of the information presented varies depending on the type of information accessed. The process of obtaining and recalling information is determined by prior knowledge, but the effect of previous knowledge researched over time is

unclear, particularly on the type of conceptual information (Chen *et al.*, 2018). Individual behavior affects changes in previous experiences. The way students access information determines the information obtained (Rodrigo *et al.*, 2013).

Everyone, including students, depends on the information available on the internet (Metzger et al., 2003). In the digital era, the use of the internet in colleges and secondary schools for learning is every day (Kuhlemeier & Hemker, 2007). The use of the internet is dominated by young people (Nelissen & Van den Bulck, 2018). Students and students as a millennial group have the potential to search for information on the internet to do Xie's assignments, find answers when discussing, and when they need information. The use of the internet to search for online assignments has been detected since 2003 (Kimber & Wyatt-Smith, 2010). Research in various countries reports that students use the internet to complete assignments (Hofer, 2004; Zhou & Xu, 2007; Tsai, 2009; Tsai, Hsu & Tsai, 2012). In the millennial era, social media has led people to gain knowledge (Leonardi, 2017). All information on the internet includes science material that requires a high level of cognitive abilities. The advancement of information technology through the internet encourages students to use it as a

learning resource to teach cognitive skills and competencies (Kabakçı et al., 2010).

An internet-based learning environment encourages the learning process (Tseng, Liang & Tsai, 2014). The information search strategy provides opportunities for students to study outside the classroom or even in cyber-space (Dewi, Muttaqin & Muftiyah, 2019). The information search strategy is expected to be more directing students in a fun and meaningful learning process following modern-day lifestyles. The results of observations made by researchers during learning, students who are bored listening to lecturers' lectures will look at cell phones. What was seen or read is not known with certainty. The learning process will be interrupted by these activities. The type of information available can be in the form of general information, the results of thoughts or reviews of a problem, and research results. The information presented can also be information that only plagiarizes other people's writings or articles to have high similarity. The internet provides information according to their needs so that it helps students during lectures and doing assignments. The learning steps with the Information search strategy are (1) dividing students into small groups; (2) Asking questions or assignments; (3) Each group has a discussion about doing the task by searching for information on

the internet; (4) Each group presents its task. Students who are induced by giving assignments can lead to greater conceptual changes than controls (Star *et al.*, 2009). Student involvement in learning can improve concept acquisition. Interaction with internet media and discussion with friends build knowledge because learning is the construction of knowledge individually and socially (Zhou, 2010). Students hold a discussion ending with a presentation that will look for answers from the internet to understand concept changes. Conceptual change refers to an organizational change from one concept to another (Abd-El-Khalick & Akerson, 2004). Students become aware that previously they did not know or changed from a previously wrong concept to a correct concept after reading information from the internet. Concept change is a process of change from preconception to conception, perhaps from conception to scientific conception (Canlas, 2021).

Giving new experiences and instructions causes a change of conceptual structures to become correct conceptual structures. This restructuring is the result of social interaction and partly due to developing students' logical structures (Ozdemir & Clark, 2007). Many researchers agree that deep cognitive engagement is integral to facilitating concept change Based on this

concept, change must be facilitated by providing a suitable learning environment in learning so that students' cognitive structure changes according to expectations, among others, by using the information search strategy. The information search strategy allows fast information retrieval in technology-based learning (Kormos et al., 2019). Internet is the fastest information technology for disseminating information. The use of the internet in the field of life has a positive effect, but the impact of the internet on human cognition, including the acquisition of knowledge, is still an open field of investigation (Firth *et al.*, 2019).

The results of survey research conducted by Asemi show that the habit of searching using the internet at Isfahan Medical University is relatively high, as many as 55% of students search for information via the internet (Asemi, 2005). The information search strategy is learning that emphasizes the ability of students to search from the internet. This understanding can also be expanded by giving lecturer assignments to students to find assignments or independent and structured learning after face-to-face learning. Students' initial knowledge of learning with information technology needs to be considered in instructional design and curriculum planning (Oyinloye & Popoola, 2013). Lecturers

need to know students' initial knowledge to plan and direct further learning (Oyinloye & Popoola, 2013). Basic science material, especially biology topics, becomes the basis for the subsequent biology-based science learning, so it is necessary to know students' conceptual development early by examining conceptual changes after using the information search strategy. The description of this change is essential for lecturers to know to plan to learn biology topics in the following semester.

This study implemented an information search strategy to help students reconstruct their initial knowledge according to scientific truth. Two main questions will be examined, namely: (1) Does the difference in student understanding as a result of the reconstruction of initial knowledge after learning using the information search strategy and (2) How many students' initial knowledge changed after learning using the information search strategy.

METHOD

In this study, we used a survey research design to determine the change in the initial concept of prospective teacher students on basic science material after participating in an information search strategy (Creswell, 2007).

Participant

A total of 26 science teacher candidate students at UIN Sunan Ampel (20 female and 6 male) were voluntarily involved as participants in this study. The student is programming a basic science course.

Instrument and Data Collection

The research data were collected using tests, questionnaires, and interviews. The test, which consists of 30 multiple choice questions, is presented in a Google form, used to determine to understand concepts before and after learning. Before being used, the questions in the test were validated by an expert. The validity of the test is calculated using a formula (Grönlund *et al.*, 2019).

$$r = \frac{\Sigma xy - (\Sigma x)(\Sigma y)}{N\sqrt{\{\Sigma x^2 - (\Sigma x)(\Sigma x)/N\}\{(\Sigma y2 - (\Sigma y)(\Sigma y)/N\}}} \quad (1)$$

Note:

r = correlation coefficient

N = the number of students who
     participated in test

X = item score

Y = total score.

The reliability of the test items was estimated using the Cronbach alpha coefficient. The way students access information on the internet and the factors that cause changes in the initial concept are identified using a questionnaire. Questionnaire in the form of Google form.

Procedure

The first meeting of the student lecture is given a pre-test. After participating in the pre-test, students take

basic science learning by using the information search strategy (introduction to lectures, group division, assigning students to search for information on the internet. The learning steps with the information search strategy are shown in Figure 1.

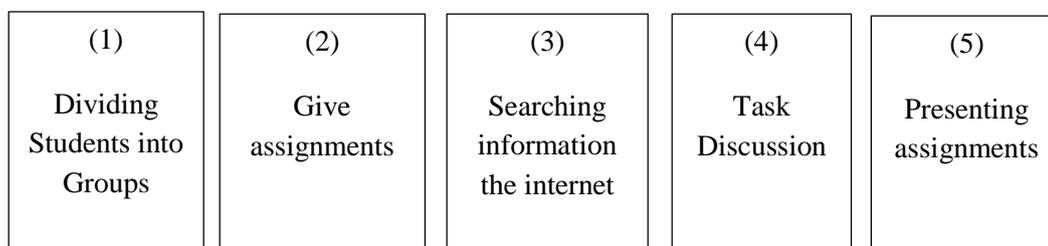| (1) Dividing Students into Groups	(2) Give assignments	(3) Searching information the internet	(4) Task Discussion	(5) Presenting assignments

Figure. 1 The stage of learning strategy of information searching

After seven meetings, students were given a post-test with the same questions as in the pre-test. Furthermore, the test results were analyzed to determine changes in the initial concept.

Data Analysis

Overall, pre-test and post-test data were compared to determine differences in understanding due to changes in initial concepts using paired t-test. Then the data were analyzed descriptively with percentages. The percentage change in concept is calculated according to the conditions shown in Table 1. The preconception change are categorized used the criteria in Table 2.

Table 1. The change orientation of students' preconception

No	Preconception change	Change the orientation of preconception	Percentage
1	False/True	Preconception changed turns into true	
2	True/False	Preconception changed turns out to wrong	
3	True/True	Preconception is maintained correctly	
4	False/False	Preconception is maintained as false	

Table 2. The category criteria of conceptual change

No	Percentage of conceptual change	Category
1	$0<p<0,25$	Low
2	$0,26<p<0,50$	Medium
3	$0,51<p<0,75$	High
4	$0,76<p<1$	Very high

RESULTS AND DISCUSSION

There is a significant difference in student understanding between before and after learning by using the information search strategy. The value of t count ($t = 6.522$) is greater than t table ($t = 2.005$). This means that the use of the information search strategy significantly reconstructs students' initial understanding due to their interactions with the environment, especially the internet. The percentage change in

students' initial knowledge is shown in Table 3.

Table 3 shows that as many as 68% of students still maintain their initial knowledge; that is, 37% (medium category) maintain their initial knowledge (preconception), which is correct, and 31% (medium category) maintain their initial knowledge, which is still incorrect. Meanwhile, as many as 32% of students changed their preconceptions, from wrong to true (24%) and from true to true (8%). Based on the percentage data, it shows that reconstructing initial knowledge (preconception) has the potential to occur even though some students try to maintain their preconception.

Change in initial knowledge (preconception) is a complex cognitive process (Walraven et al., *2008)*. Preconception changes are very dependent on the stability of the construction of knowledge in the cognitive structure. In general, the constructed preconceptions will tend to be maintained, both the actual and misconceptions, so that they can affect the following student learning process (Erman, 2017; Chen *et al.*, 2018, Chen *et al*., 2020). That is why students' preconceptions, especially misconceptions, are always recommended to be checked before students take part in learning new topics

(Alpaydin, 2017). Conceptual change strategies, such as information searches, will provide a student learning environment conducive to the cognitive reconstruction process. The internet provides a variety of information that is easily accessible and is an agent of information transfer, including science Primary school students' concept acquisition in Jordan is increasing due to pedagogic hypermedia (Ajlouni & Jaradat, 2020). Social media increases understanding of a concept, sources of knowledge, scientific communication and research references (Wehner et al., 2017; Ahmed *et al.*, 2019)

Preconception is involved in accessing, verifying, and evaluating information. Therefore, we need the right strategy and optimal lecturer assistance to help students decide whether to change or maintain their understanding of the concept. The reconstruction of the wrong understanding of the initial concept turned into a correct one. Conversely, a change in preconception from right to wrong can occur because new information obtained by students is wrong, both from the internet and from lecturers (Erman, 2017; Erman & Sari, 2019). That is why the ability to verify and evaluate information available on various social media, including the internet, is needed (Erman *et al.*, 2021).

The internet and other social media have great potential in the reconstruction of student preconceptions. Searching for internet-based information is essential in completing tasks. Lecturer information is sometimes unclear to students, so students need to find other learning sources on the internet. Information from the internet is more accessible and more diverse when compared to print media (Pattanaik & Pattanaik, 2011). Reading activities, including reading information on the internet, increase literacy and understanding (Erman *et al.*, 2021). Reading comprehension skills from the internet determines literacy (Wakhidah, 2012). Küçüközer quotes Posner, who uses Piaget's theory as saying that pre-conceptual structures assimilate new concepts (Sarioglan, 2019). Furthermore, the conceptual structure is accommodated if the concept conflicts with the new concept being learned. The information search strategy encourages assimilation, namely, changing or rearranging students' conceptions. Students have the right initial knowledge and maintain the concept after connecting with new concepts from the internet. New information can be well ordered in the brain structure if related to previous knowledge (Tse *et al.*, 2007; Tsai *et al.*, 2012; Greve *et al.*, 2019).

However, in this study, the role of the internet as an information provider has not entirely changed the human cognitive structure (Table 3), which is consistent with the statement of Draganski (Draganski *et al.*, 2004). The internet affects human cognition through three events: attention, memory/understanding, and social cognition (Firth *et al.*, 2019). The internet as a source of information influences and causes the entry of information as a new concept or assimilates existing knowledge. The assimilation process depends on the information read and how the information is in the cognitive structure. The internet is a technology that can be accessed easily and cheaply (Kane, 2017). Searching for information on the internet, including social media, can increase the acquisition of knowledge. Searching for information on the internet is sometimes ineffective because of the constant availability of information and does not always lead to the sought information (Dong & Potenza, 2015). The negative side is that much information on the internet makes students stressed, especially when they meet irrelevant information that causes psychological problems (Feroz *et al.*, 2021).

Students reconstruct their initial knowledge when they get more credible information and doubt the understanding of the initial concepts they have. Posner states that accommodation occurs when

new information makes more sense and is clearer (Lestari & Linuwih, 2014). Clearer information from the internet causes the reconstruction of initial knowledge from false to true. There are 8% of students reconstructing the correct initial knowledge to be wrong after learning. Students were confused by the concepts learned on the internet, which were confirmed through interviews (Table 4).

Table 3. Percentage of preconception change before and after science learning using information searching strategy

No	Conceptual change orientation	Percentage (%)
1	False/True	24
2	True/False	8
3	True/True	37
4	False/False	31

Table 4. Interview result whose preconceptions changed from true to false

No	Question	Pre-test Answer	Post-test Answer	Interview result
1	Algae are a group of plants with characteristics ...	Do not have roots, stems and leaves	Only has leaves	Algae have roots, stems and leaves
2	Eutrophication causes the death of aquatic organisms because water contains ...	a lot of CO_2 and a little O_2	Organic component	Contains a little O_2 (if the question is directed to O_2)
3	The relationship between mutation and evolution is ...	Natural changes cause mutations, mutations are the basis of evolution	Mutations cause evolution, natural selection is the basic ingredient of evolution	DNA change causes mutations, evolution is (cannot continue)
4	The difference between dicot and monocot vascular tissue is…	Monocots are scattered, dicots are circular	Multiples Flowers is 2, 4.5	Students couldn't answer because they were confused
5	Air enters the lungs due to ...	The air pressure in the lungs is lower than the outside air	The air pressure in the lungs is higher than the outside air	The air pressure in the lungs is higher than the outside air
6	In the process of animal reproduction ...	Meiosis in male animals produces 4 gametes, female 1 gamete	Mitosis in male animals produces 4 gametes, female 1 gamete	Students are confused about the difference between mitosis and meiosis so they cannot answer

Table 4 shows that several explanations have the potential to be correct if there is a lecturer scaffolding that leads to the correct answer. These results provide information that the concept changes from true to true because students are confused with the concepts being studied. If there is a strengthening of lecturers, students will get the correct understanding. Students look for information on surface learning to ignore the relationship between concepts such as mutation and evolution. Students understand the concept of mutation but are unable to connect the results of mutations and evolution. The search for more detailed information enhances deep learning so that students can relate concepts to one another. Deep learning improves students' ability to understand concepts (Erman *et al.*, 2021).

Before lectures, students already have biological concepts obtained from previous levels of education. Concept change occurs when students receive information and compare it with previous experience or knowledge. Previous knowledge becomes the basis for further learning. Students who get the correct understanding from previous levels of education tend to be defended. Biological concepts studied in basic science courses are biology material studied in high school so that students have basic concepts to studying biology in college. Concept change is influenced by beliefs (Gregoire, 2003). The concept that was deemed inappropriate was revised by students so that there was a change in initial knowledge. The provision of new experiences and instructions causes a change of conceptual structures to become correct conceptual structures. Concept restructuring results from social interaction and the development of logical structures (Ozdemir & Clark, 2007). Students looking for information on the internet provide experiences and interactions between students and learning resources to reconstruct their initial knowledge. Lecturers' explanations before learning directly with power points help students improve logical thinking processes before students work on assignments with the help of the internet (Hodijah et al., 2018).

Table 1 shows that as many as 8% of students changed a previous conception to wrong. The preconception change happens if students are not critical in finding, accessing, and processing information from the internet. The search for information that is not critical will be misleading (Aşkar & Mazman, 2013). Knowledge on the internet, especially social media, is limited to factual knowledge. Knowledge is presented in a

simple manner so that everyone easily understands it. The use of different keywords yields different informational information. Complex strategies lead students to improve understanding and literacy. Most students do not have good internet competence to solve problems. Engineering students find it difficult to find information relevant to tasks in a fast time (Harrison, 2009). Digital literacy determines the information search strategy on the internet (Atoy *et al.*, 2020). Students do not yet understand how to search for the correct literature on the internet (Winters, Greene & Costich, 2008; Tsai, 2009; Hinostroza *et al.*, 2018).

The questionnaire results show that students are not sure that all information on the internet is correct. All respondents (100%) stated that the information on the internet was not necessarily correct, so students had to clarify with other information. For example, information obtained from blogs needs to be compared with the research results in scientific journals. The level of accuracy of information from the internet varies depending on the type of information accessed. The information obtained depends on the search strategy (Wu & Tsai, 2007). Information search begins with searching for information on a search engine, usually Google.

The detailed search must be focusing on the search using specific keywords (Baldwin et al., 2018). Journals have higher accuracy when compared to articles. As many as 96% of respondents stated the information in journals is more valid and correct according to scientific concepts so that students often use journals as references. Sources of information that students often access through the information search strategy are shown in Figure 2.
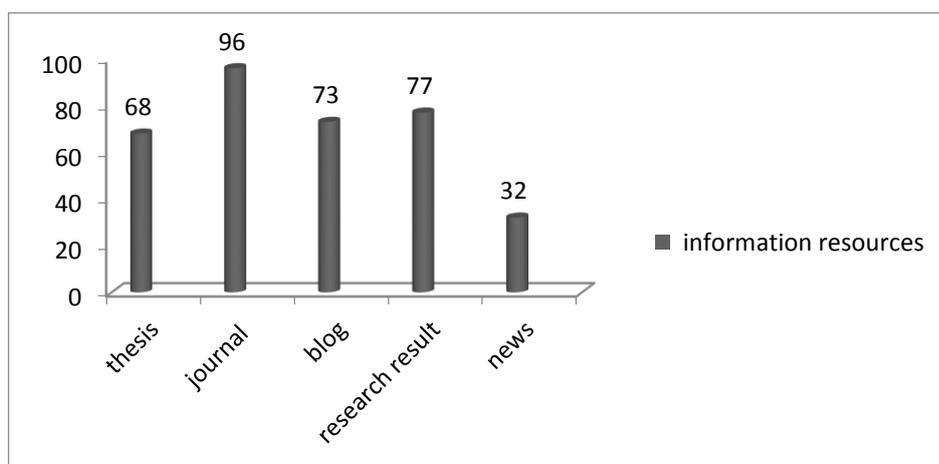

Figure. 2 Information sources that students accessed during learning

Students sometimes do not consider the reliability, validity, and relevance of the information obtained (Kurt & Emiroğlu, 2017). Based on the results of the interviews, it was easier for students to access and understand information from articles written on blogs. From Figure 1, what seems strange is the high use of blog articles as a source of information compared to theses. Students should not be guided by one source of information on the internet but must verify and evaluate the information obtained (Mason & Boldrin, 2008; Walraven et al., 2008). Students should combine information from various sources so that the information obtained from the internet is valid and according to scientific principles. The explosion of information on the internet is not directly proportional to information literacy (Bakti, 2012). Everyone can post information to the web so that the available content is not necessarily true and accurate (Marsh & Rajaram, 2019).

Students are not careful about the information they are looking for to be verified by other information. Students sometimes want convenience and comfort in finding information (Rieh & Hilligoss, 2007). Integrating online information will produce higher quality information (Zimmerman, 2008). Students state that the journal is the main source of reference for doing assignments. Journals contain information that tends to remain so that the journal is considered more accurate. Students are very competent in using social media but cannot search for information on concepts according to the demands of the curriculum (Ladbrook & Probert, 2011). Students sometimes have difficulty adjusting search terms (Tsai et al., 2012). The difficulty is the questionnaire results filled out by students that articles on blogs are preferred as sources of information rather than theses. Access to certain information requires high-speed internet access. Some journals cannot be accessed for free. Internet speed limits student access to information. Students need skills and experience to access and use information.

Student understanding is influenced by knowledge from previous levels of education or experience (Hailikari, 2009). After basic science lectures with the information search strategy, students' understanding is an initial experience for learning biological concepts in the following semester. The knowledge possessed is used to obtain further knowledge (Brod et al., 2013). According to Posner's theory, students reconstruct their knowledge if the information obtained when the information search strategy is applied four requirements. Information that makes more sense and contains clearer

concepts will cause students to change their initial concepts. Information that does not conform to scientific principles will be misleading, so the information search strategy needs to be supported by lecturers' explanations. The task of the lecturer is to provide scaffolding so that the concepts possessed by students are following scientific principles (Wakhidah, 2017). The role of lecturers in learning is still needed even though students learn from various sources.

The internet changes the structure of cognition in the brain, among others, by changing the way information is accessed (Colley & Maltby, 2008). The internet provides convenience for humans, but the internet decreases memory (Sparrow et al., 2011). Students do not remember a concept, especially a genuine concept, to search for information on the internet. In this case, the internet is seen as external memory or transactive memory. Transactive memory encourages students to look for factual and procedural information on the internet. The results of this study serve as guidelines for lecturers to determine appropriate learning strategies and plan biology materials for further learning to increase student knowledge and skills. Lecturers need to give assignments that encourage students to think according to the demands of the 21st century to combine information critically and logically from the internet

and not make the internet a second memory.

CONCLUSION

Science teaching and learning using information searching using the internet can significantly increase understanding of concepts and avoid misconceptions. As many as 63% (high category) students have a correct preconception, and only 37% (medium category) still have the wrong preconception. The majority of students maintain their correct preconception and change the preconception if it is still considered wrong. The change in students' preconception from wrong to the right was still in the low category, and even some students had a change from right to wrong. Some students (medium category) tend to maintain preconceptions, both right and wrong preconceptions. Students maintain their preconception because they hold their preconception firmly, while those who experience changes in preconception because they feel less sure about preconception and getting. The existence of new correct information or incorrect information in information searching from internet media, the role of the lecturer, and the preconceptions that students have affected the strengthening of correct preconceptions and changing wrong preconceptions to be true. For a more in-depth and detailed study, further

research is needed regarding the factors influencing students to retain their initial knowledge or turn them into correct preconceptions.

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