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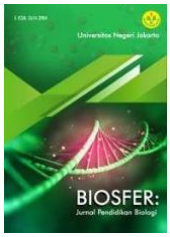

Activating students' prior knowledge of basic science concepts on animal and human system organ

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A B S T R A C T

This study aimed to analyze students' prior knowledge of basic science subjects, especially in organ systems concepts in animals and humans. This research was conducted on the lecture of Basic Science toward 46 students in Science Education class. Data were collected using a diagnostic test consisting of 12 essay questions in the first meeting before the learning process was implemented. Furthermore, findings obtained in this study were analyzed using quantitative descriptive method. Findings of the study indicated that students'prior knowledge reached a low level, with 4.8 on the average score. From out of 46 students in this study, six students reached high prior knowledge score. In contrast, 40 students reached below a high level. It can be concluded that students do not have great prior knowledge. It should be stimulated continually in every initial learning process to comprehend the new concepts during learning activities easily.

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INTRODUCTION

A teaching and learning process is a systematical activity involving everyone to learn something. It is also objective and involves an assessment to ensure students can achieve the concepts and relevant to learning objectives (Psotka, 2012). Being an educator, interactive learning environments should be provided in every comprehensive situation to learn science easily (Greener, 2012; Singh, 2014). Instructor also has to create connections and links between prior knowledge on students and new concept comprehension (Taber, 2014). As it is already stated, learning concepts are often devoid of such activities to retain their brevity and reusability in a variety of instructional processes. Students are also proved to easily learn when they can make connections from new concepts to the previous knowledge they already have before (Greener, 2012; International Labour Organization, 2013). Otherwise, educators also need to develop background knowledge to allow students to comprehend and link new information (Taylor & Whannell, 2017; Whannell et al., 2018).

Prior or background knowledge does not just relate to certain subject knowledge. It is defined as knowledge in diverse scopes, such as critical thinking, metacognitive processes, creative skills, and self-reflection. Furthermore, previous research related to prior knowledge proved that this activity is able to enhance learner retention and concept comprehension (Costley & West, 2012; Eddy, 2020). In addition, approaches such as concept-mapping, questioning, group discussion, mind-mapping, advance organizers, and debate were solutive techniques used in previous studies. Furthermore, prior knowledge can be assumed as the information or knowledge that has already known by students. This information is saved in the working memory. It can come from many activities, such as previous learning activity, reading books before coming to the class, and other experiences (Costley & West, 2012; Woolf, 2005).

Outstandingly, an educator can activate prior knowledge by starting a lesson with providing critical questions, discussing topics, and guiding students to analyze content materials. By doing so, students can enhance their sense of readiness in learning, thus being more motivated to engage in the learning process (Costley & West, 2012; Eddy, 2020; Whannell et al., 2018). Educators can also gauge the level of students' prior knowledge and use this as the establishment to prepare their learning activities and decide how it will go. It is also already explained that activating prior or background knowledge is also essential to determine whether the learner's previous information is weak, incomplete, strong enough, well-developed (Azis, 2013; Fatokun & Omenesa, 2015). Furthermore, prior knowledge influences how students analyze new information, organize the content, and understand the concepts. Remember that one of the learning outcomes is to integrate new information into the working memory. Learners apply it to assimilate new information and link them with previous knowledge (Bergman et al., 2015; Otero & Nathan, 2008; Taber, 2014).

Prior knowledge is also proved that it can influence learners to make connections for new information and apply on authentic examples. One of the ways to have greater working memory in understanding concepts is by connecting from previous and new information (Taber, 2014; Wetzels et al., 2011). The more connections, the easier it is to remember. In addition, when new information gets hooked up with a particularly rich and well-organized portion of memory, it inherits all the connections that already exist (Chen & Yang, 2017; Fatokun & Omenesa, 2015; Wetzels et al., 2011). This is why it is much easier to learn information in one's existing field of expertise than to learn information from a brand new field. When a student has nothing to hook new information to, he or she is thrown back on the most fundamental characteristics of the information such as sound, or form, or straight rote memorization(Hailikari et al., 2008; Liu et al., 2019; Özerem & Akkoyunlu, 2015).

Furthermore, using prior knowledge in instruction is useful, especially in the science learning process. Generally, science knowledge consists of plenty of concepts, principles, information, and theories in which students are used to be problematic in memorizing and

understanding that big content. Therefore, prior knowledge should be assessed in the initial learning process so educators can evaluate the students' level of prior knowledge and then learn actively and guide them during learning activities (Mccomas, 2014; Seely & Hart, 2012).

Pre-service science teachers have to master science concepts, especially concepts related to biology. Therefore, if they do so, it will be easy when they are going to teach at the class. This mastery is also related to pedagogical content knowledge, which students have to achieve as pre-service science teachers. One of the ways to reach this knowledge is by comprehending the subject matter. Furthermore, prior knowledge assessment is also needed to conduct since it can connect students' working memory from previous knowledge to new information and concepts (Diaz, 2017; Permatadewi et al., 2019; Stern, 2015).

However, during the learning process, students will find various challenges in understanding concepts. As we know, science concepts mostly represent common changeable features of objects, principles, events, ideas, thought, and activities (Otero & Nathan, 2008; Wade & Kidd, 2019). Students develop concepts at an early development when they undergo thinking and learning process (Darmawan et al., 2020; Harahap et al., 2020); however, it can trigger big problem if the concepts that they comprehend are different from scientific thoughts in which this phenomenon is referred to as misconception (Bergman et al., 2015; Fatokun & Omenesa, 2015; Whannell et al., 2018). To minimize this phenomenon, activating students' prior knowledge is necessary to be conducted in order for students are used to connect what they have taught and what they will learn since by doing activity in evaluating prior knowledge is such similar to the activity of recalling concepts and information (Costley & West, 2012). According to the previous views, this study aims at analyzing students' prior knowledge of basic science subjects, in the concepts of organ systems in animals and humans.

METHODS

Research Design

This research was conducted using a quantitative descriptive method. This research was included in quantitative descriptive since it described current conditions, used large samples, and used tests as the research instrument (Tsai & Yang, 2011). Furthermore, it also focused on information related to processes, activities, or concerns and applied statistical analysis of numerical data (Drummond & Murphey-Reyes, 2017; Lambert & Lambert, 2012). A diagnostic test was given to students to know the level and condition of students' prior knowledge of the basic science lecture. This current study relies on a test-given technique to collect data. Tests given to the students were used to evaluate the students' prior knowledge. Paper-and-pencil tests assessed the students' prior knowledge.

Population and Samples

The population in this study was 92 students in the academic year of 2017, and then the samples taken from its population were 46 students consisting of 39 girls and seven boys in the age range of 20-21. These students come from class B who learned animals and the human organ system during Basic Science lecture from a public university in Indonesia.

Instrument

A diagnostic test on the type of paper and pencil test consisting of twelve essay questions related to Animals and Human Organ System concepts were used to assess students' prior knowledge on Basic Science subjects. The test questions asked about the anatomy and physiology of animal tissues and organ systems on animals and humans. The test content outline is represented in Table 1.

Table 1
Outline of test content

Question number	Topic	Cognitive domain	Question in Bahasa (Original Version)	Translated Version
1	Animal tissue	C3	*Sebutkan dan jelaskan empat jenis jaringan pada hewan dan manusia!*	Mention and explain four types of animal tissue!
2	Skeletal system	C4	*Apa perbedaan rangka aksial dan apendikular, sebutkan rangka dan tulang apa saja yang berada pada kedua bagian tersebut.*	What are the differences between axial and appendicular skeleton? Mention the skeletal on each!
3	Muscular system	C2	*Organ apa saja yang termasuk ke dalam otot lurik dan polos?*	What organs are included in skeletal muscles and smooth muscles?
4	Digestive system	C2	*Sebutkan organ yang berperan dalam sistem pencernaan manusia!*	Please mention digestive organs in humans!
5	Respiratory system	C4	*Sebutkan dua perbedaan organ pernapasan pada pisces, aves, dan manusia!*	Please mention two differences between respiratory organs in Pisces, Aves, and humans!
6	Circulatory system	C3	*Bagaimana mekanisme peredaran darah pada manusia?*	Explain the mechanism of human circulatory system!
7	Sense organ	C2	*Organ apa sajakah yang termasuk ke dalam panca indera?*	Mention sense organs in humans and animals!
8	Central nervous system	C4	*Gambarkan struktur dari system saraf pusat!*	Please draw the structure of central nervous system!
9	Peripheral nervous system	C3	*Sebutkan dan jelaskan pembagian sistem saraf tepi!*	Mention and explain the division of the peripheral nervous system!
10	Urinary system	C3	*Sebutkan struktur organ ginjal yang berperan dalam sistem ekskresi manusia!*	Mention the structure of kidney in humans!
11	Female reproductive system	C4	*Gambarkan proses oogenesis pada manusia!*	Make a picture that represents the oogenesis mechanism!
12	Male reproductive system	C4	*Buatlah gambar yang menjelaskan proses spermatogenesis pada manusia!*	Make a figure which explains the mechanism of spermatogenesis!

Procedure

A single class consisted of 46 students who learn Basic Science lectures was the subject of this study. Basic Science is one of the lectures that students have to take in the academic year of 2017. Furthermore, students learn all concepts related to concepts in Science (Physics, Chemistry, and Biology) during this lecture. On the concepts of Biology, students have to master comprehension about several topics, for instance, structure and physiology of the cell, tissue, organ, and organ system.

A diagnostic test consisting of twelve essay questions related to the lecture was given in the initial learning to know the level of students' prior knowledge. The questions on the test asked about anatomy and physiology of animal tissues, which was represented on question number 1, skeletal and muscular system on question number 2 and 3, digestive system on question number 4, respiratory system on question number 5, circulatory system on question number 6, sense organ on question number 7, nervous system on question number 8 and 9, urinary system on question number 10, and reproductive system on question number 11 and 12. One of the questions asked about, "please mention two differences between respiratory organs in Pisces, Aves, and human."

The test has been validated and reviewed by two lecturers before given to students. Validation asked about the aspect of content in the instrument. This validation results revealed that the test instrument could be used to assess the student's prior knowledge. Furthermore, the test instrument was shared with all students in the first meeting of this lecture. Students filled out the test instrument for 40 minutes individually.

Data Analysis Techniques

Data collected in this study were analyzed quantitatively descriptively. Data on students' prior knowledge were collected from paper-and-pencil tests. Student's scores were counted using the following formula:

$$\text{Score} = \frac{\sum \text{true answers}}{\Sigma \text{ total of all questions}} \; x \; 10$$

Then, the scores obtained were categorized using the criteria below in Table 2 (Ferlazzo & Sypnieski, 2018; Seely & Hart, 2012).

Table 2
Criteria of Prior Knowledge Score

Interval	Category
8.1 – 10	Very high
6.6 – 8.0	High
5.6 – 6.5	Moderate
4.1 – 5.5	Low
0 – 4.0	Very low

RESULTS AND DISCUSSION

In this study, the students' prior knowledge was assessed by a paper-and-pencil test. The students' prior knowledge level can be shown in Table 3; meanwhile, the percentage of students' scores based on its criteria was figured out in the diagram in Figure 1.

Table 3
Student's Prior Knowledge Level

Students	Score	Criteria
B045	2.5	Very low
B046	4.2	Low
B047	4.2	Low
B048	4.2	Low
B049	4.2	Low
B050	5.0	Low
B051	7.5	High
B052	5.0	Low
B053	5.8	Moderate
B054	5.0	Low
B055	7.5	High
B056	5.8	Moderate
B057	5.0	Low
B058	7.5	High
B059	4.2	Low
B060	5.0	Low
B061	4.2	Low
B062	4.2	Low

Students	Score	Criteria
B063	4.2	Low
B064	3.3	Very low
B065	5.8	Moderate
B066	5.8	Moderate
B067	4.2	Low
B068	5.8	Moderate
B069	4.2	Low
B070	2.5	Very low
B071	4.2	Low
B072	5.0	Low
B074	4.2	Low
B075	3.3	Very low
B076	5.8	Moderate
B077	4.2	Low
B078	4.2	Low
B079	6.7	High
B080	4.2	Low
B081	5.8	Moderate
B082	3.3	Very low
B083	7.5	High
B084	4.2	Low
B085	5.8	Moderate
B086	3.3	Very low
B087	5.8	Moderate
B088	1.7	Very low
B089	5.0	Low
B090	6.7	High
B091	3.3	Very low
Average	**4.8**	**Low**

According to the findings in Table 3, it can be assumed that students' prior knowledge reached a low level, showing 4.8 on the average of a score. It also can be seen that most students reached a low level which means that students' prior knowledge related to concepts of organ system on animals and human still have to be enhanced gradually. It can also be seen from findings in Table 3 that six students reached high prior knowledge score from out of 46 students in this study. In contrast, 40 students reached below a high level. Meanwhile, if this data was represented in the percentage shown in Figure 1, 50% of students in this class reached a low level of prior knowledge. Furthermore, 20% of students got a moderate level, 17% of students reached a very low level, and 13% of students from out of 46 students had a high level of prior knowledge.

According to findings that were figured out in Table 3 and Figure 1, it can be assumed that the learners' prior knowledge was still needed to be enhanced through several meaningful activities. Therefore, various interactive learning situations have to be implemented to enhance students' comprehension, especially on Biology topics.

Data on students' prior knowledge, which was on very low level showed that some students could not answer the questions correctly, especially on questions number 8, 9, 11, and 12, which were questioned about the nervous system and reproductive system. Some students did not fill out the essay tests, so that they got a low score. Mostly students argued that those two topics are complicated topics that are difficult to remember and comprehend. Therefore, students are not easy to answer the questions on the test.

Based on the observation during this study, students also did not get ready on finishing the prior knowledge assessment since this assessment was taken in the first meeting in the class. Students argued that they did not prepare the material before coming to the class since they thought that the first meeting would be simple without any assessment activity. This phenomenon was used to occur in the class among every learner; therefore, prior knowledge assessment should be conducted to know and check whether students are already prepared to learn or not.

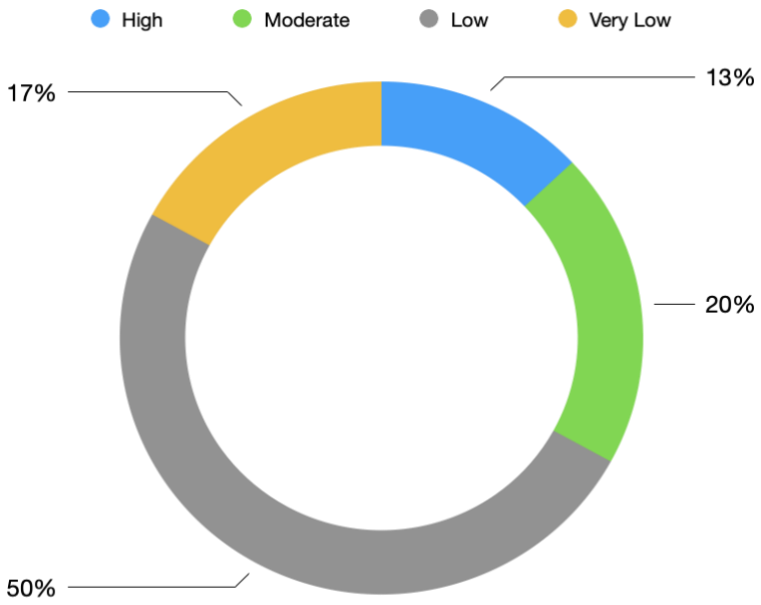

Figure 1. Number of Students' Score on Percentage

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It has been proved that students' prior knowledge is affected by learning experiences, concept comprehension, and social customs (Bergman et al., 2015; Fatokun & Omenesa, 2015). Background knowledge also plays an essential role in a student's understanding of the new concept in which it affects learners' retention and later application (Ferlazzo & Sypnieski, 2018; Wade & Kidd, 2019). Prior or background knowledge is defined as a knowledge that students use to define, analyze, and attain. By activating students' background knowledge, all information and knowledge are ready to be applied, used to analyze problems, stimulate questions, and decide conclusions (Stern, 2015; Taber, 2014).

Activating prior knowledge can be completed through group discussion, class debate, question and answer, and learning strategies such as concept mapping, mind mapping, and underlining important concepts. By doing so, students are capable to enhance their sense and learning motivation and more actively engage in the learning processes (Diaz, 2017; Permatadewi et al., 2019; Zeng et al., 2020). Furthermore, prior knowledge can be evaluated first before starting the learning activity to know whether students are ready to learn or not. Educators can gauge students' prior knowledge level and use it to prepare their instruction and decide learning methods that they will use (Mccomas, 2014; Seely & Hart, 2012). It is important to activate prior or background knowledge in learning process. Besides, it is also essential for stimulating prior knowledge to determine whether the learner's previous knowledge is low, weak, incomplete, or based on any misconception. Prior knowledge also affects how a student organizes new information (Fernández & Morris, 2018; Otero & Nathan, 2008; Wetzels et al., 2011). Furthermore, it also correlates in the learning outcomes goal in which learners can incorporate new information into the existing organization of memory (Mccomas, 2014; Özerem & Akkoyunlu, 2015; Seely & Hart, 2012).

However, it is also found that other external factors are presumed to be the cause of the lack of understanding of science concepts besides internal factors on students. The learning environment also affects learners' understanding of the basic concepts (Bahtiar & Dukomalamo, 2019; Chen & Yang, 2017; Wetzels et al., 2011). Nevertheless, many factors also affect the success of learning apart from the lack of understanding of the concept and how the educators explain concepts (Trilipi et al., 2019). Prior knowledge learners also impacts on learning outcomes, because prior knowledge is the beginning of knowledge and initial learners' abilities in the learning process. Some research findings suggest that the level of prior knowledge and cognitive styles influence on the process of how students apply this knowledge in daily life (Taylor & Whannell, 2017; Trzcieliński, 2019; Turşucu et al., 2020).

When students reach new information, it links to working memorization in which the previous knowledge is stored (Hailikari et al., 2008; Liu et al., 2019; Özerem & Akkoyunlu, 2015). Furthermore, using prior knowledge in instruction is useful, especially in the science learning process. Generally, science knowledge consists of plenty of concepts, principles, information, and theories in which students are used to be difficult in memorizing and understanding that big content. Therefore, prior knowledge should be assessed in the initial learning process, so teachers can develop the students' prior knowledge and guide them to be active users during learning activities (Mccomas, 2014; Seely & Hart, 2012).

Also, learners can be easily to comprehend such new knowledge is whether they already had prior knowledge or not. Its successful also comes whether learners can connect the previous information and new information or not. Prior knowledge is stated as the knowledge and abilities that a learner already had before in which it can link and relate to the new information (Chen & Yang, 2017). Meanwhile, it can be also defined as an existing knowledge, knowledge about the world, knowledge abilities, and background knowledge. It has been proved that learners who have background knowledge can better understand new concepts than the groups that do not have prior knowledge. Therefore, prior knowledge suggests that conceptual understanding and application will depend on the relationship between background knowledge and new knowledge(Trzcieliński, 2019; Turşucu et al., 2020).

Furthermore, using prior knowledge activity, such as assessing this in a learning process, is advantageous, especially in the science learning process(Liu et al., 2019; Mccomas, 2014). Since, as we know, science knowledge consists of big concepts, principles, information, and activities in which students are used to be difficult in memorizing and understanding that big content(Chen & Yang, 2017; Eddy, 2020; Fatokun & Omenesa, 2015). Pre-service science teachers also have to master science concepts, especially concepts related to biology. Therefore, if they do so, it will be easy when they are going to teach at the class. This mastery is also related

to pedagogical content knowledge, which students have to achieve as pre-service science teachers. One of the ways to reach this knowledge is by comprehending the subject matter. Furthermore, prior knowledge assessment is also needed to conduct since it can connect students' working memory from previous knowledge to new information and concepts (Diaz, 2017; Permatadewi et al., 2019; Stern, 2015). To sum up, prior knowledge should be assessed in the initial learning process so educators can measure the students' level of prior knowledge and guide them during learning activities.

CONCLUSION

This study aimed to analysing student's prior knowledge of basic science subjects, especially in the concepts of organ systems in animals and humans. Students' prior knowledge has to be activated since it can affect on the process of how easily students make connections for new information. According to the findings obtained in this current study, it can be concluded that students' prior knowledge of basic science lecture reached on low level with 4.8 on average. Therefore, students' prior knowledge has to be stimulated continually in every initial learning process in order for students to comprehend the new concepts during learning activities.

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